



AGSE 2009

F.-J. Behr · D. Schröder · A. P. Pradeepkumar

TAKING THE BENEFITS OF
GEOGRAPHIC INFORMATION TECHNOLOGIES

Applied Geoinformatics for Society and Environment

2nd International Summer School and Conference

Stuttgart University of Applied Sciences
Stuttgart Active Alumni Group



HOCHSCHULE FÜR UNIVERSITY OF
TECHNIK STUTTGART APPLIED SCIENCES

Franz-Josef Behr, Dietrich Schröder,
Anakkathil Purushothaman Pradeepkumar (Editors)

Applied Geoinformatics for Society and Environment

AGSE 2009

Publications of the

Stuttgart University of Applied Sciences
Hochschule für Technik Stuttgart

Volume 103 (2009)

ISBN 978-3-940670-13-7

Publications of the Stuttgart University of Applied Sciences, Hochschule für Technik Stuttgart

Volume 103 (2009)

ISBN 978-3-940670-13-7

Conference Web Site. <http://applied-geoinformatics.org/>

Authors retain copyright over their work, while allowing the conference to place their unpublished work under a Creative Commons Attribution License, which allows others to freely access, use, and share the work, with an acknowledgement of the work's authorship and its initial presentation at this conference.

Authors have the sole responsibility concerning all material included in their contribution.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Cover Design: Christian Schmidt

Typesetting: A. Shamila Jayasekare

Printing and Binding: Druckerei Walter Stolz, Kirchheim, Germany

Program Committee

Chair: Prof. Dr. Franz-Josef Behr, Stuttgart University of Applied Sciences

Members:

Prof. Dr. Dietrich Schröder, Stuttgart University of Applied Sciences

Dr. Anakkathil Purushothaman Pradeepkumar, Dept of Geology, University College, Trivandrum, Kerala, India

Prof. Dr. Michael Hahn, Stuttgart University of Applied Sciences

Local Organizing Committee

Prof. Dr. Franz-Josef Behr, Mirka Zimmermann M. Sc., Christian Schmidt B. Eng. and the staff members of the Faculty of Geomatics, Computer Science and Mathematics, Stuttgart University of Applied Sciences, Beate Baur, Ortrud Dold, Hildegard Gooss, Roland Hahn, Ulrich Haupter, Jörg Hepperle, Alexander Krämer, and Ulrich Walter.

Reviewers

The organizers would like to thank the following reviewers for their efforts to improve the quality of the symposium and the proceedings;

Dr. A. P. Pradeepkumar, Dept of Geology, Government College, Kottayam, India

Prof. Dr. Franz-Josef Behr, Stuttgart University of Applied Sciences

Prof. Dr. Volker Coors, Stuttgart University of Applied Sciences

Hala Adel Effat, National Authority for Remote Sensing and Space Sciences

Farid Ziya Gulmaliyev, National Aerospace Agency, Baku, Azerbaijan

Prof. Dr. Michael Hahn, Stuttgart University of Applied Sciences

Dr. Mohamed Nagib Hegazy, National Authority for Remote Sensing, Egypt

Halvithana A. G Jayathiss, Institute of Geosciences, University of Tuebingen

Prof. Rainer Kettemann, Stuttgart University of Applied Sciences

Alvand Miraliakbari, Stuttgart University of Applied Sciences

Florian Moder, RSS GmbH, Munich

Anthonia I Onyehialam, School of Geography, Politics and Sociology, Newcastle University

Kathrin Poser, Geoforschungszentrum Potsdam

Dr. Biswajeet Pradhan, Institute for Cartography, Dresden University of Technology

Prof. Dr. Paul Rawiel, Stuttgart University of Applied Sciences

Prof. Dr. Dietrich Schröder, Stuttgart University of Applied Sciences

Claudia Schulte, Stuttgart University of Applied Sciences

Detlev Wagner, Stuttgart University of Applied Sciences

Mirka Rodriguez de Zimmermann, Stuttgart University of Applied Sciences

Table of Contents

Environmental Issues, Sustainable Development, Millennium Development Goals

Monitoring Developments in Irrigation Network - A Quad ‘S’ Approach	3
<i>Muhammad Farooq</i>	
Development of a CityGML ADE for dynamic 3D flood information	10
<i>Claudia Schulte and Volker Coors</i>	
Cartographic Modeling and Multi Criteria Evaluation for Exploring the Potentials for Tourism Development in the Suez Governorate, Egypt	11
<i>Hala Effat and M.N.Hegazy</i>	
Modeling Land Collapse Hazard using remotely sensed Data and GIS in the Egyptian Terrain.....	19
<i>Mohamed Nagib Hegazy and Hala Effat</i>	
Location Optimization of Wastewater Treatment Plants using GIS: A Case Study in Upper Mahaweli Catchment, Sri Lanka.....	20
<i>E.A.S.K.Ratnapriya and Ranjith Premalal De Silva</i>	
Drought Risk Assessment using Remote Sensing and GIS to alleviate poverty: A case study of the Oshikoto region in Namibia	26
<i>Frans Carel Persendt</i>	
Strategic and Operational Asset Management for a Water Distribution System.....	27
<i>Yolla Alasma</i>	
Impact of Rainfall and Vegetation on Reservoir Capacity and Identification of Erosion Prone Area Using GIS & RS.....	28
<i>Mahboob Alam and Mohsin Jamil</i>	
Deformation Analysis of a Landslide using Continuum Mechanics and Interpolation Methods.....	35
<i>Paul Rawiel</i>	
Identification and Mapping of Spatial Distribution of Floating Aquatic Plants in Tanks Using Remote Sensing and GIS.....	36
<i>S. R. Wadduwage, S. Sivanandarajha and J. Gunatilake</i>	
Surveying Tourism potential for sustainable development in Bolivia: Case Study “Represa de la Angostura”	43
<i>Mirka Rodríguez de Zimmermann</i>	
Development of an Administration-Wide Geographical Information System for Agricultural Applications	44
<i>S. Brand, M. Schulz, Aitana Zambrana</i>	
Solar Panel Calculation.....	48
<i>Md. Nazmul Alam</i>	
Online GIS to Assess and Evaluate Distributions of Fresh and Brackish Waters Fish Species in AFRICA.....	49
<i>Rainer Zaiss</i>	

Photogrammetry, Earth Observation Systems, Information Extraction

Hot Spot Detection and Monitoring Using Modis and NOAA AVHRR Images for Wild Fire Emergency Preparedness.....	53
<i>Biswajeet Pradhan</i>	

High quality DTM and DSM point clouds by advanced image matching of aerial imagery	62
<i>Eberhard Gülch</i>	
Effective Flood Monitoring System Using GIS Tools and Remote Sensing Data.....	63
<i>Biswajeet Pradhan</i>	
The Provision of Digital Orthophoto Maps in Colour for Land Use Planning and Management Under the Land Administration Project in Ghana.....	72
<i>Godwin Yeboah</i>	
Color Characterization for Aerial Cameras.....	80
<i>Susanne Scholz</i>	
Creating Cadastral Maps in Rural and Urban Areas of Using High Resolution Satellite Imagery	89
<i>M. Alkan and M.A. Marangoz</i>	
A Region Based Approach to Image Classification.....	96
<i>Lonesome M. Malambo</i>	
Historical Documentation in San Agustin (Huila), Colombia, World Historical Heritage Using Close Range Photogrammetry Techniques: A Case Study of the Statue "Triangular Face"	101
<i>W. Barragán, A. Campos and J. J. Martínez</i>	
Terrasar-X's Digital Surface Model Generation by SAR Interferometry	107
<i>Ahmad Sanusi bin Che Cob and Mohamad Halmi bin Kamaruddin</i>	
Aerial Survey with a Gyrocopter.....	108
<i>A. Miraliakbari, M. Hahn and J. Engels</i>	
Recent Trends in Photogrammetry.....	115
<i>Josef Braun</i>	
Spatial Data Infrastructures, E-Cadastre	
Determining Spatio-Temporal Requirement for a Cadastral Temporal Geographic Information System (TGIS) of Turkey	119
<i>M. Alkan and C. Cömert</i>	
Registration Database for Surveying and Land Management Companies in Mongolia.....	128
<i>Tserensangi Dashzevge</i>	
Current Status and Challenges in Establishing Nsdi in Vietnam	133
<i>Hang Tran Minh</i>	
Monitoring and Mapping of Mining and Exploration Licenses for Mongolia.....	139
<i>Jamsranjav Munkhbileg.....</i>	
Nationwide Spatial Base Data Acquisition and Provision Implementation Process in Developing Countries under the Aspect of Data Actuality and Quality	144
<i>Claudia Specht-Mohl</i>	
Development of a GIS Application in Purpose of Land Valuation and Fee Collection in Mongolia.....	145
<i>Altantsetseg Purevsuren</i>	
Getting Returns on Investment on Digital Geospatial Data	147
<i>Hardy Lehmkuhler</i>	
Spatial-Temporal Modelling in Projects Monitoring and Evaluation	148
<i>Laura Nibladze</i>	

Implementation of E-Cadastre in Malaysia.....	157
<i>Latib Mohd Rozi</i>	
The Potential of Using the Earth Gravitational Potential Model Egm2008 for Geo-Informatics Applications in Sri Lanka.....	162
<i>P. G. V. Abeyratne</i>	
Geographical Names for Cartographic Purposes in Morocco	163
<i>Faquiri Meryem</i>	
Internet based Applications, Open Source Solutions	
Irrigation Infrastructure Information Management System (IIIMS)	167
<i>H. Gadain and G V. Sanya</i>	
Suas Mapserv - An Open Source Framework for Extended Web Map and Community Services.....	177
<i>H. Li and F.-J. Behr</i>	
Mashups: The synergistic approach for melting data and services	185
<i>Franz-Josef Behr</i>	
Publication of Energy Consumption Data of Scharnhäuser Park via Web GIS	186
<i>M. Z. H. Siddiquee, A. Strzalka and U. Eicker</i>	
Openaddresses - Free Geocoded Street Addresses.....	191
<i>Hans-Jörg Stark</i>	
XML-Based and Other Georelated Encodings: Overview of Main Existing Geocoding Formats.....	196
<i>Detlev Wagner , Rita Zlotnikova and Franz-Josef Behr</i>	
Open Source GIS in Cadastral Geospatial Data Bank Development of Coastal Zone, Border Zone, Small Island and Specific Region (WP3WT) in Indonesia	203
<i>Asep Yusup Saptari</i>	
Openstreetmap and Openlayers: Open Geodata in an Open Source Map Browser.....	211
<i>Franz-Josef Behr</i>	
Web GIS Based 3D Visualization of Geospatial Data	212
<i>H A Nalani</i>	
Quicker Communication of Disasters With SDI and newer XML Protocols: A Disaster Management Model for Kerala, India.....	216
<i>A.P.Pradeepkumar and Riju Stephen</i>	
uDig – An Overview of Open Source Desktop GIS Application.....	224
<i>Sandra Tress and Abdurasyid Moestofa</i>	
LiDAR Data Analysis	
3D Navigation Systems Based on Synthetic Texturing.....	227
<i>Behnam Alizadehashrafi, Alias Abdul Rahman, Volker Coors ^c and Thorsten Schulz</i>	
Two Representative Projects on LiDAR Processing in China	235
<i>Qi Wenjuan</i>	
High-Quality Range Image Registration on Complex 3D Shapes Combining Local and Global Spatial Information.....	242
<i>Hongwei Zheng and Dietmar Saupe</i>	

LiDAR Data Visualization Using IDL and Envi Image Processing and Analysis Routines for the Campus Area of University of Calgary	243
<i>N. I. Abd El Hamed</i>	
LiDAR Technologies for Effective Watershed Modeling and Hurricane Disaster Management	249
<i>M. Taner Aktas</i>	
Alumni Session: Experiences and Business Development	
Entrepreneurship in Geoinformatics: Deploying Technologies over Opportunities	253
<i>Sajid Pareeth</i>	
Geospatial Technology Trend: Extracting Reality of Developing World	254
<i>Satyendra Singh Yadav</i>	
Some Experiences after Graduation from HfT	255
<i>Godwin Yeboah</i>	
Geo-Informatics in Sri Lanka	260
<i>V. P. A. Weerasinghe</i>	
Endeavours after MPG Graduation	265
<i>Naomi E. W. Litaay</i>	
Disaster and Risk Management, Flood Modelling, Hazard Prevention	
Remote Sensing and GIS in Flood Risk and Vulnerability Assessment: Towards Conceptual and Methodological Approaches	269
<i>D. C. Roy and T. Blaschke</i>	
Geological Structures in GIS Based Landslide Hazard Zonation	276
<i>Gamini Jayathissa, Dietrich Schröder^b and Edwin Fecker</i>	
Managing Floods in the Kano Plains Using GIS	284
<i>Charles O. Gaya, M.K. Gachari and J.M.Gathenya</i>	
Usefulness of Addressable Radio in Emergency Disaster Preparedness for COX'S Bazar in Bangladesh	290
<i>A. B. A. Imtiaz and Z. H. Siddiquee</i>	
Risk Management Challenges in El Salvador: Case Study of Comasagua and Puerto de la Libertad	300
<i>Metzi Aguilar</i>	
Key Notes	
Globalization and the Internationalization of Education	303
<i>A. P. Pradeepkumar^a and F-J. Behr</i>	
Workshop on Free and Open Source Desktop GIS	304
<i>Dietrich Schröder</i>	
Fundamentals and Techniques of Social Network Analysis	305
<i>Kai Holschuh</i>	
Oil and Gas Extraction in the Niger Delta Region of Nigeria: The Social and Environmental Challenges	306
<i>Osayande Omokaro</i>	
Uniform Geo-Data Infrastructures (GDI) Challenges for the Information Society	307
<i>Matthias Moeller</i>	

Preface

Geoinformatics has grown from a routine data manipulation tool to a sophisticated suite of programs capable of providing plausible solutions to problems of development. Newer GIS endeavours seek to break free of the proprietary mould and take a participatory approach to development. This is in the true spirit of science breaking down barriers of affluence and technologies and making it accessible across the world. The papers presented at the Second Applied Geoinformatics for Society and Environment (AGSE) summer school-cum-seminar and included in this proceedings volume reflect this underlying theme of development, but also does not ignore the fact that the Web 2.0 environment has GIS as its corner stone and that technological innovations in GIS match those in other Web 2.0 applications.

The papers cover scientific and application oriented tracks classed into seven broad themes of current relevance to geoinformatics, viz., (1) Environmental issues, sustainable development, millennium development goals, (2) Photogrammetry, earth observation systems, information extraction, (3) Spatial data infrastructures, E-Cadastre, (4) Internet-based applications, Open Source solutions (5) LiDAR data analysis and 3D visualisation, (6) Alumni experiences and business development and (7) Disaster and risk management, flood modelling, hazard prevention.

The international flavour of the participants and the alumni of the department as well as the application and scope of GIS and related technologies across the world are revealed by the fact that the papers in this volume have originated from over 17 countries, spanning the globe from Indonesia to El Salvador and from Canada to Sri Lanka. Papers focusing on pressing socio-economic issues in developing nations like developing irrigation and other water distribution networks, dynamic 3D flood information systems and identification of erosion prone areas, drought risk assessment for poverty alleviation in Africa, locating wastewater treatment plants, land collapse hazard modelling and hazard zonation share space with cutting edge technology papers on mashups, aerial surveys with Gyrocopter, Web GIS based 3D visualization, and applications of the latest LiDAR technologies in 3D Building Model Reconstruction, Watershed Modeling and Hurricane Disaster Management, and LiDAR data visualization. The papers on alumni experiences and entrepreneurship in Geoinformatics hold interest to the students with a business interest and innovative spirit.

Tutorial style papers and cookbooks on geospatial visual analysis, geo-mashups, cityGML, acquisition of spatial data with terrestrial, airborne and mobile laserscanning, social networking in international contexts, setting up WMS/WFS servers, GPS data collection and GIS data integration, and Open Source GIS are included in the volume, adding to its value as a pedagogic resource.


This Second Applied Geoinformatics for Society and Environment (AGSE) summer school-cum-seminar takes forward an idea that germinated in late 2007, for a renewed internationalization effort in the Hochschule fur Technik Stuttgart (Stuttgart University of Applied Sciences – SUAS), with a commitment to ‘collaborative science for the betterment of society and environment’. A proposal for establishing a continuing series of summer schools-cum-seminars, rooted in the concept of knowledge sharing across boundaries and barriers, and with the active collaboration of the alumni of this university under the aegis of Stuttgart Active Alumni Group (SAAG) was suggested by Prof. Dr. Franz-Josef Behr of the Department of Geomatics, Computer Science and Mathematics. The first of the series was held in the city of Trivandrum, capital of the southernmost state of India, Kerala from October 28 to 30, 2008 on the theme of ‘WebGIS and Ecoinformatics’. The success of that program, funded by DAAD and other German agencies, and supported and jointly hosted by the Indian Institute of Information Technology and Management – Kerala and the Department of Geology, Government College, Kottayam, Kerala, lead naturally to the organization of this second summer school of the series.

The overall scope of this series of conferences is to offer an interdisciplinary, international forum for sharing knowledge about the application of Geoinformatics with a focus on developing countries, and simultaneously

evolving a new conceptual framework for collaboration across nations. This will be achieved by continuing this series of summer schools and conferences through the next years, supported through a planned online journal.

The conference would not have been possible without the collaboration and support of different people and organizations. The editors would like to express their gratitude to the Faculty of Geomatics, Computer Science and Mathematics, Stuttgart University of Applied Sciences, especially Beate Baur, Ortrud Dold, Hildegard Gooss, Roland Hahn, Ulrich Haupter, Jörg Hepperle, Alexander Krämer, and Ulrich Walter. The support of all sponsors (see website), especially the Federal Ministry for Economic Cooperation and Development (BMZ) and the German Academic Exchange Service (DAAD), the Deutscher Verein für Vermessungswesen e.V. and INPHO GmbH, is gratefully acknowledged. Special thanks to Mirka Rodriguez de Zimmermann for her proactive and dedicated management of the organisational issues and for keeping the contact to the participants. A. Shamila Jayasekare has done a great work while formatting and typesetting the submissions.

As 2009 coincides with the 10th anniversary of the international Master's course program in Photogrammetry and Geoinformatics it is a special honor for the Stuttgart University of Applied Sciences to invite the more than 200 alumni to meet again in Stuttgart and to share their experiences after graduating.



Prof. Dr. F.-J. Behr, Alumni Representative
Stuttgart University of Applied Sciences



Dr. A. P. Pradeepkumar, Representative
STUTTGART Active Alumni Group
(SAAG)



Prof. Dr. D. Schröder, Director Master's Degree Course
Photogrammetry and Geoinformatics

**Environmental Issues, Sustainable Development,
Millennium Development Goals**

MONITORING DEVELOPMENTS IN IRRIGATION NETWORK - A QUAD 'S' APPROACH

Muhammad Farooq

Space Application and Research Center, Pakistan Space and Upper Atmosphere Research Commission
(SUPARCO)
Sector A-3, Phase V, Hayatabad, Peshawar-25000, Pakistan
alfarooq74@yahoo.com

KEYWORDS:

Remote Sensing, SPOT, GIS, GSM, GPRS, Irrigation Network, iPAQ

ABSTRACT

Surface water is the main source for agricultural activities in Pakistan. Further, surface water resources are depleting day-by-day due to varied causes, possibly including global climate changes, resulting in scarcity of water available for agricultural activities. The water scarcity can be mitigated if water resources are utilized properly. This can be done in two ways. First, water channels should be lined in order to minimize losses, and second irrigation should be on crop-need basis. Also water can be conserved if crop pattern is practiced. Pakistan has the world's largest irrigation system which comprises rivers, dam reservoirs, barrages, canals, distributaries, branches, minors and watercourses. The watercourses run through the agriculture fields and act as the ultimate source of water to the field crops. Most of the watercourses in the entire irrigation network in Pakistan are unlined resulting in enormous loss of water due to seepage. A study conducted in Pakistan showed that about 40% of water losses take place at watercourse level and about 15% losses are due to seepage and the remaining wastage occurs due to evaporation. In view of the above scenario these watercourses are being lined, involving a huge cost. Regular monitoring of the development work being carried out through a reliable and user-friendly information system is one of the key factors for the success of such a large project. At present the official records of the entire irrigation network in Pakistan are kept in paper-based maps and registers, which are difficult to handle and analyze. Besides, these maps lack geographic referencing as well as regular updation. The paper-based approach is also used for monitoring. This paper is a case study of the irrigation system of NWFP province which comprises 70,000 watercourses. The system developed for monitoring development work involves mapping through satellite images (SPOT-5), development of customized GIS software and database development (SQL Server), and a communication system to transfer data via GPRS/GSM collected at watercourses using PDA/iPAQ by the monitoring teams. The developed methodology was named "Quad S Approach" derived from four technologies used in this study i.e. SRS, GIS, GPS, and GSM. The system is capable of: collecting field data, updating records, generating reports and maps to serve current day-to-day needs. In addition, possible futuristic enhancement may incorporate several other themes as well as attributes such as: soil classification maps, cropping pattern in command areas of watercourses and so on in order to address the needs of agricultural activities. The system developed demonstrates operational application of Satellite Remote Sensing & GIS and associated technologies for water resource management that can be adopted anywhere in the world.

1 Introduction

Most of the agriculture in Pakistan depends upon surface water i.e. rivers, streams, lakes and canals. The snow covers the northern areas of Pakistan and is the main source of five major rivers i.e. Indus, Jhelum, Chenab, Ravi, and Bias and contributes up to 80% of surface water. Pakistan has the world largest irrigation network which comprises rivers, reservoirs and barrages, canals, link canal, distributaries, minors and watercourses (WCs). The WCs run through the agriculture fields and act as ultimate source of water for field crops. The conveyance, distribution, and irrigation efficiency of the canal irrigation system is extremely low due to huge conveyance losses from main canal and their braches, from main WCs, from WCs, and from irrigation field through evaporation, seepage, percolation and overflow due to the unlined canals, poor design and ill-maintained WCs, defective irrigation practices, inequity in water distribution and lack of precision land leveling. These

factors reduce the crop yields by 50-80% below their potential (Bilal 2009). Most of the WCs in the entire irrigation network in Pakistan are unlined, causing loss of water in the form of seepage and wastage due to uncontrolled supply of water. In 1973, a team of professors and scientists of Colorado State University conducted a study in Pakistan and reported 40% loss of water through WCs, out of which seepage losses contributes up to 15% while losses due to wastage accounted for 25% (Sana 2008). Later on similar studies were also conducted by Pakistan Water and Power Development Authority (WAPDA) which also supplemented earlier results (Sana 2008).

Global warming has certain impacts on Pakistan including longer summer seasons than usual, changes in rainfall pattern, which impacts on the surface water and rise in temperature. Due to long summer and less rainfall, less water is available for Rabi and Kharif crops which ultimately affects the crop yields. According to World Glacier Monitoring Service (WGMS), measurements taken over the last century “clearly reveal a general shrinkage of mountain glaciers on a global scale.” The world’s mighty Hindu Kush–Karakoram–Himalaya (HKH) mountain ranges, called “Roof of the World,” stretch across six countries: Bangladesh, Bhutan, India, Myanmar, Nepal and Pakistan are reported to be receding fast due to rising atmospheric temperature (Rashid 2009). In 1999, a report by the Working Group on Himalayan Glaciology (WGHG) of the International Commission for Snow and Ice (ICSI) states, “glaciers in the Himalayas are receding faster than in any other part of the world and, if the present rate continues, the likelihood of them disappearing by the year 2035 is very high” (Rashid 2009).

These factors necessitate improving irrigation efficiency of the existing system so as to use available water resources effectively and to prevent wastage of land and water resources. In order to achieve this objective, on the one hand, a major project of construction and rehabilitation of barrages, head works and remodeling of canals, regular desilting of canals, distributaries and minors, redesigning and improvement of WCs, post improvement care by community participation approach and precision land leveling through laser technology need to be implemented. While on the other hand, the farmers are required to adopt recommended methods of irrigation. These measures will results in additional water which can be used to bring more land under cultivation. The above referred studies proposed following recommendations to minimize the water losses at WCs level:

- Lining of WCs
- Use of concrete structures for regulation of water flows
- Removal of weeds from WCs beds and banks
- Proper maintenance of WCs by providing culverts and buffaloes ponds
- Removal of silt from WCs on regular basis
- Remedial measures for rat holes

In view of the above recommendations WCs improvement work in Pakistan was initiated during 1981-85. Under various programs a total of 10,000 WCs were improved in NWFP only. In 2000 Govt of Pakistan decided to improve the remaining WCs under National Programme for Improvement of Watercourses (NPIWC) in all four provinces of Pakistan i.e. Punjab, Sindh, NWFP and Baluchistan. Under the NPIWC Programme about 29,000 WCs are to be improved in Punjab, 33,000 in Sindh, 10,000 in NWFP and 5,000 in Baluchistan in 5 years. For successful implementation of this huge task, an organization called Programme Monitoring Unit (PMU) was established in four provinces. They will monitor the pace and quality of WCs improvement work. This paper will address the case of PMU-NPIW, NWFP province only.

2 Study Area

This study covers the province of NWFP which is situated in the north west of the Pakistan and has plenty of surface water resources. The NWFP province have diversified landscape including snow packed mountains region in the north, flat and rich agriculture region in the middle and arid and semi-arid region in the south. Northern region is mostly mountainous and contains forest reserve in addition to the orchards. The central region is the main hub of agriculture activities and has the largest irrigation network of the province feeded by Malakand, Turbela, and Warsak based canal systems. Two major dams Turbela and Warsak in this region not only provide water for agriculture practices but also generate electricity. While most of the southern region is fertile cannot be utilized for agriculture practice due to the non-availability of water. In this region Chashma right bank canal (CRBC) is the main source of irrigation. NWFP has 12000 canal bases WCs in addition to the 58000 civil WCs. In this study whole irrigation network up to WCs level was mapped using geospatial technologies.

3 Background and Motivation

PMU-NPIW has been given the task of WCs improvement work of 10,400 WCs in all over the NWFP province comprising of 24 districts. Owing to the dynamic nature of the activity involving a huge agriculture area spreading through out the province, the monitoring system was required to be capable of providing repetitive information not only within a specific time frame, but also covering the entire spatial extent of the activity area. The existing monitoring system is paper based which is not only inefficient but also lack transparency. All these requirements lead to development of an integrated solution that uses both the synoptic coverage of Satellite imageries and the versatility of tools available through a GIS platform together with a cellular communication network i.e. GSM/GPRS technology. Developments of a solution to cater PMU needs were based on the analysis of existing system and are summarized below:

- Irrigation record i.e. maps and inventory of WCs and canal systems are maintained in hard copy format, hence a lot of difficulties in analysis.
- The available irrigation network maps are outdated and un-projected.
- The traditional system results in delays and difficult to maintain and update the monitoring records. Belated inputs from the field results in delays in corrective actions.
- The system is not transparent as well as inefficient.

4 Objective

The main objective of this study was to develop GIS based monitoring system using the 'Quad S' technologies for PMU-NPIW, NWFP in the light of the problems they were facing. The specific objectives are:

- Mapping of irrigation network up to WCs level along with command areas
- Efficient live monitoring system and field data collection i.e. minimization of delays to acceptable limits
- Database development
- Transparent information system
- Capable of receiving and analyzing the data from field
- Automated response in case of poor quality improvement work on the basis of field reporting
- Easy to update and maintain
- Capable of generating required reports and themes

5 Data and Software

The following datasets have been used:

- SPOT 2.5 m Pan-sharpened imageries of whole NWFP - SPOT Image and SUPARCO
- Index maps of irrigations systems and command maps - Irrigation Department, NWFP, Pakistan
- Mogawar registers (WCs Inventory) – Directorate General On Farm Water Management (DG OFWM)
- 1:50,000 Survey sheets – Survey of Pakistan
- NPIW data (2004-09)– PMU-NPIW

The software packages used comprise ArcGIS 9.1 (ESRI), MapXtreme 6.7 (MapInfo), Visual Basic.NET Visual Studio 2005 (Microsoft), and SQL Server 2005 (Microsoft).

6 'Quad S' Methodology

PMU NPIW officials used the paper based Performa's in order to monitor the development work of WCs and the information collected were only available for the analysis once the field staff was back to the office. This approach not only caused delays in information retrieval at PMU HQs but also delays remedial actions. There was no check on monitoring officials whether they have collected the information from the fields or filled the same at home or office without visiting the site. SUPARCO has used the 'Quad S' technologies i.e. SRS, GIS, GPS and GSM while developing the required system for monitoring WCs improvement work in NWFP province. The roles played by these technologies in this case study are discussed in following section.

The accurate, updated and projected maps are the backbone of the GIS based irrigation systems. There are four major irrigation networks namely Malakand, Warsak, Turbela, and CRBC in NWFP province. SPOT 5, 2.5m pan-sharpened data were used to map the irrigation network includes canals, branches, distributaries, minors up to the WCs level and a total of 45 SPOT scenes were used for generating NWFP Mosaic Mapping of the irrigation network was carried out in ArcGIS 9.1 with help of Index Plan and Mogawar Registers. Index Plan provides information of all sources of water up to the minor level while Mogawar register keeps WCs inventory along with RDs (distance from the source in feet) for each WCs and RDs were used for WCs mapping. A total of 12,000 canal based WCs were mapped using SPOT data along with rivers, roads, settlements, dam, and railway line layers. Command Area maps of the WCs available mostly in hard copy were digitized in ArcGIS 9.1 by matching the parcel boundaries with Satellite imageries while soft copy maps were first georeferenced and then overlaid on the Satellite imageries for vectorizing the command areas. The command area mapping task was time consuming because these maps were un-projected as well as outdated, as most of these maps were prepared in early 20th century. Satellite imageries based irrigation mapping has provided updated, projected digital base map for the whole irrigation network. The Agriculture department infrastructure and tube wells were mapped using the GPS device.

Customized software's are user friendly as in most of the cases user does not have complete background knowledge of geospatial technologies. Customized GIS software for PMU-NPIW was developed in VB.NET environment using MapXtreme while the database was designed and maintained in SQL Server 2005. The system is capable of: storing the digital inventory of irrigation system (up to the WCs level), receive, store and automatically update monitoring reports in the database from remote users, analyzing the data, generating thematic maps and reports.

SUPARCO has developed three field data collection modules which are capable of sending the information right from the field via GSM/GPRS network to the communication server. The three modules are: Monitoring Module, Module for Civil WCs and Module for NPIW WCs. The developed modules were stored in the HP iPAQ 6515 and HP iPAQ 612c models having built-in GPS and GSM capabilities. The PDAs were programmed: to store the relevant information as filled by field monitoring officials at the site and to send it to PMU HQs via the GSM/GPRS network. These modules are capable of storing the data if there is no GSM Network and sending it later once GSM service is available. The information sent from the field is received by the Communication Server and is transmitted to the main server where is stored in a database and mapped in the map window automatically.

The developed system for field reporting has not only eliminated the delays caused by the paper based approach but also corrective actions can be taken quickly in case of poor quality work. In addition a system letter is generated to the concerned authority for remedial actions. The use of PDA for monitoring development work makes the system transparent as GPS locations of the monitoring officials are verified, using the location of already mapped WCs on satellite images. GPS location also verifies the location of the WCs mapped using Mogawar registers. The overall methodology of the study is shown in figure 1 below:

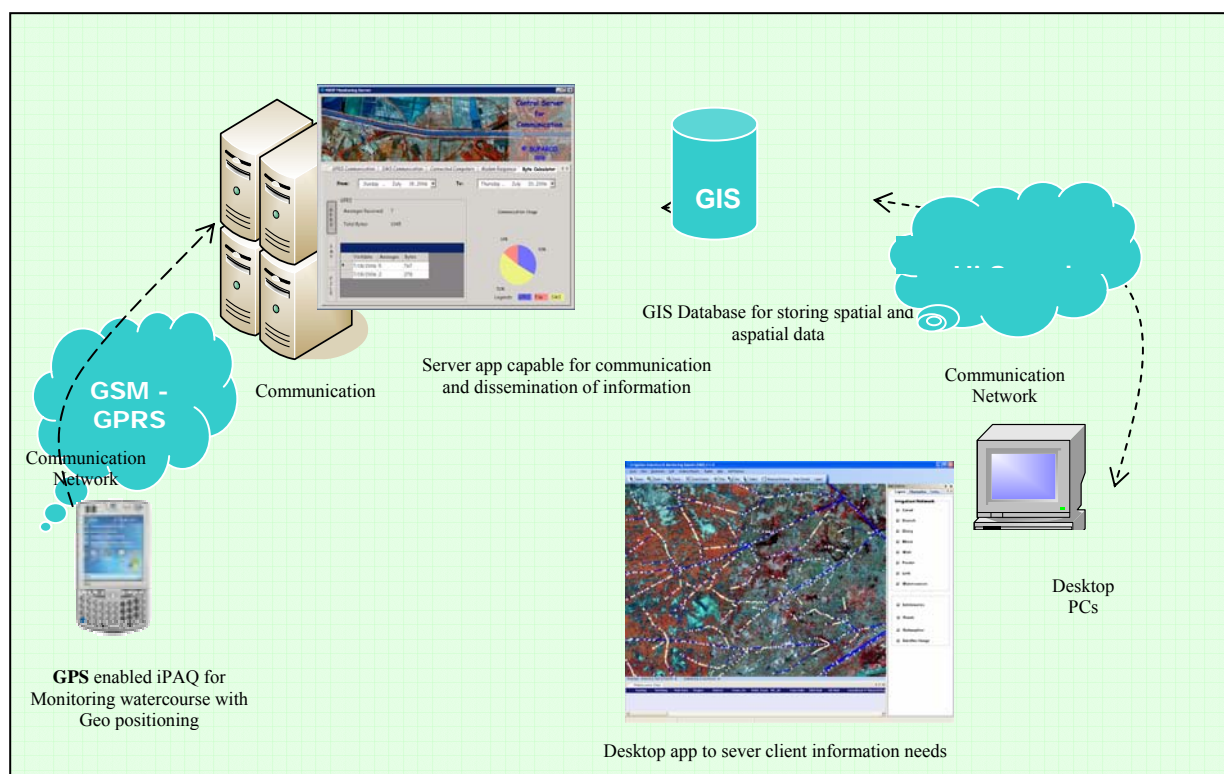


Figure 1: Overall Methodology

7 Results and Discussion

PMU NPIW was using the paper based system for monitoring the WCs improvement work. The paper based system was not only inefficient but also lack capabilities to analyze the data. Also field reports were available for analyses and corrective actions only when field teams are back to office. In view of the forgoing SUPARCO developed tailor made solution for PMU-NPIW which is capable to display all irrigation layers including rivers, canals, WCs along with administrative information, SPOT 2.5m Pan-Sharpned imageries of the whole NWFP province, receive and store data from remote users via GSM/GPRS, generate reports, and thematic maps. With the help of the tailor made solution, PMU is now capable of monitoring the development works efficiently in addition to the transparency.

The developed system has four major components i.e. GUI, field data collection modules, analysis, database and was made operational in LAN based environment. The customized software and field modules can be accessed by authorized users only which maintain the system security. The GUI has GIS functions, reports and thematic map menus, and tools for WCs addition / deletion/ relocation in addition to the automatics updates received from the field. WCs can be searched in the database either using their name or primary water source. The system store, analyze and map WCs inventory from three different sources i.e. canal based WCs, Civil WCs, and WCs lined under NPIW Project. Attributes of the WCs are maintained in separate tables in the database designed and maintained in SQL Server. WCs improved under NPIW project have more information and were grouped in four categories i.e. General Information, Social Information, Technical Information and Financial Information. Relevant attributes of the WCs are displayed in the pop window if a user selects a particular WCs in map view.

The system has four major outputs i.e. complete, projected and updated irrigation network, comprehensive database, thematic maps and reports. A number of reports and themes were generated using the WCs attributes and can be printed and maintained in hardcopy as well. The accuracy of irrigation layers mapped using SPOT imageries were checked in the field survey using GPS and the results were encouraging as the error in mapping the WCs was around 10-15 feet. However in few cases the error was more the 50 feet and the reasons for such results was relocation of WCs and the same information were not reflected in Mogawar register. Further the data sent by users from the field was received quickly on GPRS / EDGE mode while there was delay of a few minutes in SMS mode because of the GSM network used. The GUI of the developed system is shown in figure 2 below:

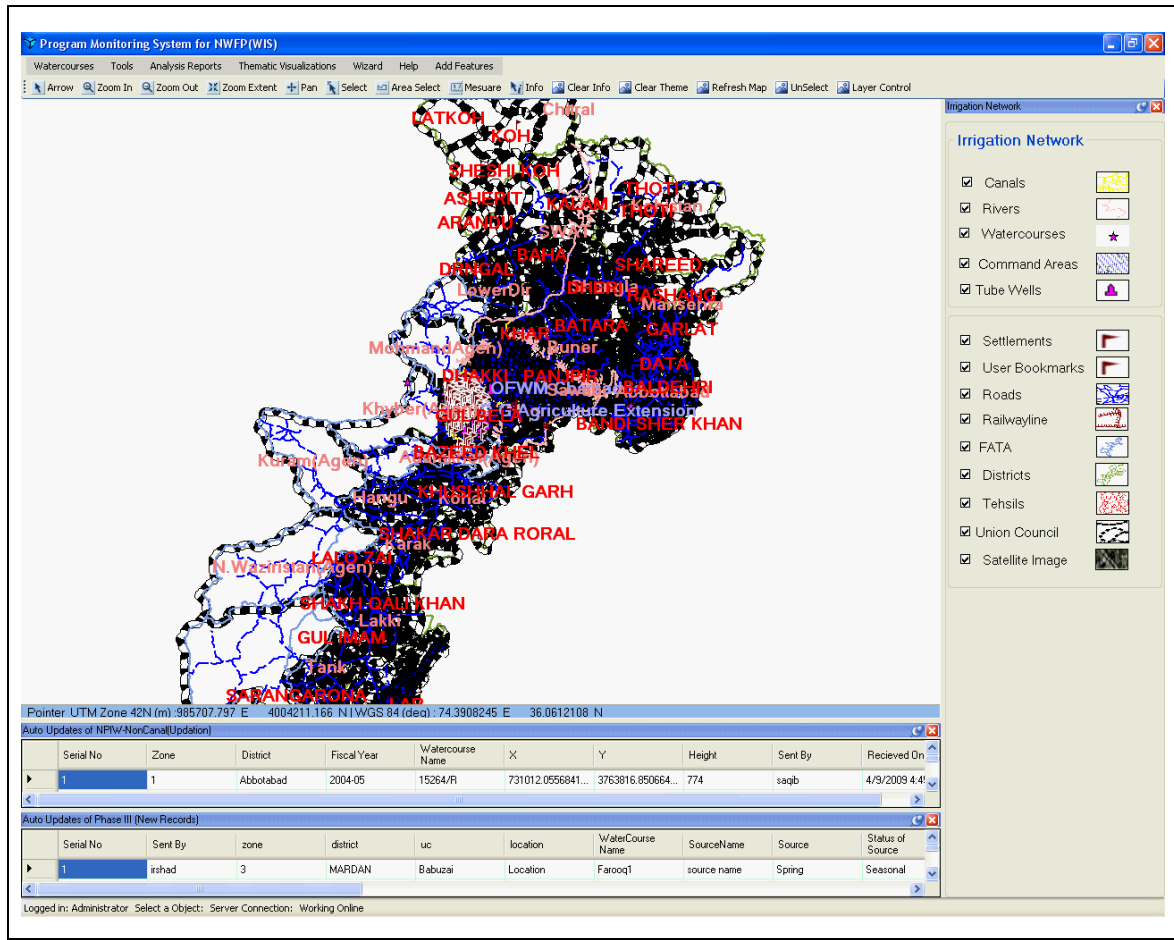


Figure 2: GUI showing the NWFP province in map view

8 Conclusion and Recommendations

PMU NPIW is responsible for monitoring the development work of WCs in NWFP province. In order to monitor this huge task efficiently, PMU decided to replace the existing paper based system with GIS based solution. In view of the PMU requirement SUPARCO developed a tailor made solution using the ‘Quad S’ technologies i.e. RS, GIS, GPS, and GSM. Complete irrigation network up to the WCs level along with command area maps were digitized using SPOT 2.5 m data. The accuracy of digitized layers were checked in the field survey using GPS and the results were encouraging as the error in mapping the WCs was around 10-15 feet. All digitized layers were linked with the relevant attributes in the database which was designed and maintained in SQL Server 2005. Customized software was developed in VB.NET environment using MapXtreme and is capable of displaying complete irrigation network up to the WCs levels; generate custom reports and themes. The customized software and field modules can be accessed by authorized users only which maintain the system security.

Field activity is the main component of PMU responsibilities and was the main focus of the project in order to make it more efficient and transparent. In view of the above three different field data collection modules for live monitoring, NPIW WCs and Civil WCs were developed and integrated with main system. The developed system was made operation in LAN based environment. In case of improper work reported, quick and timely corrective actions can be taken due to this system.

Mapping of the WCs route was a bit difficult task due the two reasons; WCs width is mostly sub-meter and cannot be identified clearly on 2.5 m resolution while secondly WCs are covered by trees on their banks. This problem was partially solved with the help of Google Earth. Command areas mapping was also challenging and time consuming task as command areas maps were mostly prepared in early 20th century i.e. 1925 and are neither projected nor updated. Command area maps were digitized / regenerated by matching parcel on Satellite imageries and paper prints. All attributes of the irrigation network were maintained in hard copies except NPIW project data maintained in Excel, were computerized initially in excel format and was then exported to SQL

Server . The data sent by users from the field was received quickly on GPRS / EDGE mode while there was delay of a few minutes in SMS mode because of the GSM network used.

Accurate WCs routs and command area map boundaries can be mapped using Mobile GIS technologies. The developed system demonstrates the operational use of SRS, GIS, GPS, and GSM technologies for assisting in such a huge and time critical task, which would perhaps not been possible without such a system. The system developed has been practically implemented in the province of Sindh and NWFP, while it is under implementation in the provinces of Punjab. This system can be used not only for planning of new developments i.e. new WCs, new minor, new canals etc but also for timely replacement / maintenance of existing networks .The developed system can be further upgraded as per user needs. Some of the possible up gradations are crop pattern analysis, incorporation of laser leveling data, appending of the parcel attributes for revenue collection. The developed system can be also upgraded to the internet based applications so that all stake holders can use the information for planning their activities.

References

- Bilal H., 2009. DAWN Economics and Business Review “Giving Irrigation system a Facelift”. www.dawn.com (Accessed 16 Feb 2009)
- DG OFWM; 2004-09. Social and Technical Data of NPIW Watercourses. Unpublished Technical Reports, PMU-NPIW, Peshawar
- DG OFWM; 2004-08. NPIW Annual Report. Unpublished, DG-NPIW, Peshawar
- Rashid, A., 2009. DAWN Economics and Business Review “Glacier on Go”. www.dawn.com (Accessed 16 March 2009)
- Shah, S.S., 2008. Monitoring Developments in Irrigation using RS and GIS., In UN/UNESCO/Saudi Arabia International Conference on the Use of Space Technology for Water Management, Riyadh, Saudi Arabia, 12-16 April 2008

DEVELOPMENT OF A CITYGML ADE FOR DYNAMIC 3D FLOOD INFORMATION

Claudia Schulte ^a and Volker Coors ^b

University of Applied Science Stuttgart

^a c_schulte@gmx.net

^b Volker.Coors@hft-stuttgart.de

KEYWORDS

Flood Information System, 3D dynamic flood visualization, OGC web 3D service, Spatio-temporal data modeling, CityGML application domain extension

ABSTRACT

Information about flood prevention, prediction and management is of high relevance nowadays. A good platform for presenting this highly spatial related information is the internet. Thus, research on online 2D and 3D visualization of flood issues is currently ongoing. As the data to be presented is coming from a huge diversity of proprietary hydro-numerical software systems, a proper data schema, respecting the needs of server side technology, is needed. We aim to demonstrate that CityGML is a good basic for providing this within three dimensions and embedded in a semantic model by presenting a concept for a CityGML Application Domain Extension for flood related data. In order to evaluate the schema a Java based implementation was coded, which is able to convert the hydro-numerical data in xml files conform to the developed "CityGML ADE Hydro". During the evaluation phase, the schema was presented and discussed with hydrologic and CityGML experts. The current schema can map data provided by the hydraulic software tools HYDRO_AS-2D, MIKE21 and TUFLOW and is ready to be integrated in a Web 3D Service in order to provide the data for dynamic 3D flood visualization in interactive 3D scenes.

CARTOGRAPHIC MODELING AND MULTI CRITERIA EVALUATION FOR EXPLORING THE POTENTIALS FOR TOURISM DEVELOPMENT IN THE SUEZ GOVERNORATE, EGYPT

Hala Effat and M.N.Hegazy

National Authority for Remote Sensing and Space Sciences, Egypt
heffat@yahoo.com

KEYWORDS:

Multi Criteria Evaluation, land use planning, suitability index, Suez, Egypt

ABSTRACT

The land use decisions and planning processes deal with large volumes of basic data where technical knowledge must be coordinated with the decision makers' visions of society. This fact makes spatial planning quite a complicated process. The issue is much more complicated when land use decisions concern a desert zone with limited resources.

This study addresses a regional scale zoning issue through cartographic modeling using Multi Criteria Evaluation in a geographic information environment through a case study. The main objectives of this research are to explore the model potential of providing an answer to the suitability of the Suez Governorate for a tourism development strategy. Also to provide a decision support tool for land use planners. Remotely sensed data such as Landsat ETM+, SPOT and Shuttle Radar Topography Mission were used for this study. A geographic database was established at a national scale. Multiple Criteria Evaluation techniques were used in a geographic information system environment to produce the land suitability index for tourism development. Factors that promote tourism activities were identified, ranked, weighted and overlaid in a cartographic model. The product of the model was a suitability index map for tourism. Such map was further classified and analyzed for proposing various scenarios for marine, safari and cultural tourism. Some recommended zones were found to be in conflict with the petroleum extraction and quarry activities. This technique provides a transparent tool that can bridge the gap between various stakeholders, decision makers, environmental managers and urban planners.

1 Introduction

The concept of *sustainability* is understood for this study in the context of the triple bottom line approach which requires the integrated consideration of environmental, social and economic issues for a sound development. This approach assumes that the development meets the criteria of the three mentioned aspects simultaneously (Belka, 2005 and Gibson, 2001). Land analysis is commonly done with map overlay and it is used to be done manually. With the rapid advancements taking place in computer hardware and GIS software, more complex land use models are being developed. These models help researchers and planners to simplify complex systems and to develop theory to understand the process of conducting a Strategic Environmental Assessment (SEA) in a better and easy way (Noble, 2000 and Grzybowski and Associates, 2001).

Cartographic modeling applies map algebra tools together with other basic analysis operations in GIS. Multi-criteria Decision Making (MCDM) is a term including Multiple Attribute Decision Making (MADM) and Multiple Objective Decision Making (MODM). MADM is applied when a choice out of a set of discrete actions is to be made. It is often referred as Multi-Criteria Analysis (MCA) or Multi-Criteria Evaluation (MCE). Multiple criteria overlay was proposed by McHarg, (1969) who suggested identifying physical, economic and environmental criteria in order to assure social and economic feasibility of the project. The main objective of MCDM is "to assist the decision-maker in selecting the 'best' alternative from the number of feasible choice-alternatives under the presence of multiple [decision] criteria and diverse criterion priorities". Every MCDM technique has common procedure steps, which are called a general model (Jankowski, 1995).

Despite the close relationship between the Geographic Information System (GIS) and land-use studies, there has been little constructive dialogue on the relationship between MCDM and land-use analysis in practical applications and actual land use decisions. Spatial multi criteria decision making refers to the use of multi criteria

analysis (MCA) to spatial decision problems (Voogd, 1983). MCA is a family of operations research tools that have experienced very successful applications in different domains since the 1960's. It has been coupled with GIS since the early 1990's for an enhanced decision making. Remotely sensed data together with GIS have been recently used in land use decision analysis. Cartographic modeling and suitability mapping of land using MCE techniques have been broadly studied. Belka, (2005) explains that in order to define the suitability of an area for a specific practice, several criteria need to be evaluated. Multi Criteria Evaluation (MCE) has been developed to improve spatial decision making when a set of alternatives need to be evaluated on the basis of conflicting and incommensurate criteria. MCE is an effective decision-making tool for complex issues that uses both qualitative and quantitative information. It has been utilized around the world for land suitability modeling and is concerned with how to combine the information from several criteria to form a single composite index of evaluation. A criterion may be a factor providing suitability of phenomenon of continuous measure or may be a constraint to limit the alternatives under consideration. The MCE in its Weighted Linear Combination method introduces a soft or "fuzzy" concept of suitability in standardizing criteria. It is scaled to a particular common range where suitable and unsuitable areas are continuous measures. The aggregation method uses weighted linear combination, which retains the variability of continuous criteria and allows criteria to trade off with each other. According to Sahoo et al, (2000), the Multi-criteria evaluation is primarily concerned with how to combine the information from several criteria to form a single index of evaluation. As the criteria are measured at different scales, they are standardized and transformed such that all factor maps are positively correlated with suitability. The weighted summation allows for evaluation and ordering of all alternatives based on the criteria preferences by decision-makers (Saaty, 1977). Example of raster-based multi-criteria evaluation is given by Grossardt, et al (2001) and Zucca, et al, (2007).

1.1 The Study Area

Suez Governorate is one of the governorates located in the northeastern part of Egypt. Between 30° 48' 20" E , 32° 49' 20" E and 28° 57' 00" N , 30° 18' 20" N, figure (1). The governorate is located in the Suez Canal Region and is bordered in the north by Ismailia, in the east north by north Sinai governorate, in the east by Suez gulf, and in the west by Cairo and Giza governorates (figure 1) with a sector of the Suez Canal passing through its lands. The governorate covers an area of 9002.21 km². It represents 0.9% of the Republic's area. According to the preliminary results of the 2006 census, population is 511,000 and the population growth rate has reached 19.9 per thousand. The governorate is well known for its potentials for both industrial and tourism activities. Rich in Limestone, Dolomite, Coal and Petroleum, the main industries include petroleum exploration, cement industry, glass industry, and chemical and fabrics industry in addition to port-based activities. The governorate has great tourism potentials reflected in unique natural Sulphur springs, desert zones with mountains overlooking the Red Sea shores, coral reef shores, in addition to some archaeological sites.

1.2 Objectives of the Study

The main objective of this study is to explore the potentials of remotely sensed data and geographic information sciences in linking the gap between this geo-science and the land use decisions and applications in the field of regional planning. The study attempts to apply the MCE theory and GIS techniques using maps and remotely sensed data for producing a suitability index map for tourism development of the lands in the Suez Governorate, Egypt. The study also aims at exploring the land resources, potentials and constraints that need to be considered in sustainable land use plans in Egypt.

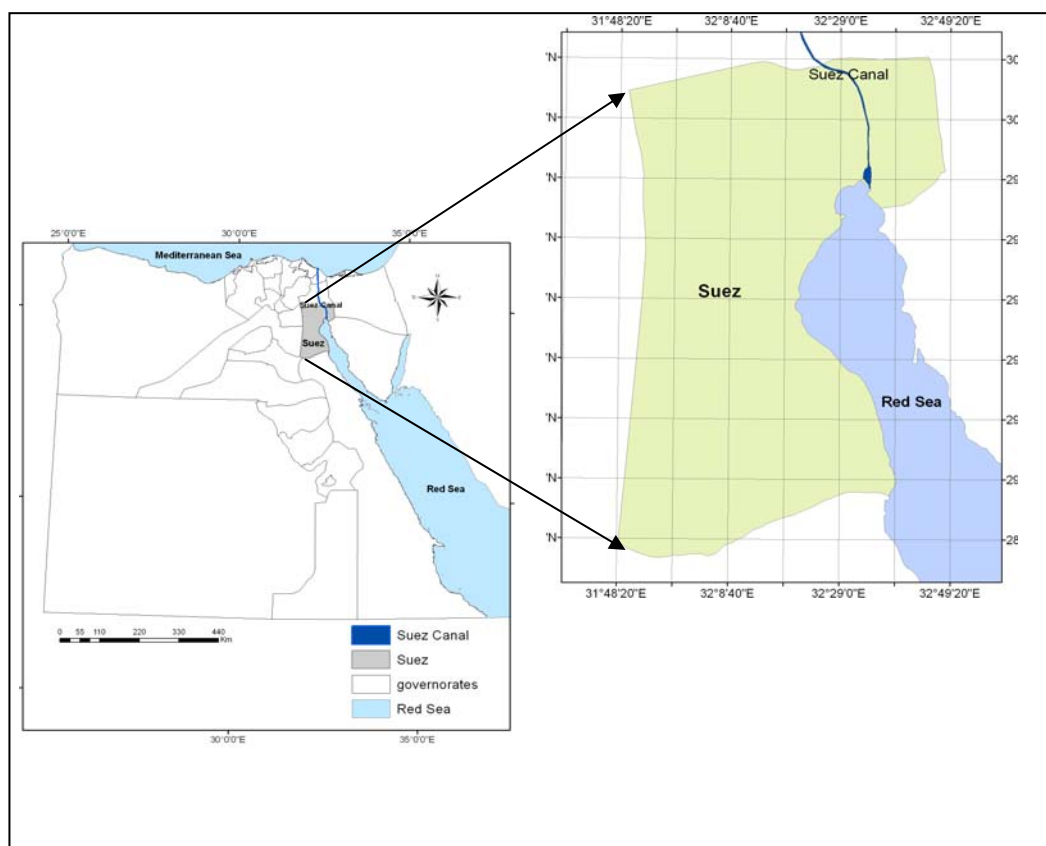


Figure 1: Location of the Suez Governorate

2 Materials and Methods

2.1 Data Acquisition

Several datasets were acquired for this study considering the heterogeneity of the area under investigation, an integrated database was established. The Primary data sets used for this study are Shuttle Radar Topography Mission (SRTM) 90 meters (9) resolution was used to derive the slope, aspect, catchments areas and drainage basins. The derived topographic grids were imported into the database. The FAO land cover map produced by the FAO organization from Landsat ETM+ data was used (10). Hydrogeological maps scale 1:500,000 were obtained from the National Water Resources Center Research Institute for Groundwater (11). The exiting and future protectorates maps after the Egyptian Environmental Affairs Authority (EEAA) (12) were rectified and digitized, in addition the topographic base map scale 1:50,000 obtained from the Egyptian Survey Authority (ESA) (13) was used. The analysis started by data acquisition and conversion of the acquired maps from the analogue to the digital format. These maps were rectified and digitized using on-screen digitizing and saved as ESRI format shape files. The shape files were imported into feature datasets in a geographic database using ArcGIS9.2 software (14). The datasets were all projected to the Universal Transverse Marketer UTM, WGS84.

The acquired maps were rectified and digitized using on-screen digitizing and saved as ESRI format shape files (.shp). The shape files were imported into feature datasets or stand-alone feature classes in a geodatabase using ArcGIS9.2 software. Tables from reports were converted to digital and imported into the database. Spot heights and contours derived from the topographic maps were used to derive the digital elevation model in ArcGIS9.2. Shuttle Radar Topography Mission (SRTM) DEM -90 meters resolution was used to check and compare the result of the model interpolation. The slope, aspect, catchment areas and drainage basins were derived. The data acquisition, rectification and establishment of the database were followed by the identification of the suitability criteria for tourism development. Identification of the essential criteria for agricultural development in the desert was done through literature review.

2.2 Defining the Potential Factors for Tourism in Suez Governorate

An extensive literature review was performed to select the set of criteria for tourism development potentials for Suez Governorate. Such factors are based on the unique resources and attraction sites. Such factors are explained as follows:

- Coral Reefs and the Red Sea Shores: The coral reefs are unique eco-systems that exist along the Red Sea shore. It is considered a main attraction to tourism.
- Archaeological Sites: A number of archaeological sites exist in the Suez Governorate. These sites have not been incorporated in a tourist plan.
- Ecological Sites: A variety of ecological sites exist in the Suez Governorate. Such sites include the famous natural Sulphur hot brines known as Oyoum Moussa and El Ein El Sokhna. These springs are internationally known for its hygiene value.
- Mountains: Mountains that overlook the Red Sea create a marvelous landscape in the investigated governorate.
- Wells: Wells generally are either constructed by investors or natives Bedouins for minor settlements. Such water resource is essential when planning for development in a desert zone.
- Airports : Existence of an airport is essential for the long term planning for tourism development.
- Roads: A road network is a mandate for developing a desert region. Despite the possibility to extend the network, it is always essential to study the distances from a main road prior to locating a new development.

2.3 Defining the Constraints

Constraints are zones that are to be excluded from the potential lands under consideration for tourism development. Such zones were defined as mines and quarry sites and their related buffer zones. For this study a buffer zone of five kilometer was chosen for each mine and a two kilometer buffer zone was chosen for quarry sites.

2.4 Ranking and Standardization of the Factor Maps

Ranking of the factor maps is a step prior to applying their relative weighs. The straight rank sum method was selected for this study. The method is one of the simplest criterion weighting techniques though criticized for its lack of theoretical foundations in interpreting the level of importance of a criterion (15). It is selected here for being a straight forward method that can be used with least confusion to the decision makers. In straight ranking, criteria are ordered from most to least relative important factor in accordance to the decision makers' point of view. After the ranks are established, relative weights are assigned to the factors, using the straight rank-sum method as explained in equation 1: (Belka, 2005)

$$w_j = (n - r_j + 1) / \text{SUM}(n - r_k + 1) \quad .(1)$$

where w_j is the normalized weight for j^{th} factor , n is number of factors under consideration , r_j is the rank position of the factor

The relative weights applied for the factors are described in table (1):

Criteria (n)	Straight Rank (r_j)	Weight ($n - r_j + 1$)	Normalized Weight (%) ($(n - r_j + 1) / \text{SUM}(n - r_k + 1)$)
Coral Reefs	1	7	25.00
Ecological attractions	2	6	21.42
Archaeological sites	3	5	17.85
Mountains	4	4	14.28
Wells and settlements	5	3	10.71
Roads	6	2	7.14
Airports	7	1	4.76
			100.00

Table1: Standardization and weighting of criteria

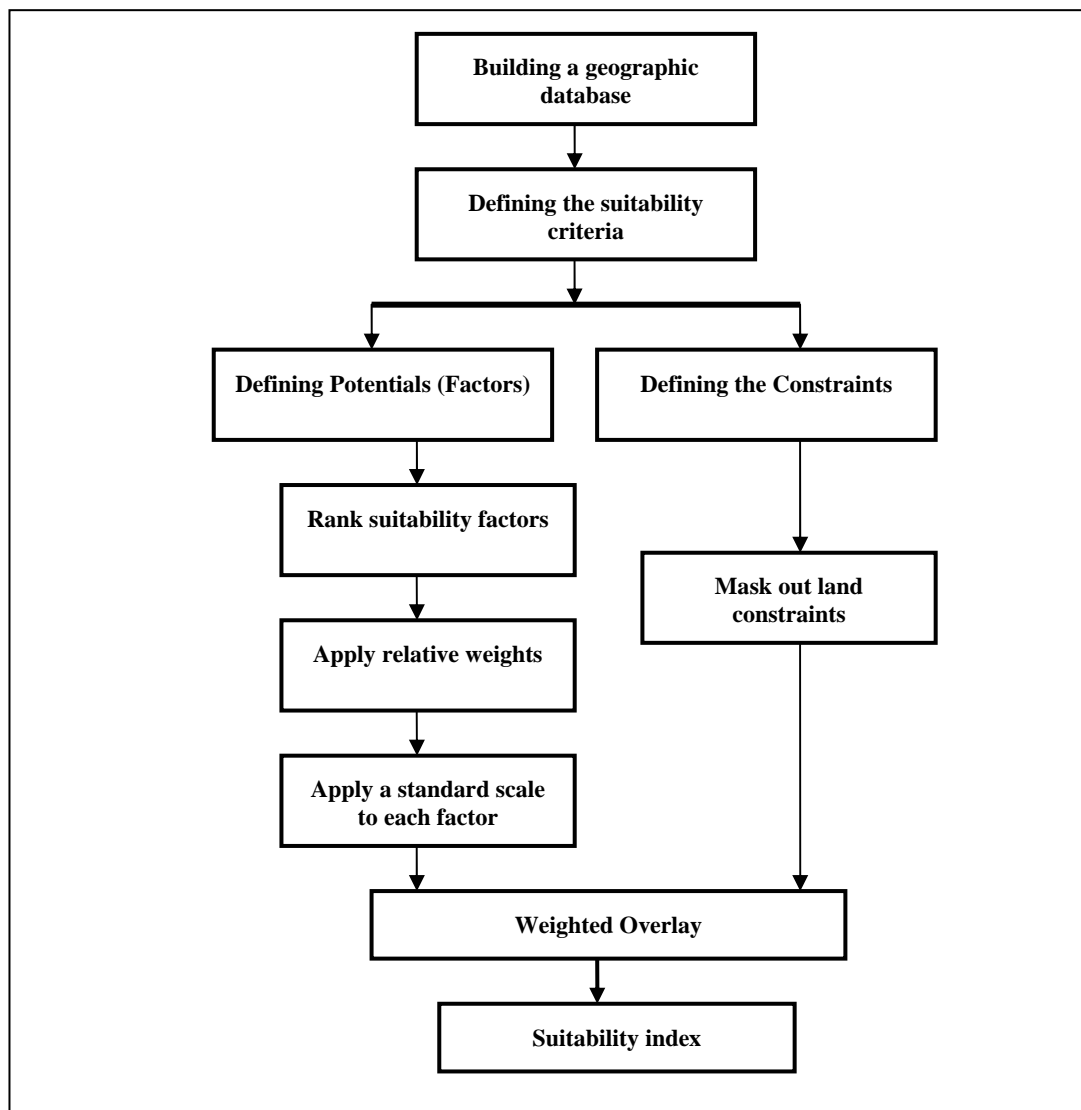


Figure 2: flow chart for the applied methodology

Several raster layers can constitute a set of criteria where every cell value is assigned a criterion score. Since the criteria attributes differ in evaluation, (example land cover map describe land cover units, while the distance maps measure distance) therefore, a common scale had to be applied, namely a suitability scale. Accordingly, each of the attributes was rated to a suitability scale that ranges from zero to nine. The higher the value the more suitable and vice versa.

2.5 Cartographic Modeling for Land Suitability Analysis:

The next phase is conducting the land suitability analysis to identify concentrated areas of potentials and limitations to development. The standardized criteria maps, given relative weights are then incorporated into a GIS- overlay model. For each location, the average suitability score is calculated as:

$$\bar{S} = \frac{\sum_{i=1}^n (W_i \times S_{ij})}{\sum_i W_i} \quad (2)$$

Where \bar{S} is the weighted average suitability score, W_i is weight for i^{th} map, and S_{ij} is score for j^{th} class of the i^{th} map. The assigned importance weight W_i depends on the variable significance with respect to the land suitability \bar{S} for a studied activity. (Caranza 2006)

3 Results and Discussions

Processing of the data revealed several interesting facts. Most of the attractions exist in the Eastern side of the Governorate where the Red Sea shores and most of the ecological sites exist. Airports exist along the Canal Suez making the Northern and North Eastern zones most accessible figure 3-a. Archaeological sites exist in the upper zone of the investigated governorate. Suitable areas for locating activities based on such sites was chosen to be within two consecutive buffer zones of 5 kilometers each, figure 3-b. Red Sea shores and coral reefs exist in the Eastern side of the governorate. Consecutive buffers of 5 and 10 kilometers along the shoreline is considered suitable for locating coastal tourism activities and resorts, figure 3-c. Hilly zones are distributed in the governorate with Mountain Attaqa being the dominant, figure 3-d. In general the development of a desert zones is necessarily coupled by the development of a road network. The road network in the investigated governorate shows that the maximum road density exists in the upper half of the governorate boundary. This fact indicates that the development is being focused on the upper half, figure 4-a. The ecological sites in Suez Governorate have international reputation for hygiene tourism. Effective distance to the ecological sites was considered within two five kilometers consecutive buffer zones. Distance exceeding such buffer zones was considered of least suitability to locating tourist sites based on such attractions, figure 4-b.

Running the suitability index for the seven factor maps produced the suitability index map, figure 5. Most of the high values exist along the Red Sea shoreline, the Western side of the Suez Canal and few scattered zones around some ecological attraction sites. This indicates the high potentiality of the governorate for coastal and ecological tourism. The suitability values decrease towards the Western side of the investigated governorate. Some medium values spread in the desert zones where some mountains and wells exist. Such zones can be developed for safari and camping in the desert and mountains.

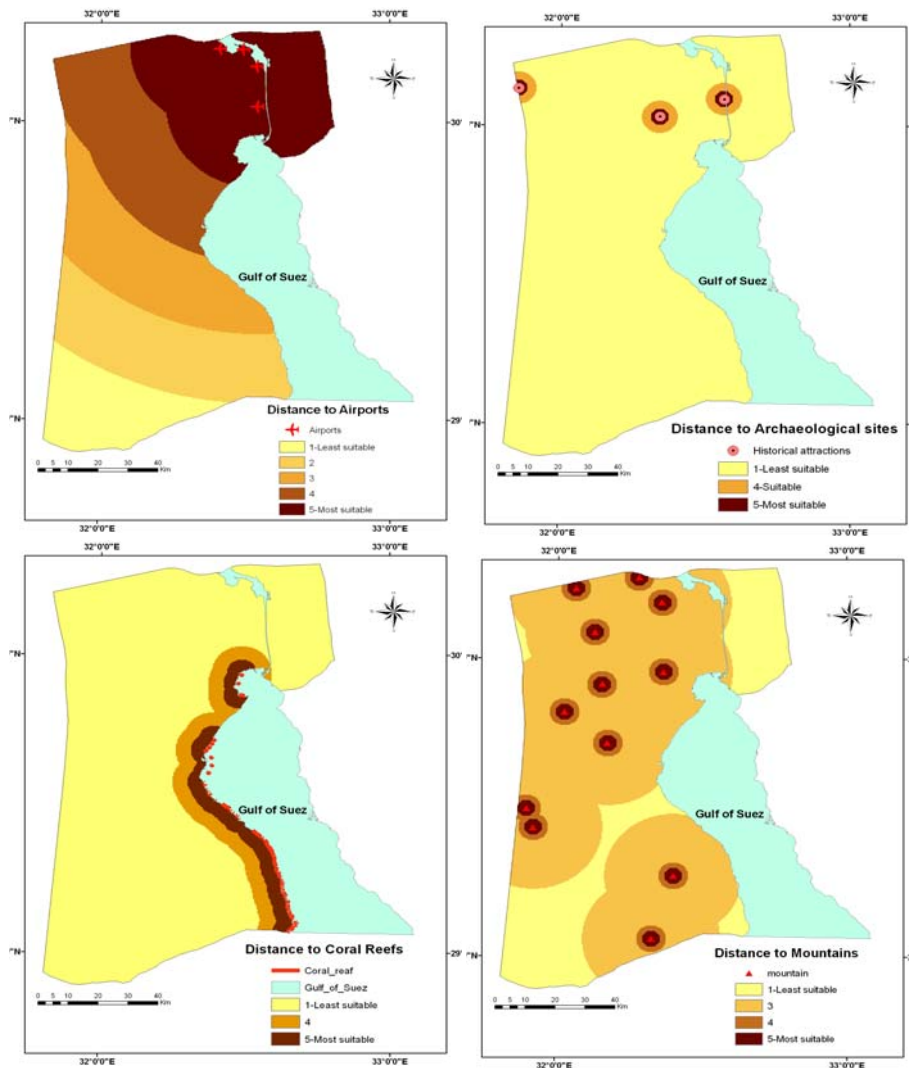


Figure (3): Standardized factor maps. (a) distance to airport. (b) distance to archaeological sites (c): distance to coral reefs. (d) distance to mountains.

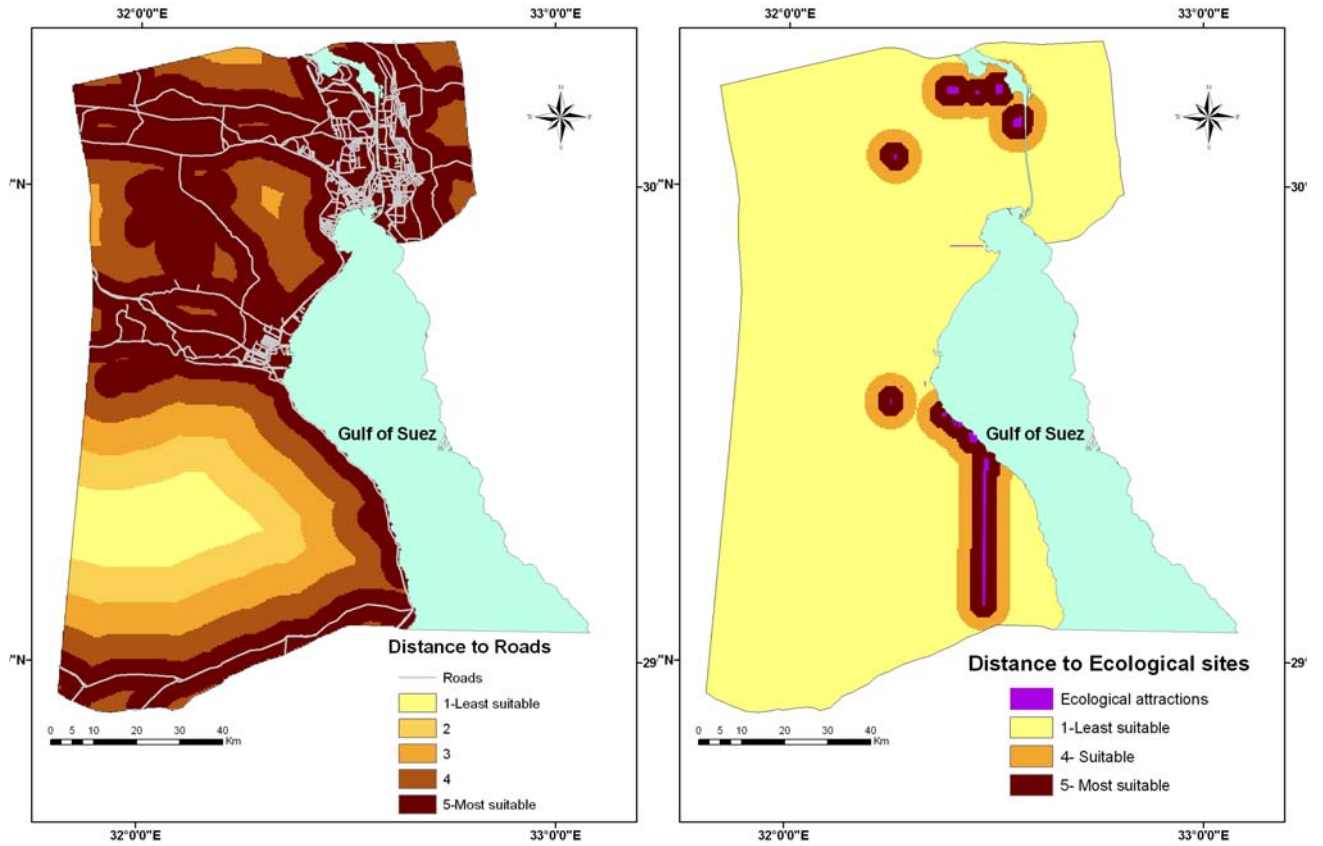


Figure4: Standardized factor maps for distance to roads and ecological sites.

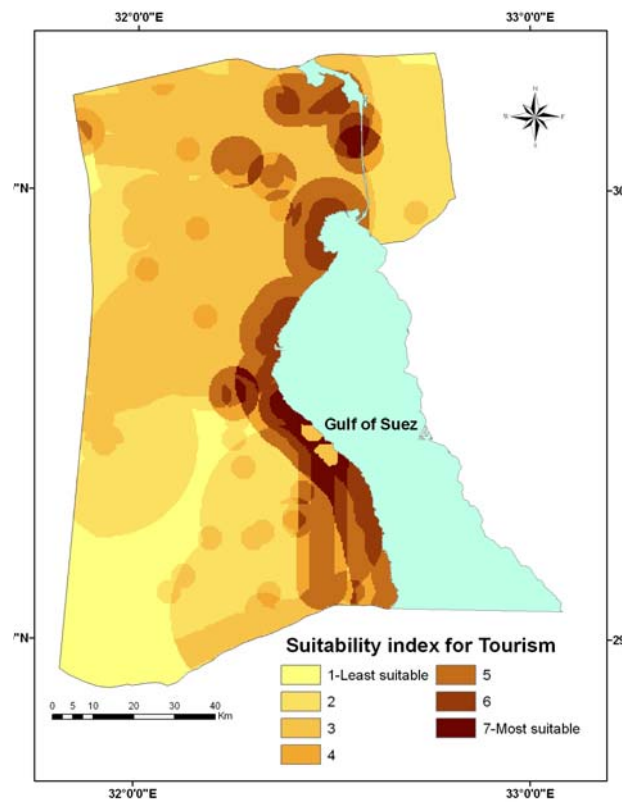


Figure 5: Suitability index for tourism development in Suez Governorate.

4 Conclusion and Recommendations

Exploring the resources and potentials of the Suez Governorate for tourism development using Multi Criteria evaluation provided a quick and integrated vision for the lands. It also provided unlimited possibilities to create scenarios based on a selected set of criteria. This technique can be time and cost saving for land use decision makers. Prioritizing and emphasizing criteria is done by the assignment of weights. Also combination of different attributes criteria is made possible by the standardization or normalization the criteria suitability scores.

The study recommends adopting the Multi Criteria Evaluation technique by land use decision makers. This technique can bridge the gap to a multi-disciplinary approach for land use planners on all levels of land use planning. Applying the technique on a national scale provides indicator maps that despite its need for further screening and enhancement by detailed local analysis, it can be used as a guide for the local scale, zoning plans and land use strategies. It is also recommended to conduct further studies for applying this technique on the different land use planning levels.

References

- Belka, K.M., 2005. Multicriteria Analysis and GIS application in the Selection of sustainable motorway corridor. Master's thesis submitted to Linköpings universitet Institutionen för datavetenskap. ISRN-LIU-IDA-D20--05/019—SE, 2005
- Carranza J., 2006. Knowledge-driven Predictive Modeling of Geo-objects: Index Overlay Method. Nuffic Refresher Course tutorials: Innovative Application of RS and GIS for female Professionals.
- Gibson, R. B., 2001. Specification of sustainability-based environmental assessment Decision criteria and implications for determining "significance" in environmental assessment. Available on: <http://www.sustreport.org/downloads/sustainability,EA.doc> (August 8, 2005).
- Grzybowski and Associates, 2001. Regional environmental effects assessment and strategic landuse planning in British Columbia. Report prepared for the Canadian Environmental Assessment Agency CEAA Research and Development Program. Hull, Quebec.
- ESRI, ArcGIS9 Desktop Software , 2001. Help References. Working with ArcGIS Spatial Analyst. ESRI.
- Egypt Multipurpose Land Cover Database (Africover). Food and Agriculture Organization of the United Nations, FAO, 2000. cited <http://africover.org>
- Jankowski, P., 1995. Integrating geographical information systems and multiple criteria decision-making methods, International Journal of Geographical Information Systems. Vol. 9, pp. 251-273.
- McHarg, I. L., 1969. Design with nature, John Wiley & Sons, London.
- Military Survey Department, 1995. The topographic map of Egypt, scale 1:50,000.
- Noble, B.F., 2000. Strategic environmental assessment: what is it and what makes it strategic, Journal of Environmental Assessment Policy and Management, vol. 2, pp.203-224.
- Sahoo, N. R., Jothimani, P. and Tripathy, G. K., 2000. Multi-criteria analysis in GIS environment for Natural Resource Development - A Case Study on Gold Exploration. Online publications cited from GIS development.net <http://www.gisdevelopment.net/magazine/gisdev/2000/may/gise.shtml>
- Saaty, T.L., 1977. A scaling method for priorities in hierarchical structures. Journal of Mathematical Psychology, vol. 15, pp. 243-281
- Voogd, H.,1983. Multicriteria Evaluation for Urban and Regional Planning. Pion, London.
- Zucca,A., Sharifi,A.M and Fabbria, A.G.,2007. Application of Spatial multicriteria analysis to site selection for a local park: a case study in the Bergamo Provin, Italy. Journal of Environmental Management, doi:10.1016/j.jenvman.2007.04.026

MODELING LAND COLLAPSE HAZARD USING REMOTELY SENSED DATA AND GIS IN THE EGYPTIAN TERRAIN

Mohamed Nagib Hegazy ^a and Hala Effat ^b

National Authority for Remote Sensing and Space Sciences (NARSS)
23 Joseph Tito Street El Nozha El Gedida P.O.Box 1564 Alf Maskan, Cairo, Egypt

^a mhegazy1@gmu.edu

^b mnhegazy@yahoo.com

KEYWORDS:

DEM, SRTM, Egypt, Land collapse, Lithology, Maximum seismic intensity zones, Fault density, Egypt, Spatial modeling

ABSTRACT

Land collapse is a challenge that faces development plans in many locations all over the world. In Egypt, it threatens facility lines as roads and urban settlements. Field detailed investigations are an effective method for conducting studies for this phenomenon but uneconomical for large areas. Remotely sensed data have facilitated geohazard exploration and monitoring as well as modeling risk and vulnerability of land collapse as one of the most important geohazard factors. This study modeled the potential land collapse hot spots all over the Egyptian territory. The model depends on using five parameters derived from different remotely sensed data of different sensors both optical and radar as well as using the Geographic Information System (GIS) modules software. The output of the model is land collapse risk index map. The model results were overlaid on the main roads and urban settlements. The resultant map identified those urban features that are vulnerable to land collapse and is useful for land use planning decisions on the existing built environment and proposed development plans. The map as a hot spot indicator can be used to prioritize zones in need for further detailed investigations, and then for mitigation measures and contingency plans.

LOCATION OPTIMIZATION OF WASTEWATER TREATMENT PLANTS USING GIS: A CASE STUDY IN UPPER MAHAWELI CATCHMENT, SRI LANKA

E.A.S.K.Ratnapriya ^a and Ranjith Premalal De Silva ^b

^a E.A.S.K.Ratnapriya, PhD candidate, Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka
ekolitha@gmail.com

^b Ranjith Pramalal De Silva, Professor (Geo-Informatics) & Head Department of Agriculture Engineering,
University of Peradeniya, Sri Lanka
rpdesilva@pdn.ac.lk

KEYWORDS:

Location optimization, Geographical Information System (GIS), Wastewater Treatment (WWT) Systems

ABSTRACT

Spatially-referred and up-to-date information system is one of the useful tools for effective watershed management and environmental protection. Since water quality-related documents and information on treatment systems are specifically designed for specific areas and specific localities and local conditions, they show strong spatial relationships. Therefore, it is necessary to have a system which provides facilities through geo-spatial relationships. The Upper Mahaweli catchment is one of the most important watersheds in Sri Lanka in terms of providing water for domestic, agricultural and industrial purposes and for electricity generation. Thus, protection of this important water source is crucial in national development. But, only very few point source treatment plants are currently in operation and non-point source treatment plants are required to be established to protect the catchment from pollution.

Locating wastewater treatment systems is one of the essential components, and that needs spatially-oriented data gathering, analyzing and visualizing. Further, GIS-based decision support systems for available treatment plants are well suited for informing improved analysis and understanding of the existing situation of treatment processes to managers and policy makers. This study was undertaken to identify the critical socio-economical and environmental factors, and to find a more comprehensive and convenient way to optimize the locations for wastewater treatment facilities that are suitable for different local conditions in the Upper Mahaweli Catchment of Sri Lanka.

Domestic, agricultural, industrial and activities which affect water quality in the catchment were identified through a transect walk on a spatially-referred 1:50,000 map by obtaining coordinates by using GPS (Global Positioning System). In addition, land use patterns and Digital Terrain Model (DTM) were used to locate the treatment facilities for point source pollutants. For locating treatment facilities for non-point source pollution by agriculture and other sources, the catchment was divided into sub-catchments and micro-catchments and the end points of those micro-catchments were identified. For non-point source pollutants, relationship between land use and the water quality of the end points was established in micro catchments. Thematic maps of stream characteristics, land use and vegetation cover and socio-economic characteristics with DTM were prepared to be used in determining the most suitable locations for putting up the treatment plants for non-point source pollutants.

1 Introduction

The Upper Mahaweli Catchment (UMC) is the upper portion of the Mahaweli watershed area, above the Rantembe dam which covers an area of about 3118 km². The four reservoirs, Kothmale, Victoria, Randigala, and Rantembe are located within this catchment contribute 60% of the electricity supply in Sri Lanka through hydro power generation and irrigation water for rice cultivation in lowland areas (Riethmüller,1996). Therefore, this area is very vital to national economy of the county. On the other hand, some of these reservoirs in Central Hill areas are now serving as drinking water sources in addition to their original purpose of water storage for hydropower and irrigation (Werellagama, 2006).

Water qualities of the Mahaweli River and its tributaries have been affected extensively due to increase of urban and sub-urban agglomeration along those water bodies, wastes disposal by local authorities, soil erosion. Even though, every new building requires including on-site wastewater disposal systems for granting approval by Local Authorities, the existing regulations or guidelines do not stipulate any system design requirements (Corea, 2001). As a result, partially-treated sewage directly is disposed to streams and canals. On the other hand, medium and small-scale industries such as service stations sawmills and agricultural waste (pesticides, fertilizers and herbicides) contribute significantly to deteriorate river water quality. Therefore, widespread demand for improved water quality requires implementation of catchment-based wastewater management system for Upper Mahaweli Catchment. Other than the City of Kandy, Upper Mahaweli Catchment is covered by sub-urban and rural settlements, where resources and technical capacities required for operation and maintenance of conventional mechanical systems are limited. Simple and low-cost but relatively high land consuming natural systems basically either belong to soil-based land treatment systems or aquatic plant- based wetlands are more appropriate to such a conditions. Therefore, locating wastewater treatment systems by analyzing socio-economical, environmental and technical aspects is vital in wastewater management process in the catchment area. With recent developments of information technology, there has been an enormous change in the way information is collected, stored, analyzed and visualized. Introduction of Geographic Information System (GIS) has made it easier to develop computer application to handle large volume of data related to water resource management. In recent years, GIS systems have been used in the field of *wastewater* management (Gemitzi et al., 2007; Finn et al., 2006; Gilliland and Potter, 2007; Zhao et al., 2009; Kallali et al., 2007; and Huffmeyer et al., 2009).

Therefore, the main objective of this study was to optimize the location of wastewater treatment systems in the study area by integrating GIS with related local factors. Selection criteria were based on technical, environmental and economical factors and topography.

2 Study Area

Upper Mahaweli Catchment covers an area of 3118 km². Therefore, sub-catchment was selected for pilot study in such a way that analyzing procedure can be scaled up-to entire the catchment. A portion of Mahaweli River at Gampola, which covers 210 km² land area was selected as the study area. Its catchment area (figure 1) was defined by using Digital Terrain Models (DTM) using in GIS. The terrain is highly undulating and the altitude varies between 520 m and 1400 m. Most of the land area is covered by tea plantation and forest. Other than tow sub-urban settlements (Gampola town and Pussallawa town) most of the population is scattered over the area in traditional villages and tea state worker communities. The dominant economic activities are tea plantation and vegetable cultivation. Even though, Industrial activities are not much prominent in this area, some medium scale and small scale industries scatted over the catchment.

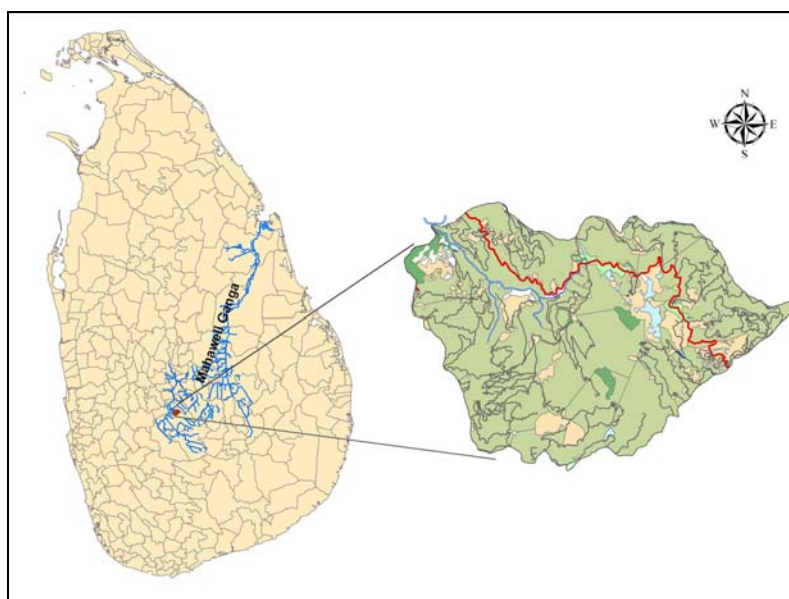


Figure 1: Study area. Pussallawa and Gampola

3 Materials and Methods

Identification of locations for wastewater treatment plants for study area was done by GIS-based multi-criteria analysis methodology involving the following main stages: (i) Identify and map entry point of pollutants sources; (ii) Criteria and define their upper or lower limits; (iii) Preparation of necessary spatial data in GIS; (iv) Analyzing Boolean maps for each criteria using GIS tools.

3.1 Identify and Map Entry Point of Pollutants Sources

Pollutants emission into water bodies can occur through different pathways depending on the source. The sources which are continually distributed over certain area is called non-point source and that can be collected at outlet of the micro-catchments with storm or surface run-off water. When waste water dispose by pipe, ditch, channel and other discrete means of sources are called point sources.

Point sources were identified by Transect walks along the river and locate the points with GPS (Global Positioning System). Those coordinates were introduced to the ArcGIS and converted into point layer. This points were located in the geo-referenced map prepaid by using GIS. Because, micro-catchment end points are characteristic of geo-morphology, it is possible to identify watershed area belongs to each entry point by using accurate DTM (Digital Terrain Model) of the area (figure 2). Prediction of dominant types of pollutant for particular micro-catchment can be done by using land use map.

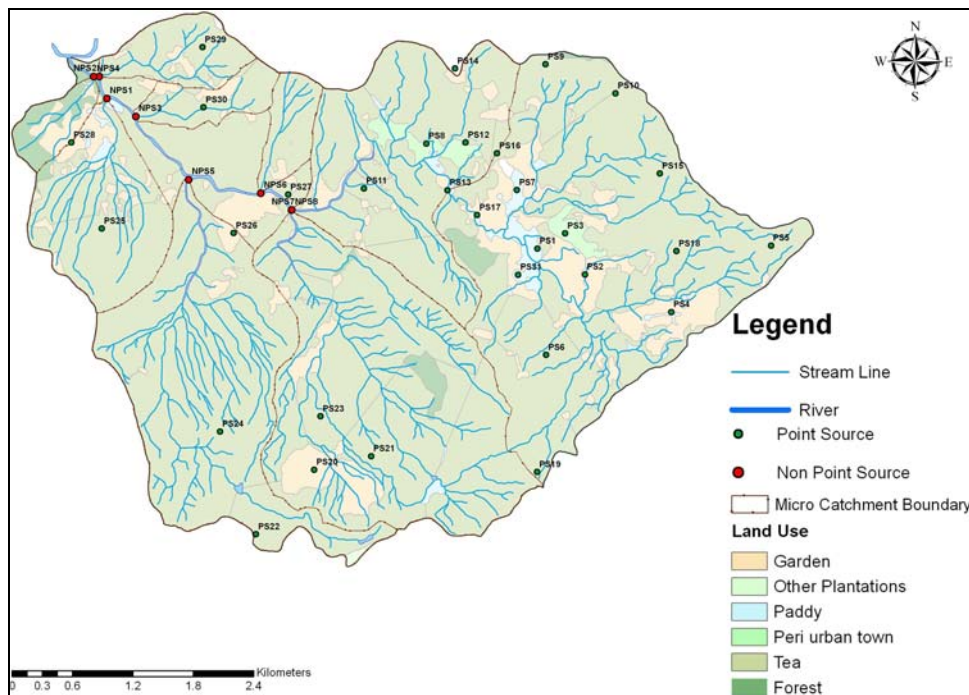


Figure 2: Red circles are entry points of non-point sources and brown boundaries are their contributed areas. Green points are locations of point sources

3.2 Definition of the Upper or Lower Limits of Criteria

Prospective technical wastewater treatment plant should be constructed on a slope less than 15% to avoid the risk by instability and minimize the construction cost. Two environmental criteria were considered: forest and protecting areas and potential flooding areas were excluded. In social criteria, minimum 300 m safe distance from human settlements was maintained to avoid mosquito problem and possible odor from the Wastewater Treatment (WWT) plant.

3.3 Preparation of Spatial Data in GIS

Selecting locations for WWT was done by thematic vector layers analyzing in ArcGIS 9.2. Slopes were obtained from Digital Elevation Model (DEM) produced by digitizing 1: 10 000 contour maps. Polygon layer was created

for the slope values less than 15 % which are shown in brown color (figure.3). Forest cover polygon layer was obtained from land use map and 300 m buffer zone was created in ArcGis vector analysis. Flood level area was established by participatory GIS during the transect walk (figure 4).

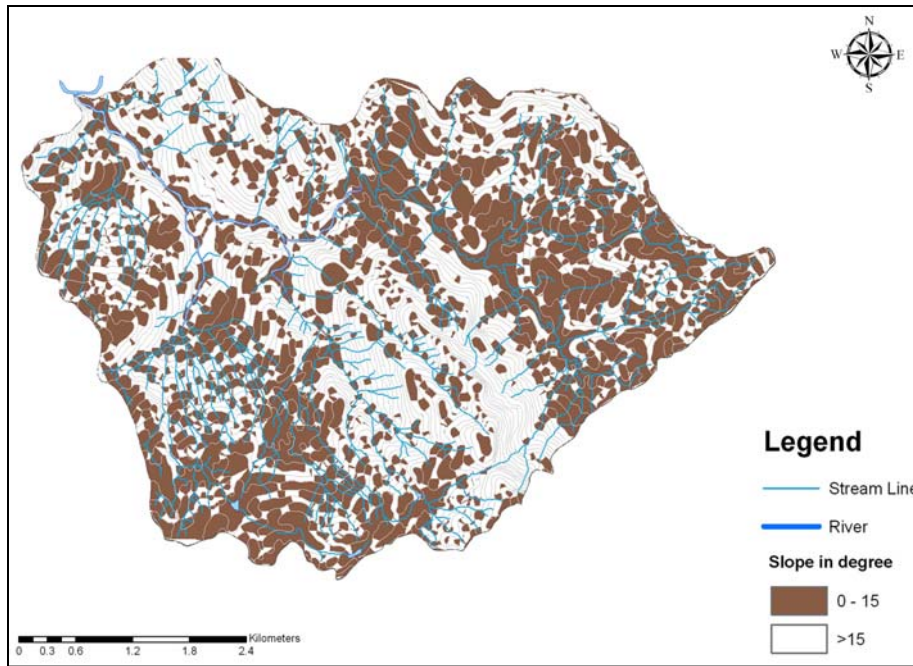


Figure 3: Land area where slope is suitable for construction WWT plants

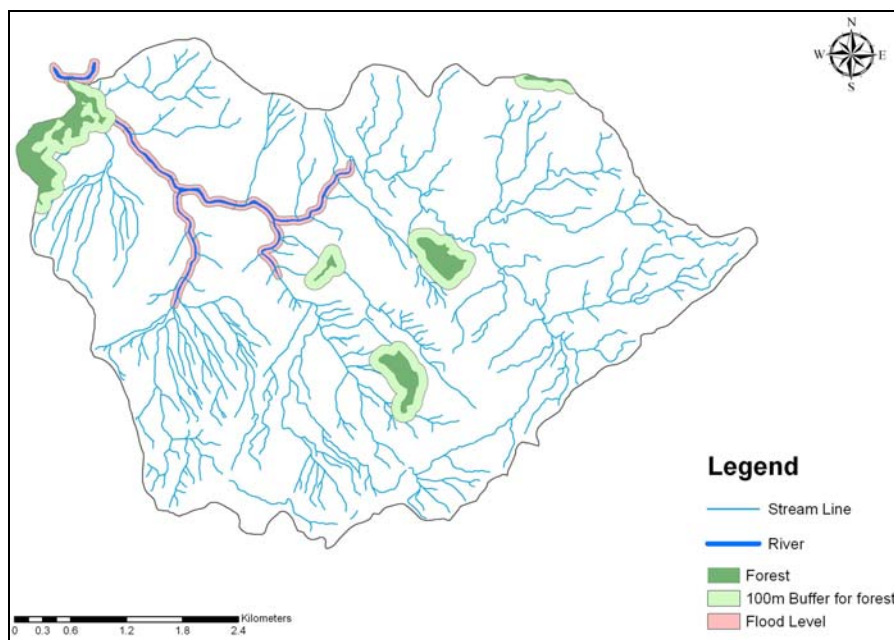


Figure 4: Forest area with buffer and flood level map

Areas covered by human settlements were obtained from 1: 50 000 land use map and polygon layer was obtained from 300 m buffer zone in ArcGis vector analysis (figure 5).

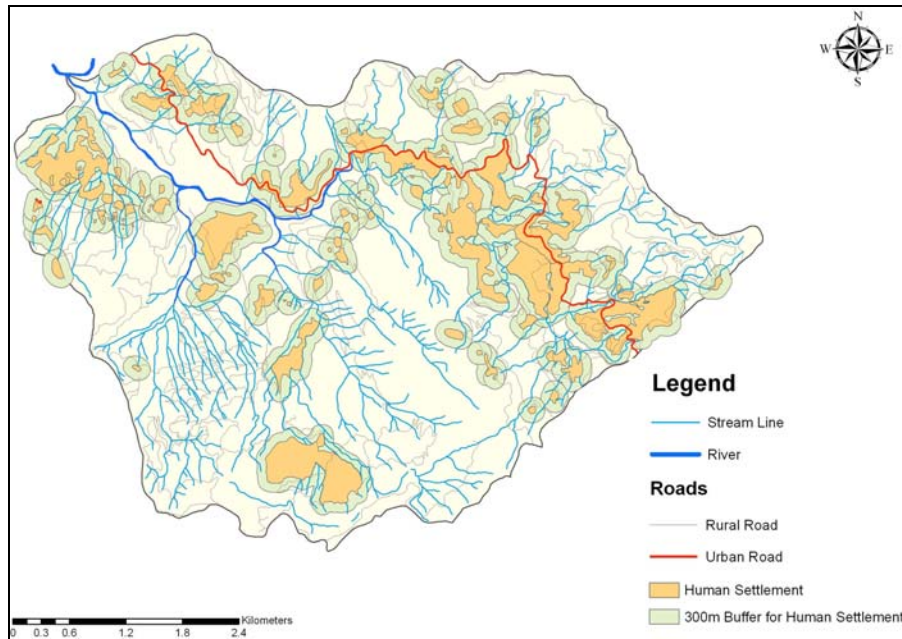


Figure 04: Human settlements and 300 m buffer zone.

3.4 Analyzing Boolean maps for each criteria using GIS tools

Analyzing was performed in vector by union and intersecting operators. Flooding area, buffered forest area, slope more than 15 %, buffered human settlements area were merged together by using analytical tool *Union in ArcGis* and excluded from the study area. Rest of the areas where all criteria satisfied and feasible areas for WWT systems construction (figure 5).

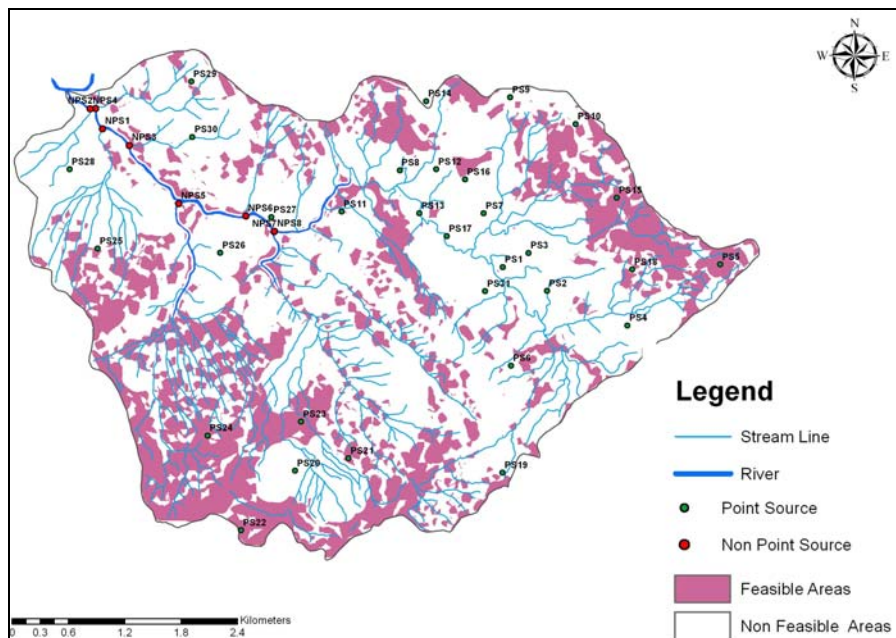


Figure 5: Suitable areas for locating wastewater treatment systems

4 Results and Discussion

Resulting map that produced through the multi-criteria analysis gave a total area suitable for wastewater system representing 23% of study area. Some micro catchments, for example micro-catchment contributing point NPS2

didn't have suitable location for which all criteria are satisfied. Therefore, another analysis should be performed by removing or changing limits that will less effect to the overall process.

Treatment systems needed for the non-point source pollutants can be established close to the river where there are suitable areas. Most of the point source points lay within the unsuitable areas due to human settlements. In such a situation, traditional mechanical treatment should be introduced instead of land-based systems.

5 Conclusions

Optimum locations for wastewater treatment systems were identified by multi-criteria analysis. GIS is a very useful tool in term of store, analysis and visualization of spatial data rather than mathematical models. After obtained optimum areas, it is essential to conduct field verification process with include feedback from the host communities. To select, among the suitable area, best wastewater treatment sites work is necessary: considering other factors that compete with land, such as land values, ecstastic appearance.

References

- Corea, H., 2001. Appropriate Disposal of Sewage in Urban and Suburban Sir Lanka. Doctor of Philosophy Thesis, The University of Leeds, p.12 Leeds, UK .
- Finn, M.P., Usery, E. L , Scheidt D.J., Jaromack, G. M., Krupinski , T.D., 2006. An Interface between the Agricultural Non-Point Source (AGNPS) Pollution Model and the ERDAS Imagine Geographic Information System (GIS), *Geographic Information Sciences*,12, pp.9-20.
- Gemitzi, A., Tsihrintzisz, V. A., Christouc, o., Petalab, C., 2007. Use of GIS in sitting stabilization pond facilities for domestic wastewater treatment, *Journal of Environmental Management* 82 , pp.155–166.
- Gilliland, M.W., Potter W.B., 2007. A Geographic Information System to predict non-pollutant source pollutant potential. *JAWRA*, 23, pp.281-291.
- Kallali, H., Anane M., Jellali S., Tarhouni, J., 2007. GIS-based multi-criteria analysis for potential wastewater aquifer recharge sites, *Desalination* 215, pp.111-119.
- Huffmeyer, N., Klasmeier, J., Matthies, M., 2009. Geo-referenced modeling of zinc concentrations in the Ruhr river basin (Germany) using the model GREAT-ER, *Science of the Total Environment* 407, pp.2296-2305.
- Riethmüller, R., Fleddermann, A., 1996. Institutional Aspects of Land Use Planning – Conditions and Experiences in Sri Lanka,p. 22 *Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH*.
- Werellagama, D. R. I. B., Abeynayaka, A., Manathunga, J., Nakayama, M. 2006. Collaborative program to prevent pollution of the Upper reaches of Mahaweli River – Sri Lanka
- Zhao, Y.W., Qin, Y., Chen, B., Zhao, X. Li, Y., Yin, X.A., Chen, G.Q., 2009, GIS-based optimization for the locations of sewage treatment plants and sewage outfalls – A case study of Nansha District in Guangzhou City, China, *Communications in Nonlinear Science and Numerical Simulation*, 14, pp.1746-1757.

DROUGHT RISK ASSESSMENT USING REMOTE SENSING AND GIS TO ALLEVIATE POVERTY: A CASE STUDY OF THE OSHIKOTO REGION IN NAMIBIA

Frans Carel Persendt

Department of Geography and Environmental Studies,
University of Namibia, Windhoek, Namibia
fpersendt@unam.na

KEYWORDS

Drought, Remote sensing; GIS; MODIS, NDVI, Namibia

ABSTRACT

Drought is a recurrent climatic process that occurs with uneven temporal and spatial characteristics over broad areas and over an extended period of time. Therefore, detecting drought onsets and ends as well as assessing drought severity using satellite-derived information is essential. This should be especially the case in an arid country like Namibia where drought is part of Namibia's climatology. It is believed that good planning and research using near real-time data can curb the devastating impacts it has environmentally and socio-economically. Weather data used currently are often from a very sparse meteorological network, incomplete and/or not always available in good time to enable delineating accurately and timely, regional and local scale droughts. Consequently, detection and monitoring efforts are hampered to provide timeless and unbiased information to decision makers for accurate drought relief allocation and for land reform purposes.

Furthermore, even though, data obtained from satellite-based sensors such as the Advanced Very High Resolution Radiometer (AVHRR) have been studied as a tool for drought monitoring for many years and provides an extensive temporal record for comparison, its coarse spatial resolution limits its effectiveness at detecting local scale variability where severe droughts might go undetected due to these data constraints.

The objective of this study was to evaluate satellite-based and meteorological drought indices for the spatial and temporal detection, assessment and monitoring of drought condition to accurately delineate drought characteristics for drought prone areas.

The study computed the Vegetation Condition Index (VCI) and Normalized Difference Vegetation Index (NDVI) from the 250 m resolution NDVI data obtained from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor and one- and three-months Standardized Precipitation Index (SPI) data from rainfall stations in the study area.

Detailed analyses of spatial and temporal drought dynamics during three seasons (2005/6 - wet, 2006/7 - normal & 2007/8 - dry) have been carried out through index maps generated in Geographic Information Systems (GIS) environment from the mentioned data. Analysis and interpretation of these maps, which give different drought scenarios, reveal that remotely sensed drought-indices detect and map the local and regional drought spatial occurrence well. Moreover, statistical analysis found good correlations between the regional crop production data and the remotely sensed data. However, the results showed that the local and regional drought occurrences detected were not reflected in national crop production data, confirming the suspicion that important local spatial variations are only detected if higher spatial resolution data are used. The study concluded that fine spatial resolution satellite data should be used to aid decision makers in monitoring and detecting drought which will also aid the allocation of millions of dollars in drought relief funds.

STRATEGIC AND OPERATIONAL ASSET MANAGEMENT FOR A WATER DISTRIBUTION SYSTEM

Yolla Alasmar

Jordan, yolla_alasmar@yahoo.com

KEYWORDS:

Asset Management, Water distributing system, Maintenance strategy, Risk management, Asset life cycle

ABSTRACT

Management of water distribution system is becoming more sophisticated as the different assets in the distribution system are aging and becoming more prone to failure, as well as to rising materials' costs and operational expenses.

*The main aim of strategic and operational **asset** management is to gain the best delivery of services through efficiently managing the assets. This can be done by including different aspects like maintenance strategies, risks management and assets life cycle.*

Asset management approaches with the aid of information technology helps the water utilities to manage assets in water distribution system in more cost effective way and improve the reliability and the performance of the system.

IMPACT OF RAINFALL AND VEGETATION ON RESERVOIR CAPACITY AND IDENTIFICATION OF EROSION PRONE AREA USING GIS & RS

Mahboob Alam ^a and Mohsin Jamil ^b

^a Room No.6, Al-Umar Plaza, G-7 Markaz, Islamabad, Pakistan
malam.pwp@gmail.com

^b Department of Meteorology, COMSATS Institute of Information Technology, H-8 Islamabad, Pakistan

KEYWORDS:

Reservoir Capacity, Sedimentation, Erosion, GIS, Remote Sensing

ABSTRACT

Most of the water reservoirs in Pakistan face the problem of sedimentation. The Mangla dam's capacity has been rapidly decreasing since its construction in 1967. The land cover changes, whether natural or man made as well as vegetation cover and rainfall have an immense effect on the sediment load. The traditional techniques to analyze the problem are time consuming and spatially limited. Remote sensing provides a convenient way to observe the landcover changes and GIS provide tools for geographic analysis. This study demonstrates a GIS oriented methodology to calculate the impact of vegetation and rainfall on sediment load by using remotely sensed data. MODIS data is used to observe the temporal change in vegetation-covered area in Mangla watershed. The total drainage area for the Mangla is calculated from SRTM data. Annual rainfall is used to compute the annual available rainwater for the watershed. The impact of annual available rainwater on vegetation-covered area is computed in this study. In addition, certain areas are also identified which are causing sedimentation to the reservoir. An inverse relation between vegetation cover and rainwater is observed.

1 Introduction

Water is a very important resource for any country, especially for an agrarian one like Pakistan. It is a resource, which cannot be generated but can be preserved. Every country is doing its best to manage the water resources for the fulfillment of its needs. Water resources are affected by many natural hazards like sedimentation, earthquakes, floods etc. The anthropogenic activities lead to the increase in sedimentation (Des E. Walling., N.D). World's 13 large rivers carry 5.8 billion tons of sediments to the reservoirs every year (Nasir et al., 2000).

Pakistan is situated in a geographical location that leads to its rivers and their tributaries to get water from mountainous regions. Summer monsoons cause heavy rainfall in south-east Asia. During the rainy season the sediment load is very high due to flash floods in rivers. The watersheds in Pakistan are facing this sedimentation problem. Most of the reservoirs in Pakistan have their source of water at the north of the country.

The intensity of rain is very high in summers as compared to the winter season. The erosion rate grows higher with growing rain fall intensity (Wischmeier & Smith., 1978). The second factor that affects the erosion rate and due to which Pakistan's reservoirs face heavy sediments is steepness of the slopes. The water source for larger mountainous watersheds like Mangla and Tarbela are from higher mountains. The third important factor, causing sedimentation problem, is vegetation cover. Vegetation protects the soil from disintegrating and reduces the sediment delivery to dams (Alejandro et al., 2007). The River Indus and its tributaries in Pakistan carry 431.55 million cubic meter (mcm) of sediments load in a year. With such sediment intake rates the Indus basin ranks third in the world (Indus Basin).

The study area for this research is Mangla Watershed shown in Figure 1. Mangla dam was constructed in 1967 across the Jhelum River. It is situated 60 Km in south-east of Islamabad. The storage capacity of the Mangla dam was 7250.04 mcm when it was constructed and now it is reduced to 585675 mcm. The sedimentation rate is so high that the reservoir has lost 19.2% of its capacity since 1967.

Erosion around the catchments area of the reservoir contributes the sediment load that reduces the capacity of the dam. To prevent soil loss from the catchments areas there is a need for proper planning. The very first step in this

planning is to uncover the main factors that contribute to sedimentation. The traditional methods of planning are time consuming and spatially limited. Geographic Information System (GIS) has reduced the effort involved in surveys and sampling. This study uses simple GIS and remote sensing based methodologies to identify the effects of Vegetation and Rainfall on reservoir capacity. Annual rainfall is interpolated spatially in GIS environment to compute annual available rainwater. Remote sensing technology serves best for the land cover assessment and topographic information. For Geo-visualization, Shuttle Radar Topographic Mission (SRTM) elevation data is used. Moderate Resolution Imaging Spectroradiometer (MODIS) sensor data is used to find out the changes in the vegetation covered area across watershed. The effect of both vegetation and rainfall parameters on sediment load is observed and the erosion prone areas are also identified in this research.



Figure 1: Mangla watershed

2 Material and Methods

There are four types of data which is acquired for this research.

- 1) Satellite Data
- 2) SRTM Data
- 3) Annual Rainfall Data
- 4) Sediment Load Data.

MODIS images are used to classify the landcover features in the study area. Indeed, the temporal images of MODIS are used in change detection. Six images with one year interval from 2000 to 2005 are selected for this study. The SRTM data is used to generate watershed area of the Mangla dam. Eight tiles of SRTM data are used to generate watershed. The total annual rainfall data from 2000 to 2005 is used in this study to compute the available water for the watershed and to identify the area of heavy rains. Fourteen meteorological observatories are selected to collect rainfall data. Sediment load data for Mangla dam is used to observe the vegetation and rainfall effect on sediment load.

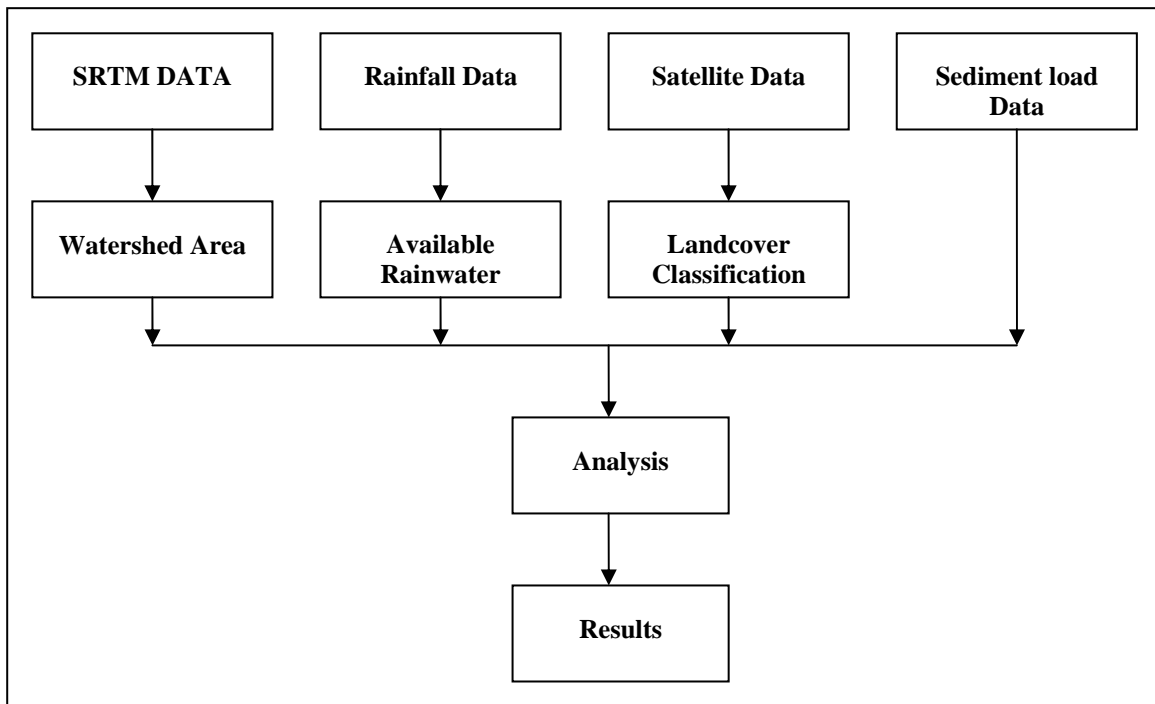


Figure 2: General methodology of research

2.1 Watershed Area

The SRTM data is downloaded in height files. The SRTM height file contains the topographic information of the earth. To generate the digital elevation model (DEM), the SRTM data need processing. By using Landserf software the height tiles are first converted into landserf format (“.srf”) and then voids in data (due to sensor defect) are removed with the help of the software,. The eight Landserf files are converted to text files.

The text files contain latitude, longitude and elevation information for each and every pixel. Triangular irregularated network is generated from the text files in ArcGIS 9.1. Triangulated Irregular Network (TIN) raster files are then converted to DEM raster files and then converted into single Dem file using Mosaic tool.

ESRI’s ArcHydro tool is used for extracting the watershed area from digital elevation model. The first step in this processing is to *fill sinks* in the DEM. Sinks are sudden change in pixel height values.

Using hydrological modeling the *flow directions* raster is generated from DEM. The flow direction raster actually shows the direction of water flow. Each and every pixel in flow direction raster is assigned a slope value.

The next process is the *flow accumulations*. The flow accumulation is computed from the flow direction raster. The flow accumulations raster contains the accumulated number of cells upstream of a cell.

By using this flow accumulation raster the stream definition raster is generated. The *Stream Definition* function takes a flow accumulation raster as input and creates a stream raster for a user-defined threshold. This threshold is defined either as a number of cells (default 1%) or as a drainage area in square kilometers. In this data processing for stream definition the default 1% is selected.

To get the stream network in the area, *stream segmentation* raster is generated from stream definition raster. This function links the stream definition raster to make the streams networks for the area.

The *catchments delineation* raster is computed from stream segmentation. The catchments raster delineation function creates a raster in which each cell carries a value indicating cells belonging to catchments. The value corresponds to the value carried by the stream segment that drains that area, defined in the stream segment link raster.

To extract catchments polygon shape file the *catchments polygon processing* is done on catchments delineation raster. The adjacent cells in the raster that have the same raster code are combined into a single area, whose boundary is vectorized. The single cell polygons and the "orphan" polygons generated as the artifacts of the

vectorization process are dissolved automatically, so that at the end of the process there is just one polygon per catchment.

The drainage lines are generated from the stream definition raster and flow accumulation raster using Arhydro tool *drainage line processing*. The drainage line processing function converts the input stream link raster into a drainage line feature class. Each line in the feature class carries the identifier of the catchments in which it resides.

Lastly the watershed extraction is done by *adjoint catchments processing* function. The Adjoint Catchment Processing function generates the aggregated upstream catchments from the "Catchment" feature class. For each catchment which is not a head catchment, a polygon representing the whole upstream area draining to its inlet point (reservoir) is constructed and stored in a feature class that has an "Adjoint Catchment" that is basically the watershed of Mangla Dam. The Mangla Watershed and its stream network is shown in Figure 1.

2.2 Available Rainwater

Annual available rainwater for the watershed is calculated from the annual rainfall data. From 2000 to 2005 total rainfall for 14 stations are collected.

Six raster files for each year from 2000 to 2005 are generated from annual rainfall data having projected coordinate system "WGS 84 North UTM zone 43".

To calculate the available rainwater the watershed area is clipped from the rainfall interpolated raster files. So the rainwater is calculated using function "Area and Volume" from the rainfall raster files. The available rainwater for the watershed for each year from 2000 to 2005 in million cubic meters is given in Table 1.

Sr.#	Year	Available Rainwater (mcm)
1	2000	22853.14
2	2001	19850.58
3	2002	18533.38
4	2003	21982.79
5	2004	22696.98
6	2005	21741.84

Table 1: Computed annual available rainwater

2.3 Landcover Classification

The landcover classification to monitor the vegetations cover in the watershed area is performed with MODIS data. Seven MODIS images are used for landcover classification.

To observe landcover changes over a six year period, supervised classification technique is adopted. Six images as discussed before are used for classification. As described before the band combination that was used for the interpretation is 7, 5, 3 of MODIS data. All the images are classified using supervised classification technique. In this classification user has to select the training area to specify one landcover feature. In this study, four classes are addressed i.e. vegetation, snow, water body, and bare land. All six MODIS images are classified having these four classes. In the first instance, spectral signatures are made for each image by selecting ten to fifteen training area for each landcover feature and then by using these signatures the images are classified using ERDAS Imagine 8.7. The results of the classification of the area covered by each landcover feature in square kilometers (km²) for all six images are given in Table 2.

S#	LandCover Practice	2000	2001	2002	2003	2004	2005
		Area (km ²)	Area (km ²)	Area (km ²)	Area (km ²)	Area (km ²)	Area (km ²)
1	Vegetation	12543.09	18125.86	18228.45	17061.85	17827.73	16915.07
2	Bare Land	7230.39	6938.74	6578.05	5138.91	8095.24	9098.61
3	Water Body	1553.62	807.50	1009.48	486.90	767.96	494.21
4	Snow	7932.41	3390.78	3438.74	6555.21	2569.48	2753.79

Table 2: Landcover Classification Results

3 Results and Discussions

3.1 Impact of Rainfall on Vegetation

The vegetation trend is observed to be inversely proportional to rainfall. The vegetation covered area for year 2000 was 12543.09 km² with annual rainwater available for year 2000 as 22853.14 mcm. Rain water that was available for watershed in year 2001 was 19850.58 mcm and vegetation covered area in 2001 was 18125.86 km². In 2002 the vegetation trend remains the same with decrease in available rainwater to 18533.38 MCM, while the vegetation increased to 18228.45 km². Again the available rainwater increased to 21982.79 mcm and vegetation decreased to 17061.85 km². The vegetation trend changed slightly in the year 2004 with increase in rainwater from 21982.79 MCM to 22696.98 mcm. An increment in vegetation was observed from 17061.85 km² for 2003 to 17827.73 km² for 2004. Again in 2005 the vegetation and rainwater both decreased rainwater 21741.84 mcm and vegetation 16915.07 km². Graphical representation of rainfall impact on vegetation is given in Figure 3.

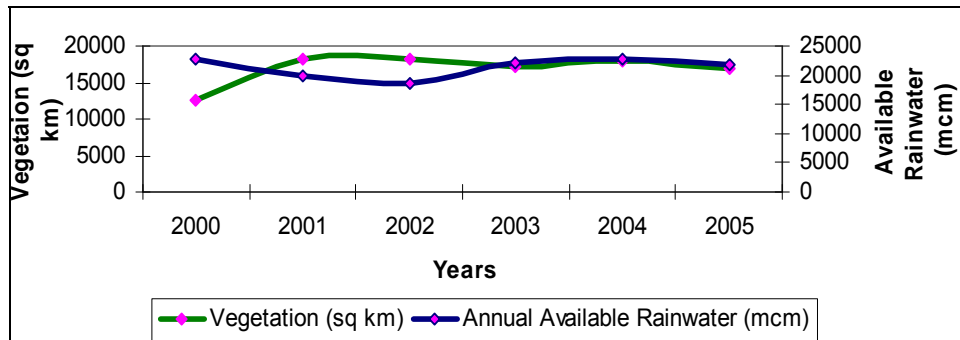


Figure 3: Impact of Rainfall on Vegetation

3.2 Impact on Reservoir Capacity

The comparison between sediment loads is performed differently because the data for sediment load is recorded as total load for two to three year rather than for a single year. The sediment load, vegetation covered area and rainfall water are given in Table 3.

S#	Name	2000	(2001-2002)	(2003-2005)
1	Vegetation (km ²)	12543.088	Average 18177.150	Average 17268.216
2	Annual Available Rainwater (MCM)	22853.140	Average 19191.980	Average 22140.550
3	Sediment Load (MCM) Data Source:(WAPDA)	34.524	Total 115.902	Total 73.98

Table 3: Rain water and Vegetation Impact of sediment Load

The sediment load for 2000 was 34.524 mcm with 12543.088 km² of vegetation covered area and rainwater 22853.140 mcm. The average vegetation covered area for the year 2001 and 2002 was 18177.150 km² and average rainwater for same two years was 19191.980 mcm with total sediment 115.902 mcm. The average rainwater available for three years from 2003 to 2005 is 22140.550 mcm and average vegetation covered area is 17268.216 km² while the total sediment load was 73.98 mcm.

3.3 Identification of Erosion Prone Areas

The erosion prone areas are identified for each year from 2000 to 2005. The identified erosion prone areas and rainfall distribution maps are given in figure 4.

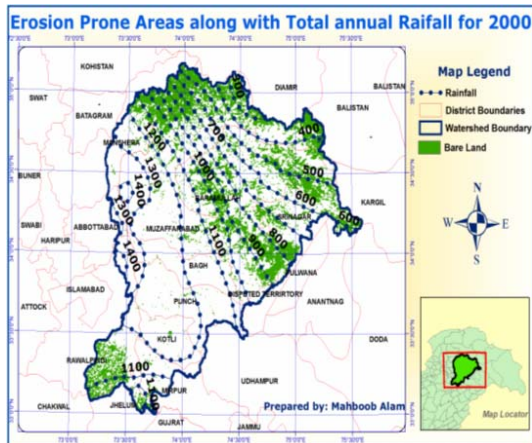


Figure 4(a): Erosion Prone Area's Maps for year 2000

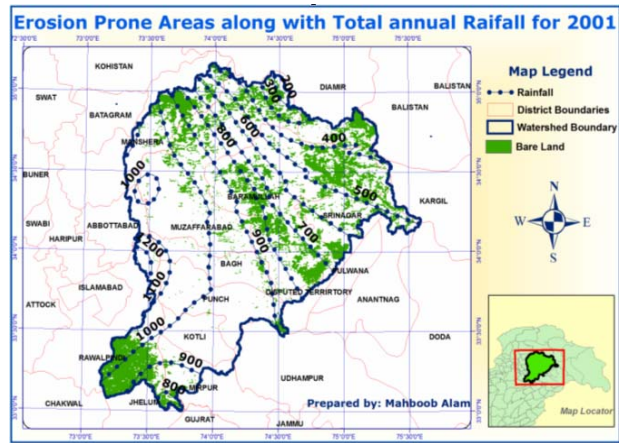


Figure 4(b): Erosion Prone Area's Maps for year 2001

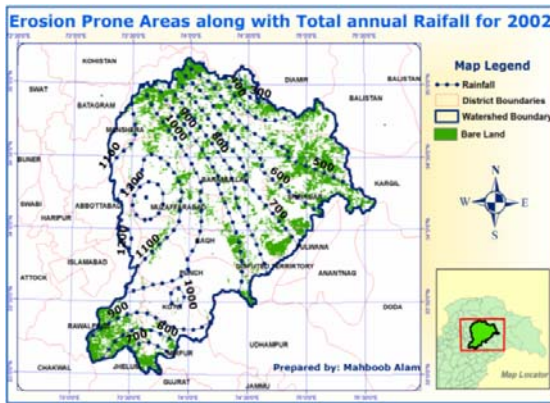


Figure 4(c): Erosion Prone Area's Maps for year 2002

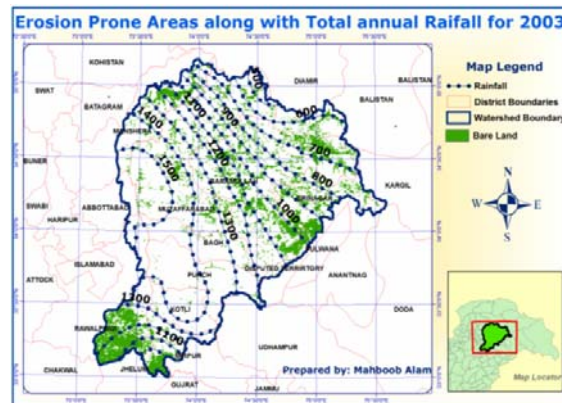


Figure 4(d). Erosion Prone Area's Maps for year 2003

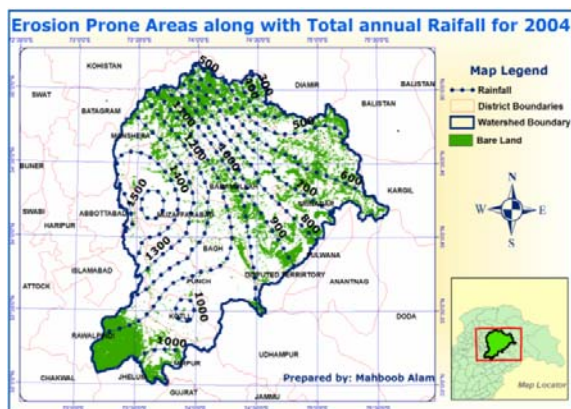


Figure 4(e): Erosion Prone Area's Maps for year 2004

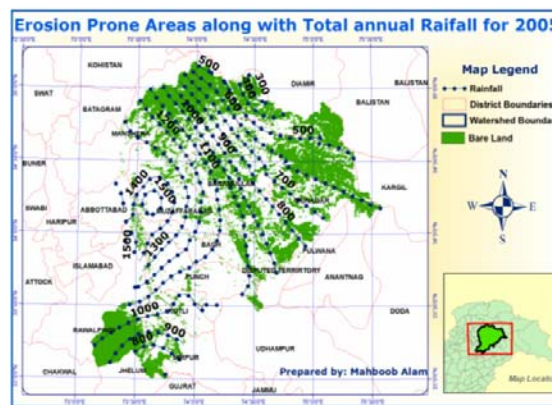


Figure 4(f): Erosion Prone Area's Maps for year 2005

4 Conclusions

Resource conservation has always been a critical issue as far as its efficient preservation and utilization is concerned. This study has helped enlighten the effects of different parameters that have majorly caused sedimentation in Mangla water reservoir. Incorporating the rainfall interpolation procedures have revealed the complex relationship between vegetation and available rainwater, depicting that decrease in vegetation along with heavy rainfall triggered the erosion process.

References

- Alejandro, M. de Asis, Kenji Omasa., 2007. Estimation of vegetation parameter for modeling soil erosion using linear Spectral Mixture Analysis of Landsat ETM data. *ISPRS Journal of Photogrammetry & Remote Sensing* 62 309–324
- Des E. Walling, N.D, *Global Change and the Sediment Loads of the World's Rivers*. Department Of Geography, University Of Exeter, Amory Building, Rennes Drive, Exeter, Devon, Ex4 4rj, Uk.
- Nasir A, Uchida K, and Ashraf M, 2000, Estimation of Soil Erosion by Using RUSLE and GIS for small Mountainous Watershed in Pakistan. *Pakistan Journal Of Water Resources*, 10(1) :
- Mangla Dam . N.D, Report by Pakistan Water and power Develoment Authority, Pakistan. <http://www.waterinfo.net.pk/pdf/md.PDF> (accessed 10.02.2008)
- Indus Basin. N.D, Report by Pakistan Water and power Develoment Authority, Pakistan. <http://www.waterinfo.net.pk/pdf/indusbasin.PDF> (accessed 15.03.2008)
- Wischmeier, W.H., Smith, D.D., 1978. *Predicting Rainfall Erosion Losses: A Guide to Conservation Planning*. US Department of Agriculture, Agricultural Handbook Number, vol. 537. Government Printing Office, Washington, D.C.
- Baver, L.D., 1956. *Soil Physics*, third ed. John Wiley & Sons Inc., New York.

DEFORMATION ANALYSIS OF A LANDSLIDE USING CONTINUUM MECHANICS AND INTERPOLATION METHODS

Paul Rawiel

Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
paul.rawiel@hft-stuttgart.de

KEYWORDS:

Deformation analysis, continuum mechanics, interpolation, approximation, landslide

ABSTRACT

One important topic in surveying is the monitoring and analysis of deformations of different kinds of objects, such as buildings, industrial constructions or geological structures like rocks, glaciers and landslides. Especially geology, hydrology, geodesy, geotechnical and mechanical engineering are cooperating concerning triggering effects, dynamic models, disaster prediction and technical countermeasures. One important interface between mechanics and geodesy is the interaction between dynamic models for an object under influence of physical interactions and the motion or deformation pattern coming from geodetic measurements, which can be used to develop, adjust or tune the model. Geodetic measurements usually are done to individual discrete points that represent the object to be analyzed. Usually the deformation analysis is then based on the movements of several single points without considering the moving object as a continuum. The paper presents a method to interpolate a continuum out of the single point measurements that allows the calculation of deformations in the infinitesimal surrounding of any point of the object at any time. This paper presents the results for a project in the Austrian Alps, where a land slide caused damages to buildings near a ski slope.

IDENTIFICATION AND MAPPING OF SPATIAL DISTRIBUTION OF FLOATING AQUATIC PLANTS IN TANKS USING REMOTE SENSING AND GIS

S. R. Wadduwage^a, S. Sivanandarajha^b and J. Gunatilake^{c,*}

^a Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka
surangagis@gmail.com

^b Survey Department Sri Lanka, Colombo-5, Sri Lanka
ssgis@slt.net.lk

^c Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka
jagath@pgis.lk

KEY WORDS:

Floating Aquatic Plants, Remote Sensing, IKONOS, Management, Sri Lanka.

ABSTRACT

An attempt was made to identify and map the floating aquatic plants in a small tank called "Mahawewa" in Puttlam district of western Sri Lanka, since most Sri Lankan dry zone tanks are affected by the invasive floating aquatic plants (IFAP) creating many ecological and socio-economic problems. There are no sufficient studies on IFAP spatial distribution to manage and conserve these valuable cascade ecosystems in the country.

Increasingly, efforts are made to avoid invasions or eradicate or control established IFAPs. It has long been recognized that Remote Sensing (RS) and Geographical Information System (GIS) could contribute to this, for instance through mapping actual IFAS distribution and areas at risk of invasion. Potentially GIS could also be used as a synthesizing tool for management of interventions aiming at invasive species control.

This study is an attempt to identify the IFAS spatial distribution using IKONOS satellite imagery analyzing Electro-Magnetic Radiation (EMR) emitted by different species. IKONOS Multi Spectral Scanning (MSS) imagery was used to obtain NDVI classification of the tank. Classified classes were identified using the sampling data, Quick Bird imagery and digital photographs of the study area. Finally, IKONOS MSS imagery was classified according to the derived classes. Error estimation was done to find the accuracy of the FAP classification. Based on these results, FAP extent was quantified.

Accordingly images are analyzed to identify major FAP spread and GIS mapping can be done in a large scale. GIS software allows generating geo-referenced large-scale maps of IFAP locations and abundances. These maps can be used to quantify the threat of IFAP, and assist in management decisions and future monitoring.

1 Introduction

Sri Lanka has more than 100 water basins, varying from 10 km² to over 10,000 km² in size. Today's map of Sri Lanka, especially the so-called dry zone, is dotted with literally thousands of ancient tanks of varying sizes and shapes (IUCN-WANI, 2006).

At present, most of the small tanks in the dry zone of Sri Lanka have been affected with the rapid expansion of the Invasive Floating Aquatic Plants (IFAP) which has severe ecological impact and economic cost. Invasive species are a current focus of interest of ecologists, biological conservationists and natural resources managers due to their rapid spread, threat to biodiversity and damage to ecosystems. Invasions may alter hydrology and nutrient accumulation (Polley et al., 1997). These IFAP help to increase the flood threat in different parts of the Island. Highly abundant IFAP in Sri Lanka are Eichhornia crassipes, Pistia stratiotes, and Salvinia molesta. It forms dense mats over lakes and slow moving rivers and causes large economic losses and a wide range of ecological problems to native species such as Nelum (Nelumbo nucifera) and communities.

These IFAP have been introduced to Sri Lanka in different periods due to various reasons. At present these IFAP have dominated the stagnant fresh water bodies in most parts of the Island. Especially, this situation has highly affected the people who live in the dry zone areas by disturbing their day to day activities. But there is no proper

survey carried out so far regarding these IFAP due to lack of resources, difficult accessibility and inadequate attention. These species spread on fresh water bodies rapidly and dominate and suppress native vegetations. There are lots of variables such as temperature, water quality, salinity, etc which influence this process. Nobody knows the way of spreading and what the locations are. Identification of spreading pattern of these IFAP is very important to take actions to control or manage in future. However, the conventional survey methods take more time to estimate spreading areas and it is a costly event. Integrated Geographical Information Systems (GIS), Remote Sensing and Global Positioning System (GPS) can be used as a tool to mitigate above problems and it gives very accurate and precise maps and models for predictions on future distributions (Gunawardana et al., (2007). These kinds of information are very important to appropriate management practices and conservation efforts. Satellite remote sensing has come up as a potential tool to map and classify land use cover and vegetation cover classes in remote and in inaccessible regions (Lal et al., 1991).

Study Objectives

This study explores the relationship between IFAP emitted radiation and satellite imagery data; identifies possibility of mapping the spatial distribution of IFAP and vegetation using IKONOS imagery.

The specific objectives are to

- Assess the relationship between IFAP and vegetation classes using different band combinations of multi-spectral IKONOS satellite imagery.
- Assess the spatial distribution of FAP.
- Explore the possibility of mapping the spatial distribution of IFAP and vegetation with high accuracy using imagery.

2 Research Method

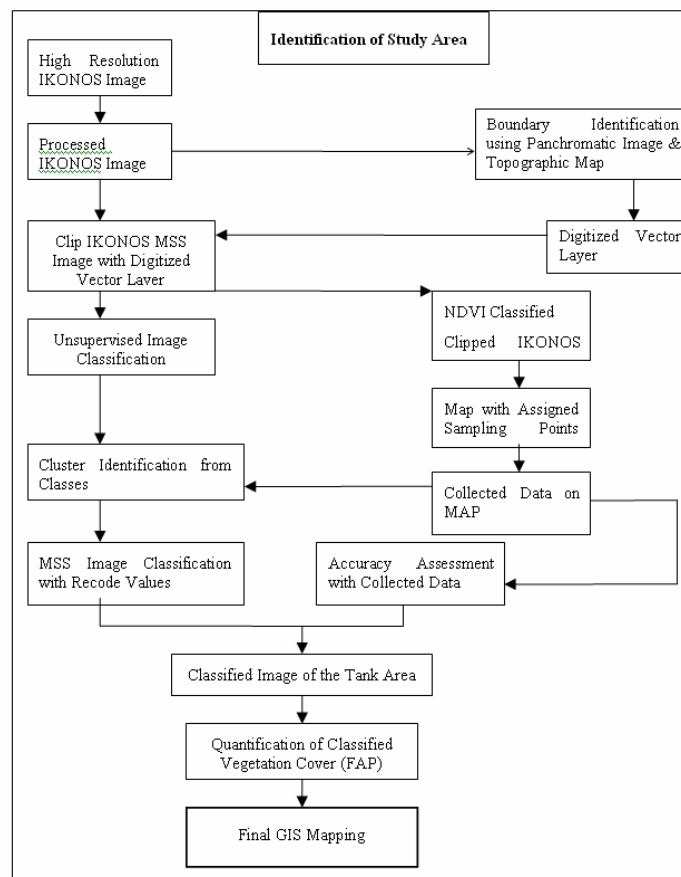


Figure 1: Research Methodology

2.1 NDVI Image Classification

Image classification is based on the different spectral characteristics of different materials on the earth's surface (Wim et al., 2001). Sub set of IKONOS image was used as the input image for NDVI classification. This NDVI classification was done according to the formula with the use of Image Interpreter in ERDAS software. The resulted grayscale NDVI of the classified image ranges from -0.13217 to 0.222997. But there is no possibility of using this grayscale NDVI image to identify the different classes by visual image interpretation. Therefore this NDVI image was sliced to different colours by assigning colours to start and end. It resulted imagery with clearly differentiated classes. Considering different classes in the classified NDVI image, four major vegetation types were identified. True Colour, high resolution Quickbird imagery was also used to verify the reliability of the classification. Boundary of water bodies were demarcated using existing topographic maps and multi-spectral satellite imagery- panchromatic band.

2.2 Sampling Design

Spatial data comes in many varieties and it is not easy to arrive at a system of classification that is simultaneously exclusive, exhaustive, imaginative and satisfying. Due to that reason proper sampling method should be adopted in order to represent the total population (Graham and Fingleton, 1990).

This Classified NDVI image was used to identify the major vegetation types and to allocate sampling points for the study area. The imagery was first interpreted visually based on false colour composite. Vegetation in water body is heterogeneous and to capture this variation for classification purposes, sampling points were selected based on proportionate random sampling design. This was done using the results of the sliced NDVI image which was classified using unsupervised scheme.

2.3 Field Data Collection and Analysis

A set of hand held GPS (Sub-meter accuracy) and high resolution Quickbird Satellite imagery were used to navigate to the sample points in the field. The images were predetermined using the NDVI sliced image. Shape of the tank boundary and the physical landmarks were used to confirm the sampling points. Major classes of the sliced image were also helpful to find vegetation types.

Square plots of 30X30 feet were established for vegetation attributes assessment. In particular plot's water percentage, IFAP cover percentage and other vegetation cover percentage were visually recorded. Water height was also measured in each and every sampling point.

2.4 Identification of Different Classes

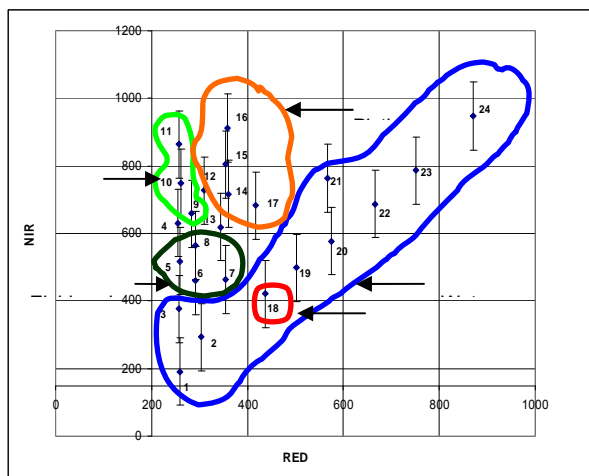


Figure 2: Feature Space with Major Clusters Clusters.

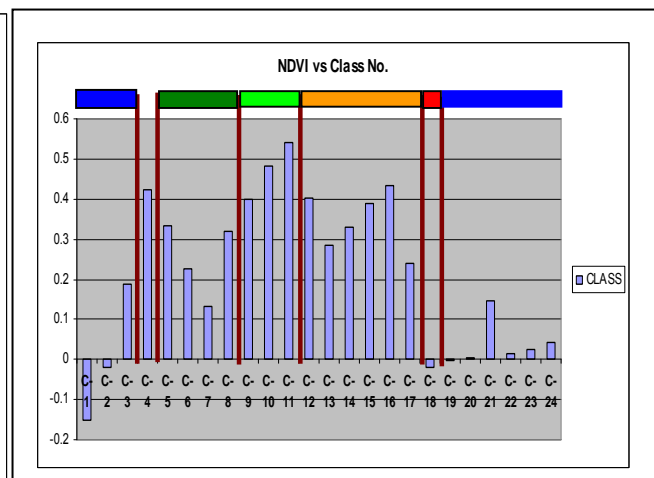


Figure 3: NDVI Graph with Major

Identified clusters were scattered in five different groups as above. Scattered classes were grouped together and finally merged these signatures and observed five major classes (clusters) out of 25 classes.

Cluster 1: (C1-C3, C19-C24) Water, Cluster 2: (C5-C8) Eichhonia, Cluster 3: (C9-C11) Grass, Cluster 4: (C12-C17) Pistia, Cluster 5: (C18) Nelum.

In visual interpretation, trained eye and brain operate as a very sophisticated contextual classifier and adaptive expert system, interactively learning from mistakes and refining the classification (Christopher and Nicholas, 1995).

Clipped IKONOS multi spectral imagery were subjected to unsupervised classification into 25 classes using ERDAS software while creating a signature file to these classes. Numbers of classes were assigned considering the levels of detail we require, pixel resolution and mapping scale (Chandrashekhar, 2006). Visual interpretation was done using high resolution Quickbird satellite imagery, before assigning the classes into clusters. At clustering stage, each and every cluster was visually cross checked with the classified layers as well as with high resolution satellite imagery. Classified image was recoded according to the identified clusters with different colours at the final stage.

Most of these classifiers are sophisticated and require good knowledge of remote sensing and classification, and sometimes advance equipment. This may be a challenge to many resource managers in developing countries despite the need for mapping skills in resource monitoring (Zacchaeus, 2007).

3 Results

The FAP of the tank covering study area was classified into 6 classes based on Maximum Likelihood and Minimum Distance classifier: *Eichhornia crassipes* (Eichhornia), *Pistia stratiotes* (Pistia), grass grown on IFAP (Grass), native plant (Nelum) community and water.

These classified classes were represented in map with different colours according to the legend. Sites were assigned to these classes based on dominant species within the sampled plot. While water body is represented in Blue, FAP Species are represented with other colours. According to the results, maximum cover was due to *Pistia stratiotes* (Pistia) whereas minimum cover was by Nelum (*Nelumbo nucifera*). *Eichhornia crassipes* (Eichhornia) and Grass always acquire larger area while native plant (Nelum) exist as small patches in the tank area Figure 4 shows the spatial distribution of the cover classes based on maximum likelihood classifier.

Most of the *Pistia stratiotes* (Pistia) distribution could be seen at openings of the water body. There is a high competition to survive native plants from IFAP spread, mainly with *Pistia stratiotes* (Pistia) in exposures of the water body. Grass and the *Eichhornia crassipes* (Eichhornia) distributed along the boundary of the study area and narrowed areas. Most of the *Eichhornia crassipes* (Eichhornia) distributed in the stagnant water areas.

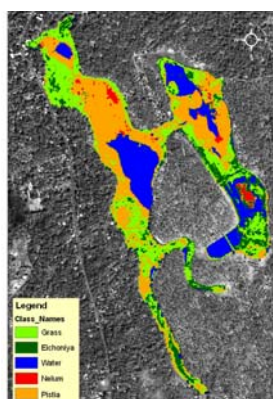


Figure 3: Mapped FAPs with Tank Surrounding Area

	Area (ha)	% Cover
Pistia	24.3504	35.96
Eichhornia	10.1792	15.03
Grass	18.7824	27.74
Native Sp.	1.4624	2.16
Water	12.9328	19.10
Total	67.7072	100.00

Table 1 FAP Quantified Data

Small species such as *Salvinia molesta* and other small ferns couldn't be identified in this scale due to their hidden characteristics and small scale. These small species won't register in satellite images due to few amounts of homogeneous scattered species present.

According to the observed results, approximately 80% of the study area is covered with the FAPs. Only 15% - 20% of the tank area was existing as water body exposure. These water body exposures mainly exist in the center areas except the South-East areas. These areas were maintained by a coconut plantation company. Tank area was mapped with its surrounding features to get clear idea about the study area. This map was used to compare the spread of classified FAPs with respect to the sizes of surrounding features.

These features were mapped by overlapping the classified FAP layer and digitized features with the IKONOS high-resolution panchromatic imagery.

3.1 Floating Aquatic Vegetation Cover Quantification

Classified FAPs of the study area were quantified to get exact percentages of different feature classes. Quantification was done analyzing the relevant species pixels of the classified classes. Area of extent for each and every classified class could be obtained by counting the relevant pixels. Area of each species was calculated using relevant pixels in the map. Exact ground representation of each species was taken using the scale of the map.

3.2 Spatial Distribution of Aquatic Vegetation Cover Classes

Spatial distributions of the identified main classes were directly linked with different variables. Most of the IFAP start spreading from the peripheral of the tank. Then it spreads towards the centre of the tank while dominating the native FAP Species. This condition is more significant in stagnant shallow water.

Analysis was done to find relationships between water height and floating vegetation cover.

Initially, DEM was created with the use of the interpolated layer which derives from the water heights. Then the tank boundary was identified with the DEM by overlapping the two layers. Classified layer overlapped with the water height helped to find any relationship between water height and floating vegetation cover. According to the results, openings of the tank area have higher water depth than the vegetation covered areas. This is significant especially with the IFAPs.

This observation was justified with the 3D layer which was created with the classified FAP layer using the water heights. According to the results, most of the peaks were representing the water openings, native species or *Pistia stratiotes* (*Pistia*). Lower areas of the 3D layer having the Grass and *Eichhornia crassipes* (*Eichhornia*) exist as thick layer. High level of silt could be observed with these species located in the peripheral areas of the tank.

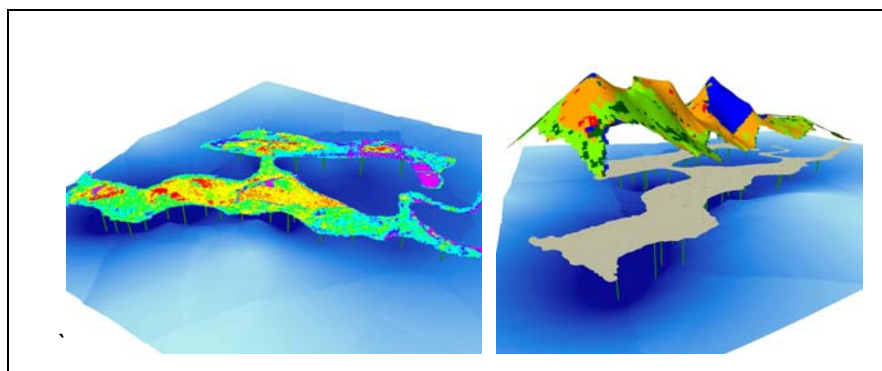


Figure 5: Classified Layers with Water Heights in Different Angles.

	Ref	Classified total	Correct	Producer accuracy	User accuracy	Kappa Sts.
Un classified	0	1	0	N/A	N/A	
Eichhornia	11	11	8	72.72	72.73	0.641
Grass	16	15	12	75	80	0.7142
Pistia	12	13	11	91.6	84.6	0.7837
Nelum	2	3	1	50	33.3	0.290
Water	9	7	5	55.55	71.42	0.6676
Total	50	50	37			

Overall Accuracy = 77.48%

Overall Kappa Statistics = 0.6818

Table 2: Accuracy Assessment for Classification

3.3 Accuracy Assessment

Accuracy of the classified image was tested with the data which were collected at the accuracy assessment sampling points. Testing was done comparing the classified classes information with the ground collected data. The quality of classified maps depends on their classification accuracy (Foody, 2002). This is because the accuracy of a thematic map influences the output of its application (Powell et al., 2004).

Therefore accuracy assessment is an essential step in proper image classification in order to check for errors propagated by the way data is acquired, analyzed, and converted from one to the other. The most commonly used method to assess classification accuracy is the error or confusion matrix (Congalton et al., 1999). However it may have shortcomings that the result from the ambiguity of implementation, lack of acceptance on the appropriate accuracy to report or virtually the way the results are interpreted (Powell et al., 2004; Foody, 2002).

4 Conclusion and Recommendations

This study was an attempt to evaluate the potential of RS and GIS techniques for the critical task of IFAP mapping. Through the integration of RS and GIS techniques, high scale mapping could be done to visualize the current conditions of IFAPs' spatial distribution in the Mahawewa tank area as a pilot study.

Following conclusions were derived from this study.

- The spatial distribution of IFAP was mapped with high producer accuracy (73.7%) and user accuracy (77.18%) using IKONOS imagery. Overall accuracy of 77.48% was achieved in the final cluster classification.
- IKONOS imagery provided a good source for classification of FAP vegetation. However, care is needed for its application in mapping and identifying the spatial distribution of FAP and grass vegetations especially, in the heterogeneous areas or when undertaking detailed mapping at local scale. This is due to inseparability between classes and generalization resulting from MSS satellite imagery.
- *Pistia stratiotes* presence declined with elevation of the water depth. *Eichhornia crassipes* and grass species showed preference for lower zones prone to regular flooding.

5 Recommendations

This study explored the FAP Species spatial distribution and the way of its spreads in tank area. It further evaluated the relationship between water depth and FAPs distribution in this environment. However, there is a need to investigate how the observed vegetation (FAPs) changes over time through seasons. There is a possibility to carry out the same research methodology in a wet zone tank to identify the relationship between IFAPs reflectance with spectral indices.

References

- Chandrashekhar, B. (2006) Integrating RS-GIS Data in mapping and modeling; A case study of Udawalawa river basine. IWMI.
- Christopher, L. and Nicholas, J. (1995) 1:50,000-scale forest mapping of Sri Lanka: basis for a National Forest Geographic Information System. The Sri Lanka Forester. Forest Department. Sri Lanka.
- Congalton, R.G. and Green, K. (1999) Assessing the Accuracy of Remotely Sensed Data, Principles and Practices , Boca Raton Lewis Publications.
- Foody, G.M. (2002) Status of land cover classification accuracy assessment, Remote Sensing of Environment, 80, 185-201.
- Graham, J.G. and Fingleton, B. (1990) Spatial data Analysis by Example, John Wiley & Sons Ltd. UK.
- Gunawardana, J.A.R., Edussuriya C.H. and Chandrakanthi K.G. (2007) Monitoring of Water Plants Distribution in Tissa, Debara and Yodakandiya Tanks using the remote sensed data. Central Environment Authority, Sri Lanka.
- IUCN Water & Nature Initiatives (WANI), (2006) Integrating Wetland Economic Values into River Basin Management Project. Available at <http://www.iucn.org/places/srilanka/policyProjects.htm>. (Accessed 7th November 2007).
- Lal, J.B., Gulati, A.K. and Bist, M.S. (1991) Saterllite mapping of alpine pastures in the Himalayas, International Journal of Remote sensing, 12(3): 432-443.
- Polley, H.W., Mayeux, H.S., Johnson H. B., and Tischler, C. R. (1997) Atmospheric CO₂, soil water, and shrub grass ratios on rangelands. Journal of Range Management 50, 278–284.
- Powell, R. L., Matzke, N., de Souza, C., Clark, M., Numata, I., Hess, L. L., Roberts, D. A., Clark, M., Numata, I., and Roberts, D. A. (2004) Sources of error in accuracy assessment of thematic land-cover maps in the Brazilian Amazon. Remote Sensing of Environment 90: 221-234.
- Wim, H.B., Lucas, L.F., Colin V.R., Ben, G.H.G., Christine, P., Michale J.C., Weir-John, A.H., Anupama, P., and Tsehaie W. (2001) Principal of Remote sensing, The International Institute for Aerospace Survey and earth science (ITC), Netherlands.
- Zacchaeus, K.N. (2007) Mapping and Monitoring Wetland Vegetation used by Wattled Cranes using Remote Sensing: Case of Kafue Flats, Zambia. Masters of Science Thesis, ITC, Netherlands.

SURVEYING TOURISM POTENTIAL FOR SUSTAINABLE DEVELOPMENT IN BOLIVIA: CASE STUDY “REPRESA DE LA ANGOSTURA”

Mirka Rodríguez de Zimmermann

Faculty of Geosciences, University Tübingen, Germany
mirka_rod@gmx.de

KEYWORDS:

Angostura, tourism potentials, spatial-analysis, sustainability, development, regional, Bolivia

ABSTRACT

Bolivia belongs to those countries owning the biggest biodiversity worldwide. Moreover, the country owns very rich ancient cultures. Although all these assets offer a big potential for tourism, Bolivia does not play a big role at the international tourism market. However, the significance of this sector to the national economy may not be underestimated. The international tourism is for the country between the main foreign currency sources after the soy export and oil derivatives.

During the last years tourism has been considered in some rural Communes in Bolivia, as possible potential development factor to be implemented. According to the principles of sustainable development this process must lead to the population welfare increment, conserving or rather improving the ecological stability. That means for the tourism, that its development must occur according to these principles. The sustainability can then be appreciated when it improves the population quality of life in such a way that still offers social security to later generations and therefore no irreparable resources damage will occur (Vorlaufer, 1996).

This paper handles the case study “Surveying Tourism potential at the Angostura dam and surroundings”. La Angostura is a water reservoir, which originally was built as part of a national irrigation system located in the Arbieta Commune in Cochabamba, Bolivia. La Angostura is one of the principal touristic areas of Cochabamba. A regional spatial analysis from the tourism point of view will be performed, together with empirical data research methods like expert’s interviews, fieldwork as well as GPS-tracks survey, between others. These investigations are being executed in order to know which culture and nature spatial factors exist and which role tourism is playing over there. Because of the different kinds and sources of information required as input for this project, Geographical Information Systems are used to support their different phases.

DEVELOPMENT OF AN ADMINISTRATION-WIDE GEOGRAPHICAL INFORMATION SYSTEM FOR AGRICULTURAL APPLICATIONS¹

S. Brand, M. Schulz, Aitana Zambrana

GAF AG, Arnulfstraße 197, D-80634 Munich, Germany

KEY WORDS:

EU, GIS, IACS, LaFIS[®], LPIS, StMELF, WMS

ABSTRACT

Due to the importance of the agriculture in Europe the European Union (EU) created the CAP (Common Agricultural Policy), system of agricultural subsidies and programs. In 1992 a reform to the CAP introduced a direct area-based subsidies for farmers, part of the CAP Integrated Administration and Control System (IACS), required the Member States to set up a Land Parcel Identification System (LPIS) based on land registry, maps, cartographic references, aerial or satellite imagery, mainly used for area bases subsidies and crosschecking of the farm declarations. The Geographic Information System (GIS) and the LPIS tools just achieve that. Therefore the use of alphanumerical and geographic data made compulsory the use of GIS.

1. INTRODUCTION

Within this European Agricultural context, GAF AG an international consulting company with extensive experience in applied remote sensing and spatial information systems, has provided many services in the area of Agriculture from research to development of Geographic Information System for Agriculture, LaFIS[®] (Agricultural Land Information System), the predominately software used as IACS-GIS solution in Germany which was adopted to various IT environments and administrative procedures in various Federal States.

Since 2004, a Geographic Information System for parcel declaration was created for the Bavarian Ministry of Food, Agriculture and Forestry (StMELF) to accomplish with the European Policy of Agriculture. In this paper, the system will be described, starting with the declaration of the farmers to the maintenance of the data by the Ministry and Agricultural Offices.

2. FARM DECLARATION

Every year during the winter begins the period for parcel declaration. The farmer must declare their managed agricultural parcels by giving information of the location, area and details of crops like landscape elements to their allotted Agricultural Office. The declaration can be done in analogue form such as: paper maps of each parcel drawn by the farmers and declaration forms or digital, via the MfA Online (Multiple Formular Forms Online) that contains forms for alphanumerical declaration located in the Bavarian Ministry.

Additionally a web service called BayernViewer hosted by the Bavarian Surveying Authority (BVV) is connected to the database of the Bavarian Ministry that contains the geographic information of the farm declaration, where the farmers can see information about their parcels and specify which parcels not longer belong to them.

As part of the task of the editors in the Agricultural Offices is to check the received declarations of the farmers and to enter the analogue alphanumerical data in the LPIS database BaLIS (Database application on an IBM host

¹ Adapted paper for presentation proposes at the Summer School AGSE 2009, based on original paper written by: Schulz, M. & Brand S., 2009. Development of an administration-wide Geographical Information System for agricultural applications.

system). The alphanumeric data that was handed in digital form is checked for plausibility by the host system. As a next step, the agricultural parcels have to be either newly entered or updated in the GIS-System. The parcels of a farmer have to be edited because of building and road constructions influenced agricultural land as well as the transfer of a parcel to another farmer. The client application for this task is the software LaFIS®.

The parcels in the GIS-system are the basis for the subsidy payments for the farmers. The subsidies for Federal State of Bavaria go up to € 1.4 billion per year. The agricultural authorities are forced to check and verify the agriculture parcels eligible for the subsidies. Therefore is necessary to measure the parcels on-the-spot controls or by remote sensing means, usually done with the most recent satellite images (IKONOS, SPOT) available provided by the Surveying Ministry of Bavaria. At least 5% of the 125,000 farmers have to be controlled each year. For the on-the-spot controls, the mobile GIS-client called LaFIS®-VOK (on-the-spot-control) is used. This data can be exported from the main database. The exchange of data for GPS-measurements is also included. The on-the-spot-control consists in verify that the information provided (type of crop, the hectares of the parcel, and applied harvest techniques among others) in the declaration is correct.

3. OVERVIEW OF THE SYSTEM

Figure 1 gives an overview of the system and the components and administrative authorities involved. The core system with declaration data and reference plots is maintained by the StMELF. It consists of the LaFIS®-system and the interface to the LPIS-database BaLIS. Connections exist to the BVV with the BayernViewer –agrar and the Web-Mapping Service (WMS). The WMS is used for the retrieval of raster images (digital orthophotos) for the LaFIS® clients. Therefore, standardized interfaces, like Web Feature Server with Transactional (WFS-T) and WMS, are used in the connection to the BVV. For the communication of LaFIS® with BaLIS customized EntireX interfaces are developed. The BayernViewer, MfA and BaLIS were created and are maintained by the Bavarian Ministry.

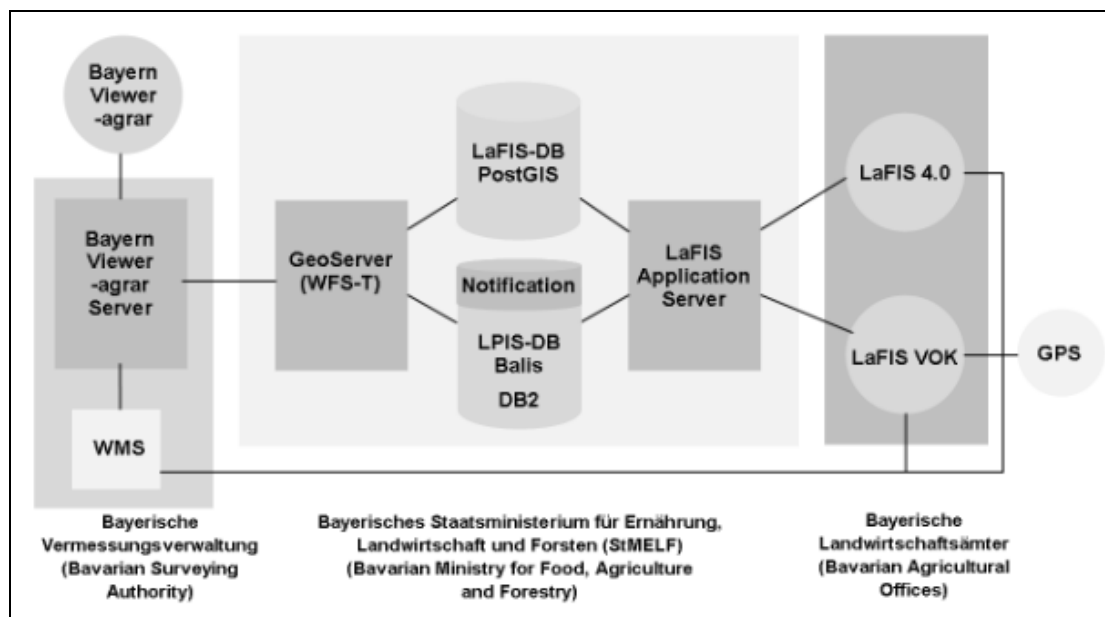


Figure 1: Overview of the system

4. THE CENTRAL GIS-SYSTEM LaFIS®

The central GIS-system uses a flexible three tier architecture, consisting of a spatial database (PostGIS), an application server and the LaFIS® clients.

The application server communicates with two databases: a PostGIS database (LaFIS®-Database) - that is the main GIS-Database storing the spatial data – and BaLIS-Database which stores alphanumeric data maintained by the StMELF. The communication between the Database2 and the application server is managed by EntireX.

The GIS-clients LaFIS®4.0 and LaFIS®-VOK use the application server for data exchange. During the start-up of the LaFIS®4.0 client, spatial data are loaded from the LaFIS®-Database together with the relevant declaration information from BaLIS.

The main GIS-client is LaFIS®4.0, used for the maintenance of reference plots and landscape elements and preparation of on-the-spot control data.

After the preparation of the parcels the data for the spot or remote sensing control can be exported to the mobile client LaFIS®-VOK. The data is exported to an Access Database on a mobile PC. These exported data is locked in the central database. During the export the raster images of the Area of Interest of the farms are retrieved from the WMS. In the field, the parcels can be also exported as shapefiles to a GPS for measurements and the results re-imported to LaFIS®-VOK. After the on-the-spot control, the data are transferred back to the central LaFIS®-System. In LaFIS®4.0, the results of the on-the-spot-controls can then be directly transferred to BaLIS.

5. WFS-T and BayernViewer–Agrar

The main online application used by the farmers for the declaration is the MfA Online which allows registering the alphanumeric data (see Figure 2).

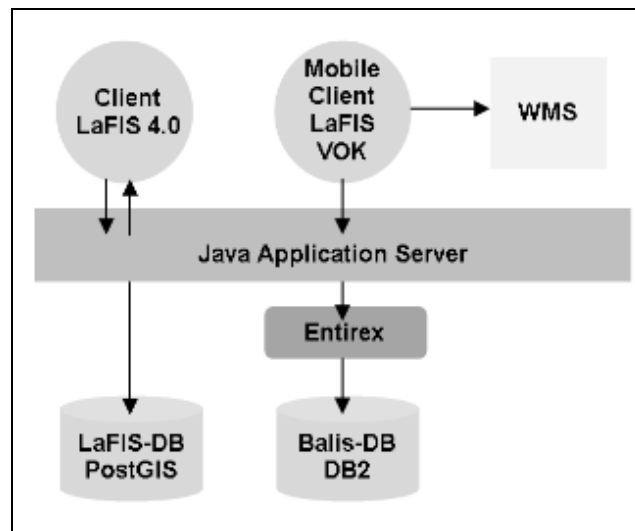


Figure 2: Overview of the central GIS-System

The declaration data has to be processed before is stored as final in the Database. Due to security reasons, the working data is temporarily store in a table; the data is review by an authorized user who will be informed by a notification system based on BaLIS.

Therefore the WFS-T server has to fulfill two tasks. Firstly, the modified data has to be persisted and made available to the LaFIS® system and secondly the notification system has to be activated which is based on BaLIS. In the last step, the authorized user incorporates the notified changes. This is done by means of the LaFIS® client including specific tools for the completion of this task.

The requirements for the creation and implementation of the WFS-T server were defined by the Bavaria Surveying Office. The server should fulfill the following requirements: a product free of cost or at least a lower price, open source-code, easy to use, that deals with security issues, easy to install and maintain, and it should support WFS-T service. Two servers were chosen to test UMN (University of Minnesota) Mapserver and Geoserver. UMN is an open platform for publishing spatial data. The setup of this server was not easy, it didn't have features for dealing with security issues and lack of a good technical support. On the other hand, Geoserver was easy and fast to install and moreover fulfilled the expected requirements.

The WFS-T gives to the user the facility to accomplish task like splitting the parcel, edit the polygon to redefined the the new parcel or new size of the parcel to harvest. WFS-T deals with these data and is send to a temporally table to LaFIS® -Database without modifying the original Fieldblock table and sending a message to BaLIS database to be processed by the editor of the office in charge of this Fielblock. Currently the verification of the changes is done manually by the responsible office where the Fielblock belong to. This is a functionality that could be done by the WFS-T server, but for security reasons the Ministry prefers to keep it in this way. One

future functionality could be that when the farmer enter and submit the data through BayernViewer-Agrar, then the WFS-T sends a notification to the authorized editor and immediately after the change has been approved by the editor, the new modified and approved data could be send via the WFS-T server and displayed again in the BayernViewer-Agrar, notifying the farmer that the data was processed and can be visualized. Futures changes or improvements depend on the time, effort and requirements of the Ministry.

6. SUMMARY AND CONCLUSIONS

The IACS-GIS system-components of the LaFIS® product suite has provided a clear advantages: to allow the administrative checks, and on-the-spot checks, improving time, processing, control and maintenance of LPIS, what means more reliability of the declaration, which benefit the interest of the farmer and European administrations.

The advantages of this system are: no additional paper is necessary, no break in the chain of data, support is provided by plausibility checks in the program and use of data from the previous year speeds up the process.

Since the introduction of subsidies, their annual eligible area and obligations has increased the procedures enormously. Even for Agricultural Staff is difficult to know every detail of the European Agriculture guidelines. This product has become in a straightforward tool reduce the complexity of administrative procedures and data transference.

REFERENCES

- Commission Regulation (EC) No 2419/200, 2001. Laying down detailed rules for applying the integrated administration and control system for certain Community aid schemes established by Council Regulation (EEC) No 3508/92.
- Commission Regulation (EEC) No 3887/92, 1992. Laying down detailed rules for applying the integrated administration and control system for certain Community aid schemes (OJ L 391, 31.12.92, p. 36).
- Council Regulation (EC) No 1593/2000, 2000. Official Journal L 182, 21/07/2000 p. 0004 – 0007.
- Council Regulation (EEC) No 1765/92, 1992. Establishing a support system for producers of certain arable crops (OJ L 181, 1.7.92, p. 12).
- Council Regulation (EEC) No 3508/92, 1992. Establishing an Integrated Administration and Control System for Certain Community Aid Schemes (OJ L 355, 5.12.92, p.1).
- European Commission, 2000. The Community budget: the facts in figures.
- Heider, A., et al., 2001. LPIS related GIS Implementation in Germany. In: Proceedings of the 7th Annual Conference on Control with Remote Sensing of Area-based Subsidies, European Commission, JRC.
- S. Kay, 2002. Implementation of IACS-GIS, Reg 1593/00 and 2419/01, JRC IPSC/G03/P/SKA.
- European Commission, 2001. Land Parcel Identification Systems in the frame of Regulation (EC) 1593/2000 (Version1.4) (Mars ref: OL/I03/M2580/01).
- Lippert, A. et al., 2002. New Technical Components for the Production of Digital Orthophotos within the Remote Sensing Controls; In: Proceedings of the 8th Conference on Control with Remote Sensing of Area-Based Subsidies, JRC.
- Schulz, M., 2007. Sicherheitskonzept Online-Antragstellung, GAF AG.
- Schulz, M. & Brand S., 2009. Development of an administration-wide Geographical Information System for agricultural applications.

ACKNOWLEDGMENT

I would like to thank to GAF AG two allow to present one of the main products, also I would like to thank Matthias Schulz, Steffani Brand and Andreas Kempft from GAF AG for providing me the all the required information and let me used this paper for presentation purposes at the Applied Geoinformatics for Society and Environment 2009.

SOLAR PANEL CALCULATION

Md. Nazmul Alam

Stuttgart University of Applied Sciences

KEYWORDS:

Internet GIS, Rich Internet Application, Solar radiation, Photovoltaic, Data Access Objects, Geocoding, Polygon, Map API, BlazeDS, Adobe Flex

ABSTRACT

Internet GIS is the GIS based on the network technology of the internet. Client, web server, application server, map server, data server etc. are the components of a three tier or n tier client server computing architectural model in Internet GIS. Web 2.0, the second generation of web development and design, has made web applications more interactive and expressive. Adobe Flex, JavaFX, Microsoft Silverlight etc are the frameworks for building RIAs. The Map APIs from Google, Yahoo, ESRI etc and other mapping services, made spatial information more significant and freely available for the users. The task was to build a RIA for calculating produced energy by photovoltaic cells. Adobe Flex has been used for developing the application. Google Maps API has been used for base map. BlazeDS has been used for middleware. The radiation data from NASA has been used for calculation purpose and placed in the Oracle data server.

The research included a close comparison among the similar technologies like Flex, Silverlight, JavaFX, and AJAX to build the RIA, then Google, Yahoo, ArcGIS maps apis were critically compared to provide a suitable base map and services like geocoding. The formulae were developed to calculate energy produced by photovoltaic cells. The data source was selected among various data sources for radiation data.

The client is based on flex/flash for increased interactivity and expressiveness. MXML has been used for user interface and ActionScript for functionality. Google Maps API has been compared and chosen among other APIs for flex available. So the RIA will use the Google Map Server as an External Map Server. BlazeDS which is a J2EE based data server running over Tomcat servlet engine has been used as the middleware for this application. The data server is ORACLE at this moment and will be shifted to MySQL. Here the solar radiation data of SSE dataset from NASA is stored. The data was imported from the source after critically comparing them with one another.

In this application client can search for the desired location, digitize the roof of the house, specify azimuth of the roof by digitizing a line, specify slope, photovoltaic type and shadow and get the area of the roof in sqm, azimuth in degree and the average daily energy production data for 12 months. The client can also compare the monthly bills with the result and see chart to better understand the savings. After creating a user account the user can save and load his data. The application will be launched very soon and will be freely available all over the world.

ONLINE GIS TO ASSESS AND EVALUATE DISTRIBUTIONS OF FRESH AND BRACKISH WATERS FISH SPECIES IN AFRICA

Rainer Zaiss

L'Institut de Recherche
pour le Développement (IRD), *44, boulevard de Dunkerque, CS 90009
F-13572 Marseille Cedex 02, France
Rainer.Zaiss@bondy.ird.fr

ABSTRACT

Biodiversity of fresh and brackish waters fish species in Africa is both highly diverse and of great regional importance to livelihoods and economies. Many areas in Africa are still not well surveyed such that available information on fish species is insufficient for environmental and development planning. Lack of basic information on species distribution and threatened status has long been a key obstacle facing freshwater ecosystem managers in Africa. Therefore, IRD has initiated a project to put in place an online GIS to collate, store, manage, and make widely available information about the distributions of fresh and brackish waters fish species in Africa.

The build up of the GIS required identifying and collating fundamental data themes for the entire African continent, which are point locations on all known species, hydrography, hypsography, international boundaries, geographic names and land cover. Lack of accurate, reliable and up-to-date fundamental geo-spatial data sets as well as problems caused by error, inaccuracy, and imprecision were the main challenge to put in place the application. The database holds actually around 7000 sample sites spread all over the continent, 3300 distinct species, and about 100 000 records.

The online GIS consist of open source components. PostgreSQL is used as object-relational database management system, PostGIS adds support for geographic objects, and the UMN MapServer provides raster data layers. The graphical user interface is based entirely on SVG, a standardised XML language for describing 2D graphics via vector graphics, text and raster graphics. Data from the server is retrieved asynchronously in the background without interfering with the display and behaviour of the existing page to create a rich Internet application. The first beta version of the application is accessible at the address <http://www.ird.fr/poissons-afrique/faunafri/>.

**Photogrammetry, Earth Observation Systems,
Information Extraction**

HOT SPOT DETECTION AND MONITORING USING MODIS AND NOAA AVHRR IMAGES FOR WILD FIRE EMERGENCY PREPAREDNESS

Biswajeet Pradhan

Faculty of Forestry, Hydro and Geosciences; Dresden University of Technology, 01062 Dresden, Germany
Tel: +49-351 463 37562; Fax: +49-351 463 37028; Email: Biswajeet.Pradhan@mailbox.tu-dresden.de

KEYWORDS:

Hot spot, wild fire, MODIS, NOAA AVHRR; GIS, remote sensing, Malaysia

ABSTRACT

Forest fires cause significant economic damages and hazard to environment all over the world. Apart from preventive measures, early warning and fast extinction of fires are the only chance to avoid major casualties and damage to nature. This paper describes methodology based on remote sensing and GIS for provision of various early warning of forest fire (so called hot spots) danger conditions for regulatory authorities to take actions for mitigation. Hot spot locations were identified through an automated procedure from MODIS and NOAA AVHRR satellite images. Combination of the Daily Hotspot Images coupling with various GIS layers generated Active Forest Fire Map. For the study area Results from the model can support detection and monitoring for wild fires in the forest and enhance alert system function by simulating and visualizing forest fire and helps for contingency planning.

1 Introduction

Fire has been identified as one of the major threats causing the loss of forests in several states in Malaysia. According to Forestry Department of Peninsular Malaysia (JPSM) and Forest Research Institute Malaysia (FRIM) statistics show that during the last 17 years (between 1992 and 2009), more than 256600 ha of peat swamp forests of Peninsular Malaysia have been destroyed by fire (Wan Ahmad, 2002). In the event of a prolonged spell without rain, and a lowering of the water table in the peat swamp forest, the organic layers becomes completely dry and is very prone to fire. Fires in these peat swamp forest create much more smoke per hectare than other types of forest fires and are difficult to extinguish. Therefore, the understanding of the areas at risk to fire needs to be closer concentration in peat swamp forests. A precise evaluation of forest fire problems and decision on solutions can only be satisfactory when a fire hazard zone mapping is available (Jaiswal et al, 2002).

Remote sensing techniques can offer cost-effective ways to assess wildfire risk in nearly real time with wider spatial and regular temporal coverage. Such estimations of fire risk influence local policies in terms of fire prevention and the management of prescribed fires, the latter becoming increasingly important for controlling the buildup of fuel and in revitalizing the landscape (Pradhan et al., 2005, 2006 and 2007). The Terra and Aqua satellites were launched more than seven years, both carrying the Moderate Resolution Image Spectroradiometer (MODIS) sensors. MODIS makes possible of monitoring earth four times a day. The Malaysian Ground Receiving Station (MGRS) can directly receive MODIS data. Geospatial technology, including Remote Sensing and Geographic Information Systems (GIS), provides the information and the tools necessary to develop a hot spot information system in order to identify, classify and map fire hazard area. Before, during and after disaster, the accurate sharing of information is important. Making the information available via the world-wide web, people can share information to assess the situation and make decisions. Within the last few years, forest fire detection and analyses using GIS and remote sensing data methods have been applied by researchers in different countries (Anderson et al., 1999; Boyle, 1999; Carlson and Burgan, 2003; Chrosciewicz, 1978; Chuvieco and Congalton, 1989; Chuvieco et al., 2003, 2004; Danson and Bowyer, 2004; Fensholt and Sandholt, 2003; Fosbering and Deeming, 1971; Gao, 1996; Gao and Kaufman, 2003; Goward et al., 1987; Hardy and Burgan, 1999; Ketpraneet, 1991; Li and Cihlar, 2009; Qadri, 2001; Rothmel, 1972; Salas and Chuvieco, 1994; Stibig et al., 2002; Zarco-Tejada et al., 2003).

2 Study area

There is a high potential of danger of fire in the dry season especially in the peat swamp forest and plantation forest. Most of fires are caused by human activities, either due to carelessness or burning activities in crop plantations. On 1995 and 1999, fire was occurred in the peat swamp forest area within the study area (Pradha et al., 2006). Figure 1 shows MODIS images for Peninsular Malaysia which is the study area. This study utilized two types of remote sensing data, i.e. MODIS, NOAA AVHRR for automatic identification of hot spot area. Therefore, the study areas were different for each dataset. The study area for MODIS data and NOAA is Peninsular Malaysia as depicted in Figure 1.

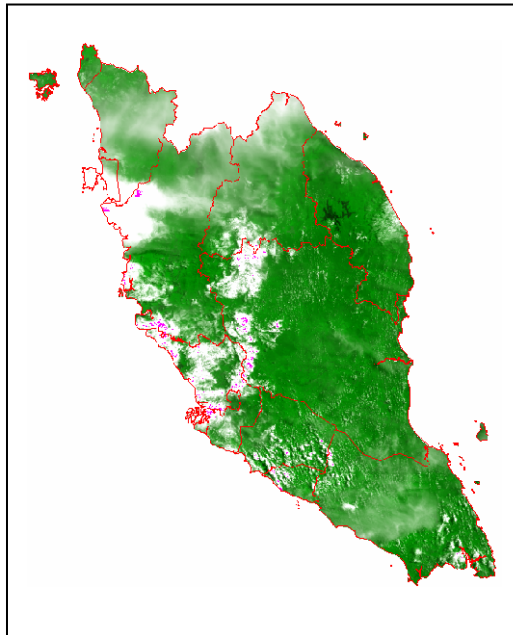


Figure 1: Location of the study area

3 Materials and Methodology

Accurate detection of the location of hotspots is very important for probabilistic forest fire susceptibility analysis. Recent advances in remote sensing, GIS and computer technologies provided an opportunity to assess and monitor the land cover changes in a near real time basis. NOAA AVHRR and MODIS satellite data with a spatial resolution of 1.1 km at nadir was found to be extremely useful for national-scale assessment and monitoring of major land cover types (Giri & Shrestha, 1996). Historical forest fire data were collected from satellite remote sensing NOAA AVHRR 12 and NOAA 14 sensors for last 5 years. To assemble a database to assess the surface area and number of hotspots in the study area, a total of 112 hotspots were mapped in a mapped area of 616 km². Fuel map were extracted from satellite imagery.

GIS data and ancillary data consist of biophysical and socio-economic variable is based on 1: 25,000 scale. Contour, administrative boundaries, water resources, settlement, transportation infrastructure are based on the topographic map from Survey Department (JUPEM). Forest fire reports have been collected from Forest Department Peninsular Malaysia (JPSM). Hotspots prone areas, fire occurrence map, peat swamp map and soil map were acquired from MACRES. Socio-economic data such as population data and socio-economic data were obtained from Statistical Department. Meteorological data such as temperature and relative humidity and Fire Danger Rating System (FDRS) map were obtained from Malaysian Meteorological Services Department. Image processing was carried out using ERDAS Imagine 8.7 and PCI Geomatica 9.0.

The primary objective of this study is to make an automated procedure for detection of hotspot areas using MODIS and NOAA satellite images and ultimately produce forest fire risk map. This map is indicated using the Fire Susceptibility Index (FSI) produced during FSI computation. The overall processing flow that included the MODIS data, and weather data for forest fire risk assessment is illustrated in Figure 2.

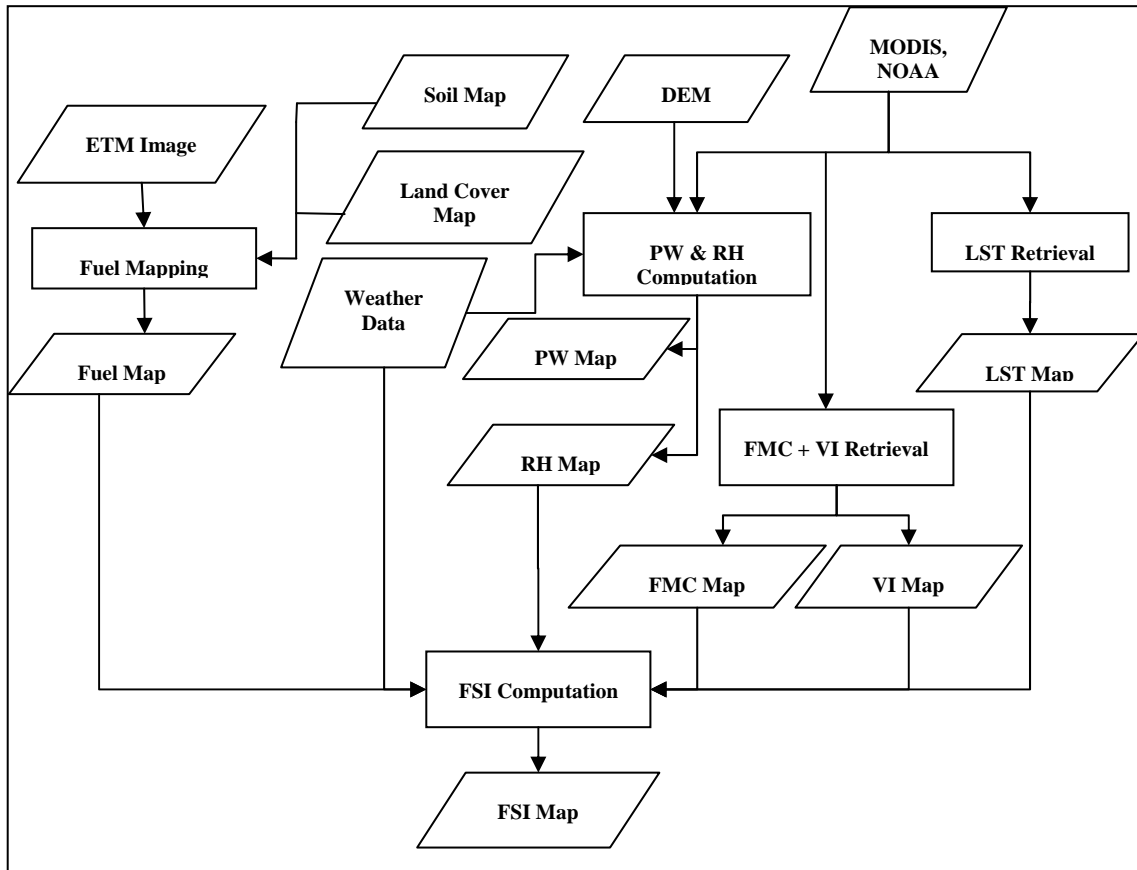


Figure 2: Overall methodology and data flow diagram

One MODIS image is sufficient to cover the whole Peninsular Malaysia. However, fuel mapping of MODIS would require a cloud free image which is rare in this region. A relatively cloud free image was selected for this purpose. First, cloud masking was performed to analyze the cloud coverage of the image acquire on 14 August 2005. The result indicated that that the clouds could be visualized obviously after performing equalization enhancement. The MODIS data which looked relatively cloud free with linear enhancement actually contained a lot of thinner cloud. The cloud mask generated using a simple threshold algorithm indicated that the cloud scattered randomly about 65.1% of this particular MODIS image.

4 Results and Discussion

The landcover map was extracted from MODIS image and is shown in Figure 3. It was observed that some of the cloud areas could be classified using the DEM of the same areas. However, the land cover map produced using MODIS data still has many null data.

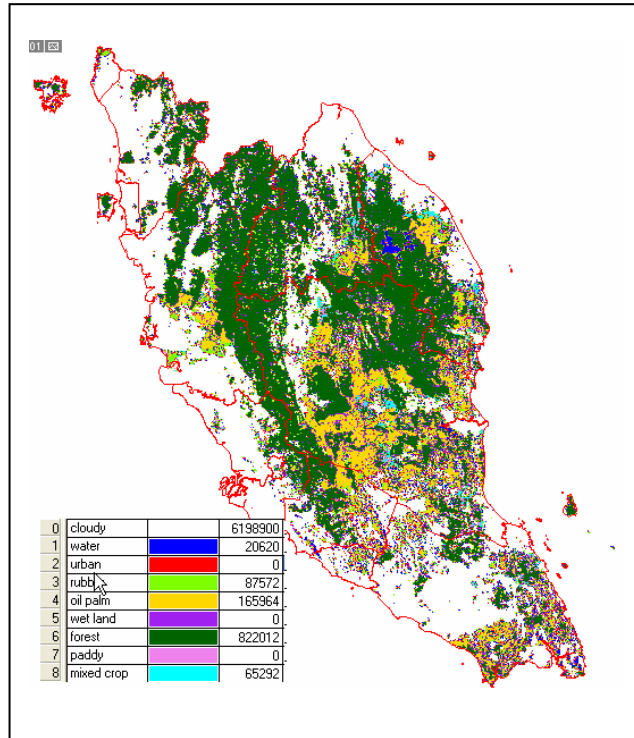


Figure 3: Land cover map produced using MODIS image

4.1 MODIS LST Retrieval

The MODIS LST retrieval utilized the split window method proposed by Mao et al. (2005). The simplified algorithm requires only two parameters (transmittance and emissivity) and the accuracy of this algorithm is very high. The main advantage of Mao’s algorithm is that the transmittance was obtained from the retrieval of water content by near-infrared (NIR) bands of MODIS and this can make the computation of transmittance for every pixel accurately. Mao assumed the pixels of MODIS are composed of three components (vegetation, soil, and water) under 1 km scale of the thermal band at Nadir, which enables the use of empirical knowledge for emissivity estimation (Please refer to Appendix II – Land Surface Temperature Retrieval for detailed descriptions). The comparison between the results obtained using Mao’s algorithm and NASA level-2 LST product is illustrated in Figure 4. It was observed that the LST values calculated were almost the same with those in NASA’s LST product. Therefore it was concluded that Mao’s algorithm is able to provide an accurate estimation of LST from MODIS data.

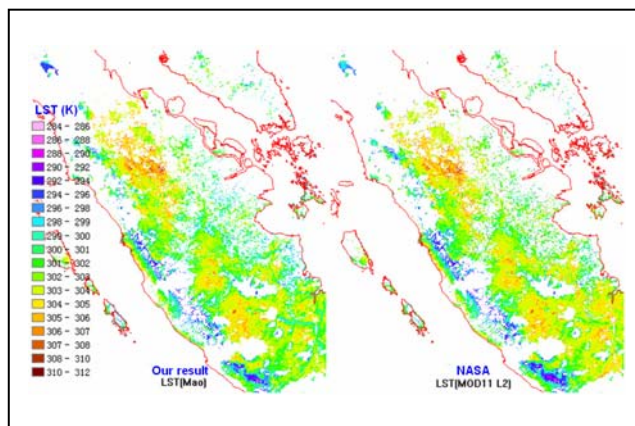


Figure 4: Comparison between the results obtained using Mao’s algorithm and NASA level-2 LST product

4.2 PW and RH Computation

Precipitable Water (PW) can be obtained from MODIS level-2 product MOD05. In this study, the PW was computed from MODIS data using the NIR method. The parameters used in this method were adjusted to fit the local condition. Subsequently, Relative Humidity (RH) computation was performed by integrating the computed PW, weather data and DEM.

4.2.1 PW Computation

Previous studies indicated that water content of the atmosphere can be retrieved from NIR bands. In NIR method, five MODIS NIR bands, 2 (0.865 μm), 5 (1.24 μm), 17 (0.905 μm), 18 (0.936 μm) and 19 (0.940 μm) were used for the PW computation. The two and three band ratio approaches were used to retrieve the water content of the atmosphere. The three water content obtained from three ratio algorithms were then integrated using weight functions. The result computed in this study was compared with the NASA PW product, MOD05 and is shown in Figure 5. It was observed that there was not much difference between the two. However, it is important to note that cloud cover gives extreme values.

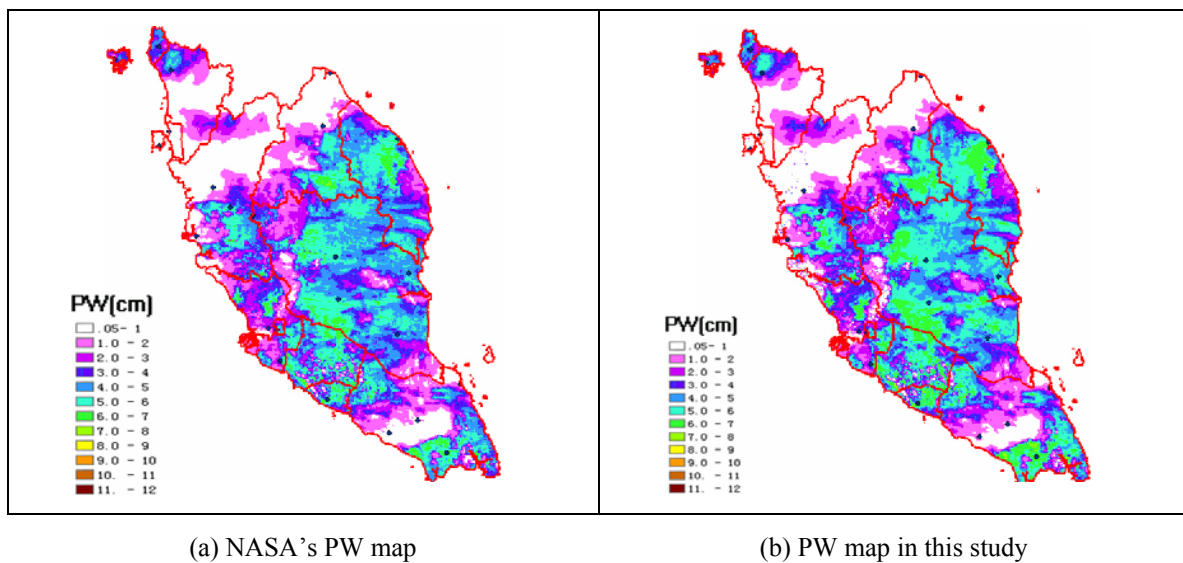


Figure 5: Comparison of computed PW map and NASA's product

4.2.2 RH Computation

RH computation in this study required computed PW map, DEM, weather data, i.e. temperature and pressure. The weather data was collected from ground based weather stations and interpolation was performed on the data. The DEM was used to adjust the interpolation result since the interpolation technique did not consider the elevation factor which has significant influences on the weather data. Subsequently, humidity was estimated from computed PW map using empirical model and RH was finally calculated by including the adjusted weather data in the calculation. The computed result and the interpolated weather data is depicted in Figure 6.

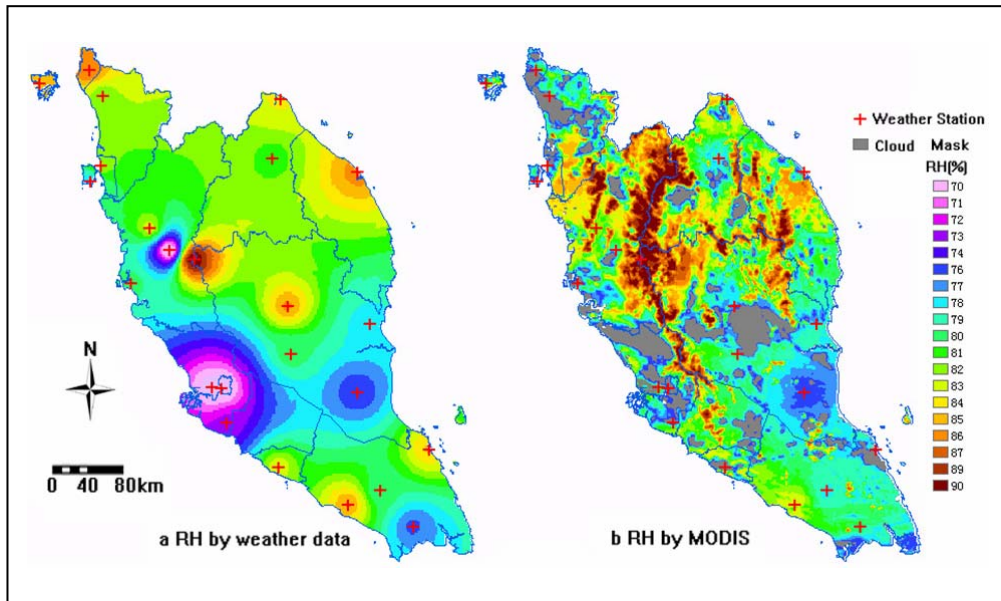
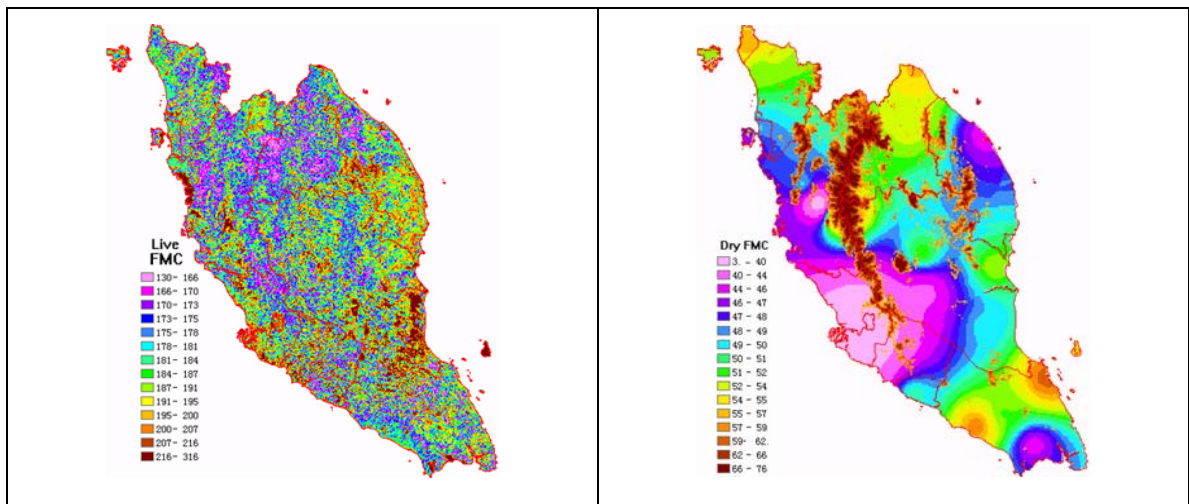


Figure 6: Interpolated weather data and computed RH

4.2.3 FMC Retrieval

FMC retrieval in our study can be segregated into two, i.e. live FMC (FMCL) and dry woody FMC (FMCD). FMCL was estimated using spectral indices calculated from remote sensing image while FMCD was estimated from weather data. Many indices have been used to evaluate its sensitivity to FMCL, i.e. Moisture Stress Index (MSI), Normalized Difference Water Index (NDWI), Ratio of TM5 to TM7, Global Vegetation Moisture Index (GVMI), Water Index (WI), Shortwave Infrared Water Stress Index (SIWSI) and NDVI/LST. Based on the evaluations, it was observed that SIWSI could reflect the FMC efficiently. Nevertheless, FMCD was calculated from RH and temperature using empirical model. The results computed for MODIS images are shown in Figure 7.



(a) FMCL of 25 August 2004

(b) FMCD of 29 August 2004

Figure 7: Estimation of live FMC and dry woody FMC

4.2.4 FSI Computation

The FSI model was utilized based on the method proposed by Dasgupta et al. (2006) which is based on the physical variable of preignition heat energy. This model takes live fuel and dead/dry fuel into account to compute FSI for FMCL and FMCD. The computed FSIL and FSID were then integrated to get the FSI of the study area. In this model, two parameters were included to further refine the FSI computation. EVI and fuel map were involved in FSI adjustment so that the adjusted FSI can reflect the true phenomenon based on local parameters. The fire risk was finally analyzed based on the computed FSI and the fire risk map produced is illustrated in Figure 8.

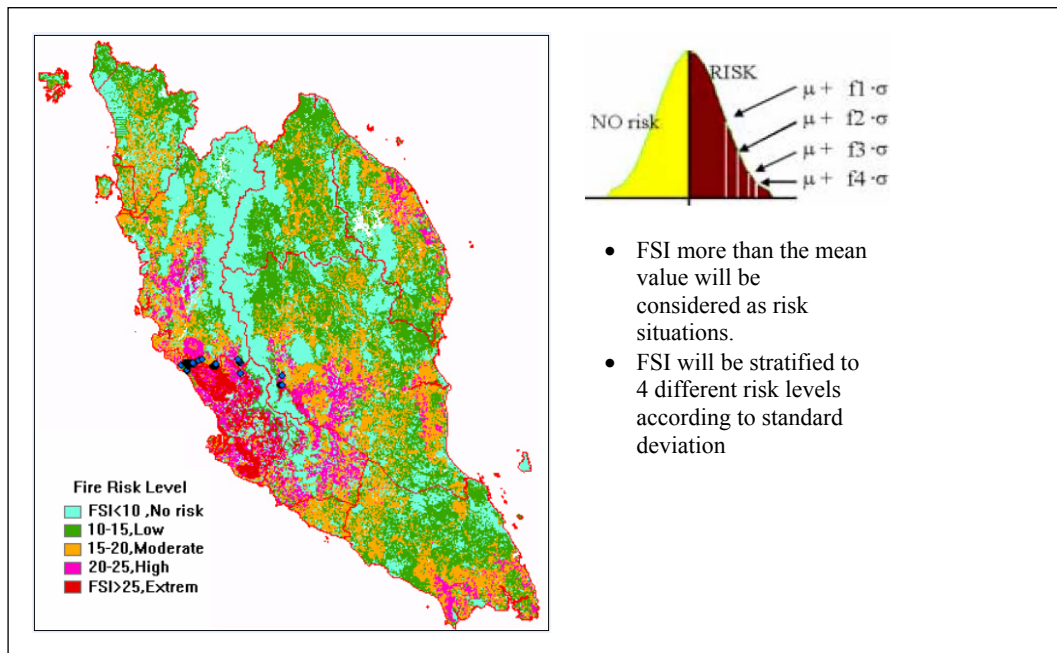


Figure 8: Fire risk map with hotspot

The produced forest fire risk map was overlaid with hotspots collected from ASMC for accuracy assessment. Figure 8 shows that most of the hotspots fall on the high risk areas, where FSI was greater than 20. No/low risk areas were identified as urban areas and dense forests.

5 Conclusion

In this study, various remote sensing data have been utilized to generate various parameters that are essential for forest fire management. The successfully derived parameters are Fuel Map, Land Surface Temperature (LST), Relative Humidity (RH) and Fuel Moisture Content (FMC). These parameters can be integrated with weather data to calculate Fire Susceptibility Index (FSI) which can provide useful information on forest fire risk.

Besides that, this study has also successfully combined two major parameters, remote sensing derived parameters and weather information for forest fire risk assessment. The final product, i.e. FSI, has combination of remote sensing based measurement (FMC, LST) and weather data (T, RH) for forest fire risk assessment. The results suggests that these two data can compensate each other to achieve better results especially in tropical region where cloud cover causes a problem for optical remote sensing data. The integrated product is believed to be able to provide greater spatial sensitivity and better accuracy.

The process of input data, and computation of intermediate products were processed in ERDAS IMAGINE and ArcGIS software and the generated output can be readily understood. The large amount of data can be processed in the GIS environment quickly and easily. Moreover, it is hard to process the large amount of data in the statistical package. Recently, forest fire susceptibility mapping has shown a great deal of importance for haze detection and fire prevention in forest area. The results shown in this paper can help the concerned authorities for forest fire management and mitigation. However, one must be careful while using the models for specific mitigation. This is because of the scale of the analysis where other forest fire related factors need to be considered. Therefore, the models used in the study are valid for awareness so that necessary prevention measures can be taken during the time of forest fire. In this paper, Forest fire susceptibility map was developed to determine the level of severity of forest fire hazard zones in terms of mapping susceptibility to fire by assessing the relative importance between fire factors and the location of fire ignition

Acknowledgments

Thanks are due to the Malaysian Center for Remote Sensing for providing the remote sensing datasets. Data provided by Mapping Agency (JUPEM) and Malaysian Meteorological Service Department were useful for this research.

References

- Anderson, I.P., Imanda, I.D., Muhnandar, 1999. Vegetation Fires in Sumatra, Indonesia: A First Look at Vegetation Indices and Soil Dryness Indices in Relation to Fire Occurrence, European Union Ministry of Forestry and Estate Crops.
- Boyle, T. 1999. Malaysia: Conservation and sustainable use of tropical peat swamp forests and associated wetland ecosystems, United Nations Development Programme (UNDP), Project Brief.
- Carlson, J.D., Burgan, R.E. 2003. Review of User's Need in Operational Fire Danger Estimation: The Oklahoma Example, *Int. J. Remote Sens.*, vol. 24, no. 8, pp. 1601–1620.
- Chrosiewicz, Z., 1978. Slash and Duff Reduction by Burning on Clear-cut Jack Pine Sites in Central Saskatchewan, *Can. For. Serv., North For. Res. Cent. Inf. Rep*, NOR-X-200.
- Chuvieco, E., Congalton, R.G., 1989. Application of remote sensing and geographic information systems to forest fire hazard mapping, *Remote Sensing of the Environment*, 29, pp.147-159.
- Chuvieco, E., Aguado, I., Cocero, D., Riano, D. 2003. Design of an Empirical Index to Estimate Fuel Moisture Content from NOAA– AVHRR Images in Forest Fire Danger Studies, *International Journal of Remote Sensing*, 24, 1621– 1637.
- Chuvieco, E., Cocero, D., Riaño, D., Martín, P., Martínez-Vegac, J., Rivad, J., Pérez, F. 2004. Combining NDVI and Surface Temperature for the Estimation of Live Fuel Moisture Content in Forest Fire Danger Rating, *Remote Sensing of Environment* 92 (2004), 322 – 331.
- Dasgupta, S., Qu, J.J., Hao, Z. 2006. Design of a Susceptibility Index for Fire Risk Monitoring, *IEEE Geoscience and Remote Sensing Letters*, Vol. 3, No. 1, pp 140-144.
- Danson, F.M., Bowyer, P. 2004. Estimating Live Fuel Moisture Content from Remotely Sensed Reflectance, *Remote Sensing of Environment*, 92, pp. 309–321.
- Fensholt, R., Sandholt, I. 2003. Design Derivation of a Shortwave Infrared Water Stress Index from MODIS near-and Shortwave Infrared Data in a Semiarid Environment, *Remote Sensing of Environment*, 87, pp. 111–121.
- Fosberg, M. A., Deeming, J. E., 1971, Derivation of the 1-and 10-Hour Timelag Fuel Moisture Calculations for Fire-Danger Rating, Note RM-207, USDA Forest Service.
- Gao, B.C. 1996. NDWI—A Normalised Difference Water Index for Remote Sensing of Vegetation Liquid Water from Space, *Remote Sensing of Environment*, 58, 257– 266
- Gao, B.C., Kaufman, Y.J., 2003. Water Vapor Retrievals Using Moderate Resolution Imaging Spectroradiometer (MODIS) Near-Infrared Channels, *Journal of Geophysical Research*, 108, 13, 4389-23-43.
- Giri, C., Shrestha, S. 1996. Land Cover Mapping and Monitoring from NOAA AVHRR data in Bangladesh. *International Journal of Remote Sensing*, Vol. 17, No. 14, pp. 2749-2759.
- Goward, S.N., Kerber, A., and Kalb, V. 1987. Comparison of North and South American Biomass from AVHRR Observations. *Geocarto International*, Vol. 2, No. 1, pp. 27-39.
- Hardy, C. C., Burgan, R. E. 1999. Evaluation of NDVI for Monitoring Live Moisture in Three Vegetation Types of the Western U.S, *Photogrammetric Engineering and Remote Sensing*, 65, 603– 610.
- Jaiswal, R.K., Saumitra, M., Kumaran, D.R., Rajesh, S. 2002. Forest fire risk zone mapping from satellite imagery and GIS, *International Journal of Applied Earth Observation and Geoinformation*, Vol. 4, pp. 1-10.
- Jensen, J.R. 1996. *Introductory Digital Image Processing*, Prentice Hall, Upper Saddle River, New Jersey
- Ketpraneet, S. 1991. *Forest fire and effects of forest fire on forest system in Thailand*, Kasetsart University, Bangkok.
- Li, Z., Nadon, S., Cihlar, J. 2000. Satellite detection of Canadian boreal forest fires: development and application of the algorithm, *International Journal of Remote Sensing* 21(16): 3057-3069.
- Mao, K., Qin, Z. 2003. A Practical Split-Window Algorithm for Retrieving Land-Surface Temperature from López, A.S., Ayanz, J.S-M., 2002. Integration of Satellite Sensor Data, Fuel Type Maps and Meteorological Observations for Evaluation of Forest Fire Risk at the Pan-European Scale, *Int. J. Remote Sens.*, vol. 23, no. 13, pp. 2713–2719.
- MODIS Data, *Int. J. Remote Sens.*, vol. 26, no. 15, pp. 1601–1620. ERDAS Imagine, Field Guide

- National Disaster Data and Information Management Center (NADDI) 2003, Forest Fire Technical Specification, Cilix Corporation Sdn. Bhd (Contract No: KSTAS/PEMB/2/2003), Project Proposal.
- Pradhan, B., Suliman, M. D. H., Awang, M. A. 2007. Forest fire susceptibility and risk mapping using remote sensing and geographical information systems (GIS). *International Journal for Disaster Prevention and Management*, Volume 16, No. 3, pp: 344- 352
- Pradhan, B., Awang, M. A. 2006. Application of Remote Sensing and GIS for Forest Fire susceptibility Mapping Using Likelihood Ratio Model. *Proceedings of Map Malaysia 2007 held at Kuala Lumpur, 3 – 4 May 2006.*
- Pradhan, B., Suliman., M.D.H., Awang. M.A., Assilzadeh, H. 2005. Forest Fire susceptibility Mapping Using Frequency Ratio Model”, *Proceedings of International Conference on Spatial and Computational Engineering- International Advanced Technology Congress, 2005, 6-8 December 2005, Putrajaya, Malaysia*
- Qadri. S.T. 2001, *Fire, Smoke and Haze, The ASEAN Response Strategy: Asian Development Bank, Manila.*
- Rothermel, R.C., 1972. A Mathematical Model for Predicting Fire Spread in Wildland Fuels, U.S. Dept. Agricult. Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT, Res. Paper Int-115.
- Salas, J., Chuvieco, E. 1994. Geographic information systems for wildland fire risk mapping, *Wildfire*, Vol. 3 No. 2, pp. 7-13.
- Stibig H-J., Beuchle, R, Janvier, P. 2002. Forest cover map of insular Southeast Asia at 1:5 500000, TREES Publications Series D: N°3, EUR 20129 EN, European Commission, Luxembourg, available at: <http://www.gvm.sai.jrc.it/Forest/>
- Wan Ahmad, W.S. 2002. Forest fire situation in Malaysia, *IFFN*, No. 26, pp. 66-74.
- Zarco-Tejada, P. J., Rueda, C. A., Ustin, S. L. 2003. Water Content Estimation in Vegetation with MODIS Reflectance Data and Model Inversion Methods, *Remote Sensing of Environment*, 85, 109– 124.

HIGH QUALITY DTM AND DSM POINT CLOUDS BY ADVANCED IMAGE MATCHING OF AERIAL IMAGERY

Eberhard Gülch

Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
eberhard.guelch@hft-stuttgart.de

KEYWORDS:

Image matching, Point clouds, DTM, DSM

ABSTRACT

Since about 1990 image matching is playing a major role in digital photogrammetry. Current tools of image matching allow the generation of high quality point clouds for Digital Terrain Models (DTM) and Surface Models (DSM), which is challenging the established Airborne Laser Scanning (ALS) technology. The imagery provides a much higher planimetric resolution and can provide much denser point clouds. Still the problems of vegetation and the problems of occlusions in urban areas, like also in ALS, need to be addressed.

The new technology of multi-image matching and DSM generation exploits the high quality image data and high overlap when imaging with modern digital cameras:

Results on the highly demanding DSM generation in an open pit coal mine are presented and the potential for high quality change detection discussed.

Similarities between filtering point clouds from image matching and that of ALS are analysed. RGB and NIR channels of digital cameras are used to improve the classification of point clouds.

Finally an application using stereo satellite data demonstrates the potential for automated DSM generation in regions, where no aerial flights are available.

EFFECTIVE FLOOD MONITORING SYSTEM USING GIT TOOLS AND REMOTE SENSING DATA

Biswajeet Pradhan

Faculty of Forestry, Hydro and Geosciences; Dresden University of Technology, 01062 Dresden, Germany,
Tel: +49-351 463 37562; Fax: +49-351 463 37028; Email. Biswajeet.Pradhan@mailbox.tu-dresden.de

KEYWORDS:

Flood monitoring, geoinformation techniques, remote sensing data

ABSTRACT

Flood monitoring over a large area for short time period using Remote Sensing (RS) and Geographical Information System (GIS) technology by disaster relief authorities have become a significant operation in the world. In this paper, an Operating Procedure (OP) for mapping flood extent and assessing flood damages have been developed which can be served as a guideline for RS and GIS operations to improve the efficiency of flood disaster monitoring and management in tropical countries like Malaysia. The flood monitoring system was developed using RADARSAT images, with its exclusive cloud penetration capability coupling with various flood disaster related parameters. For rapid capturing of food extent and assessing flood damage during and after flooding events, an efficient Flood Inundation Model was developed in GIS. This model integrates many types of data and multiple geo-processing tools that can automate the processes in an efficient manner. It is able to quickly determine and report the extent of flooding and the land use types under water during flooding events as well as the number of people affected in the affected built-up areas. The derived results from the whole process will provide very essential and valuable information for immediate response and assess flood, disaster relief, and damage caused by future occurring floods.

1 Introduction

Kelantan is a flood-prone state with the State's total land areas of 15,000 sq.km. The frequency of flood occurrence in Kelantan almost every year has claimed more lives and caused more property damage as well as affected a wide range of environmental factors and activities related to agriculture, vegetation, wild life and local economies. The flooding affects the flat coastal plains of Kelantan River which normally occurs during the north-east monsoon period between October and January. This monsoon season causes a lot of clouds with heavy rains to be present at the flood prone areas. Due to this reason, RADARSAT SAR images, with its exclusive cloud penetration capability have been used at the Malaysian Centre for Remote Sensing (MACRES) for the past few years for flood monitoring.

In this age of modern technology, the integration of information derived from Geographical Information Systems (GIS) and Remote Sensing (RS) with other datasets - both in spatial and non-spatial formats provides tremendous potential for identification, monitoring and assessment of flood disasters (Pradhan et al., 2009; Pradhan, 2009; Pradhan and Shafie, 2009; Jeyaseelan, 1999). MACRES Airborne Remote Sensing (MARS) programme is a research and development programme which focuses on the utilization of SAR sensor and hyperspectral sensor for remote sensing applications in Malaysia. In this programme, the Flood Module which is a component under the Disaster Management module is conducting various researches on the capabilities of RS and GIS technology in flood mapping. This paper describes the Operating Procedure (OP) and the Flood Inundation Model creation for mapping the flooded areas using RADARSAT SAR images acquired in the year 2003 and estimating the flood damage, i.e. land use types under water during flooding events and the number of people affected in the affected built-up areas, which is useful information for disaster response and mitigation.

1.1 Study area

The northern part of Kelantan state, east coast of Peninsular Malaysia was selected as a study area as this state is threatened with flood that normally occurs during the north-east monsoon period between October and January.

The specific area which covers seven districts (3242 km²) comprises of flat and generally low-lying coastal plains as well as heavily populated and economically important to the state. The location of the study area is shown in Figure 1.

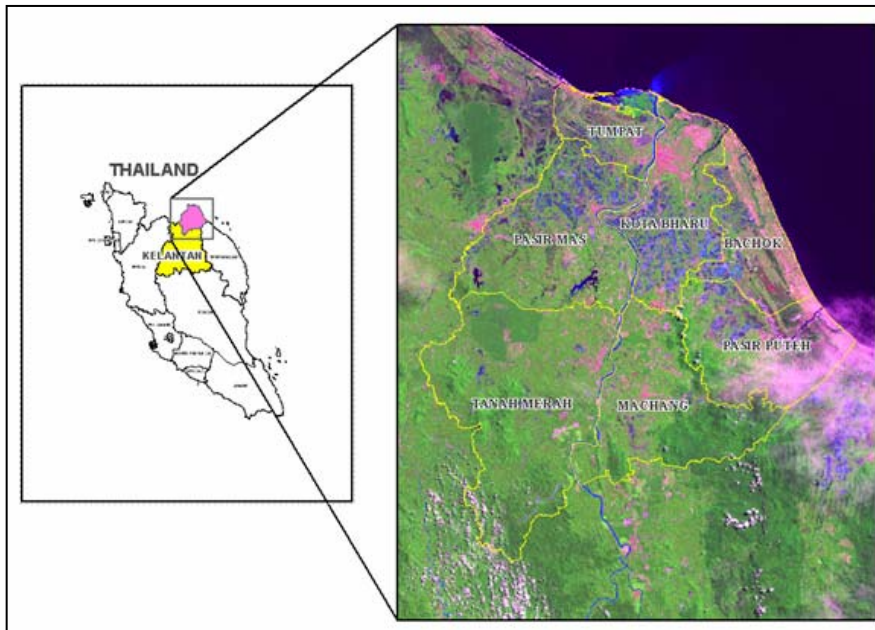


Figure 1: Location of the study area

1.2 The System Components

The Flood Forecasting System consists of both remote sensing and GIS based modelling and hydrological components. The system is based on the River Flow Forecasting System (RFFS) which was developed by the Centre for Ecology and Hydrology (CEH). The Module offers powerful and comprehensive facilities that integrate sophisticated hydrological and hydrodynamic modeling with real-time decision support and control. The calibration (process of adjusting parameters) and verification of the Flood Forecasting model was carried out with daily rainfall and historical flow data to make it suitable representative of the Kelantan river basin. Ideally, it is recommended to use hourly processed rainfall data for calibration. An initial calibration results have been presented by considering the quality of the input data used in the calibration. However, calibration can be regularly improved by using hourly historical data for rainfall, flows and water levels from all telemetry stations in the Kelantan River Basin. It is strongly recommended that the calibration be upgraded by using those data.

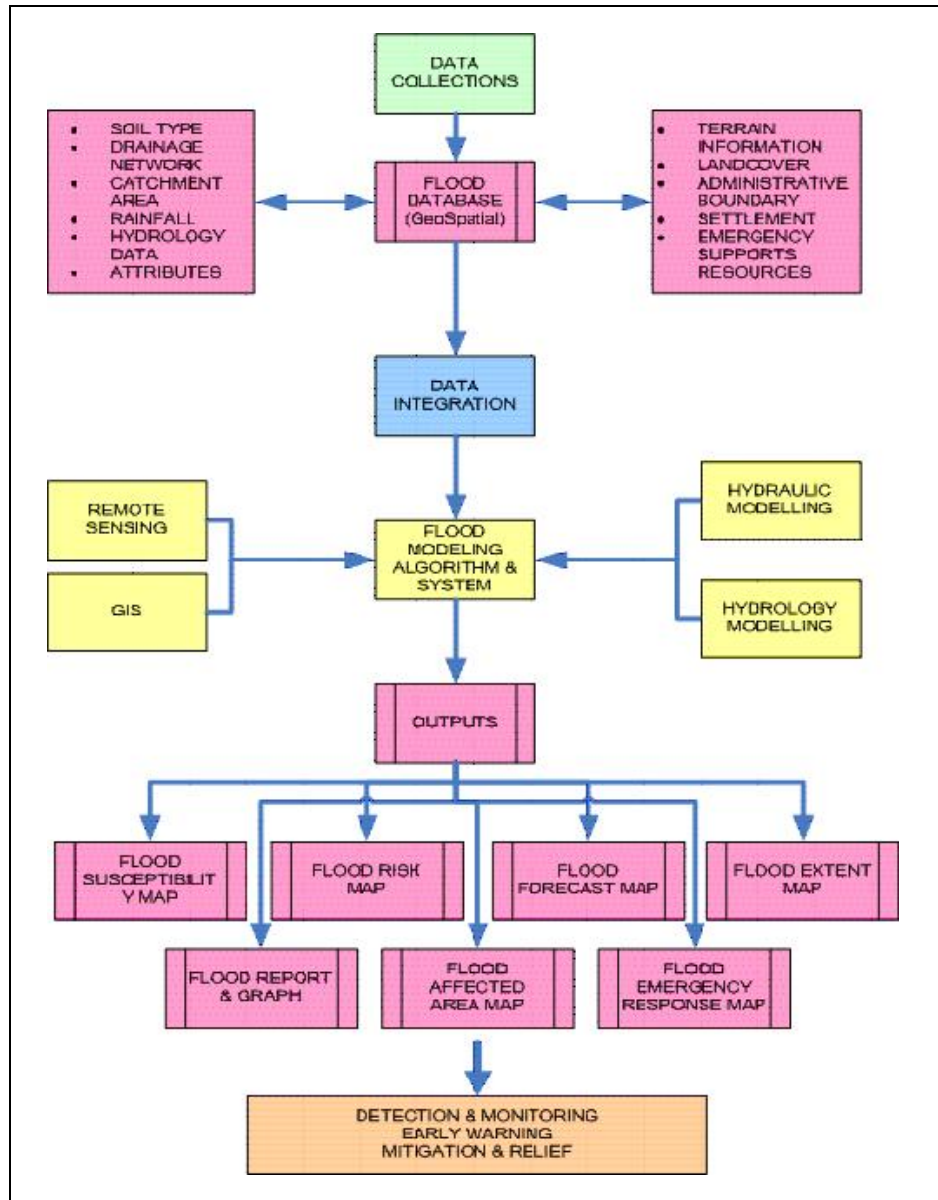


Figure 2: Overall flood forecasting model data flow diagram

2 Data and methodology

2.1 Data Used

Both visible and SAR satellite images which were used as primary data source in this study are LANDSAT ETM, SPOT, and RADARSAT SAR images. The LANDSAT ETM image was used as reference image to geo-reference the RADARSAT images. Multi temporal RADARSAT images of 1998, acquired before, during and after floods were processed to extract the water body information. In this study, the Wide 2 beam mode of RADARSAT SAR image dated 6 December 2003 captured before the flood in Kelantan was used to extract the normal water extent while the Standard 6 beam mode of RADARSAT SAR image dated 14 December 2003 captured during the peak flood in Kelantan was used to extract the flooded areas. The SPOT V images were mosaicked and used to extract and classify the built-up areas for the flood-affected population estimation. Other data sources used for the study are: vector data including population 2000, land use, administrative boundaries, river, contour, spot heights and DEM.

2.2 Methodology

In this study the ERDAS Imagine v8.7 software was used to process the SAR images and the ArcGIS 9.0 software was used to perform GIS spatial analysis and models development. The eCognition software was used to classify the built-up areas and land use classes.

2.2.1 Image Processing

Noise or speckle normally degrades the quality of SAR imagery. In this study, the Gamma-Map filter was chosen to remove speckle while preserving the contrast of the water body, so that flood information can be extracted from the enhanced images. The filtered SAR images were then geometrically corrected and registered to the LANDSAT ETM image as the reference image and to the Malaysian Rectified Skew Orthomorphic (RSO) projection. Registration of SAR images proves to be the most time consuming and difficult, especially the ground control point (GCP) collection on various time series SAR images. However, the time required to register the image can be significantly improved by using a set of common well-identified GCP and a geo-referenced SAR image. These data can then be used for image-to-image registration of any new SAR image in future.

2.2.2 Threshold Value Determination

The water extent extraction of the processed SAR image was carried out using the threshold method (Liu Zhaoli et al., 1999; Yang Cunjian et al., 1998). The threshold value, K was identified using the histograms of the SAR images. The histogram of SAR images normally has two peak regions, low gray values of one peak region reflecting the water extent (e.g. 6 to 22 grey values), while the other peak region has high gray values showing the non-water extent (e.g. 22 to 252 grey values). Therefore, the intersection grey value of this two peak regions was the threshold value, 22 (figure 3).

$$DN < K \text{ is water extent}$$

$$DN \geq K \text{ is non-water extent}$$

Where DN represents the grey value in SAR image; K is threshold value.

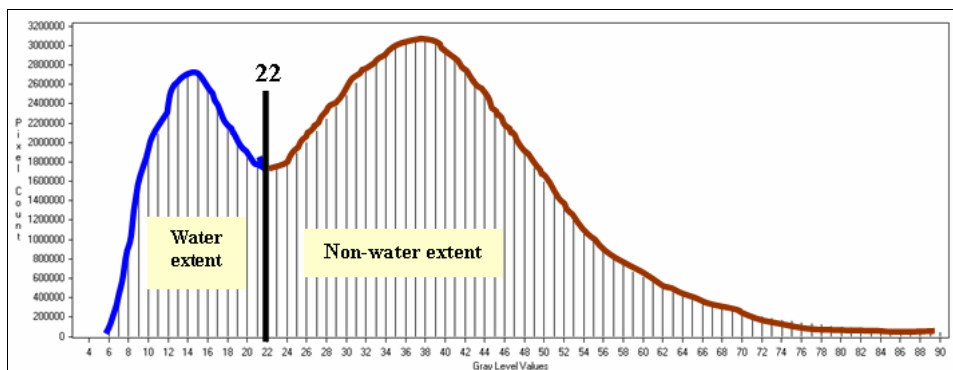


Figure 3: The histogram of SAR image and the threshold value is 22

2.2.3 Model Development

For rapidly extracting the flooded areas from SAR image and assessing the extent of damage, we developed a flood model using ModelBuilder in the ArcGIS software. The ModelBuilder window provides a graphical environment for model development, allowing user to create model diagram like a flowchart (McCoy, 2004). The flood model comprises three stages of processes, i.e. the flooded areas extraction, the assessment of inundated land use types and the number of people affected in flooded areas. Preparing data is an initial step to provide the essential input to the model and these input files are district boundary, mountain shadow extent, normal water extent, land use classes, built-up areas, mukim boundary and population density. The whole process of the flood model workflow is illustrated in figure 4.

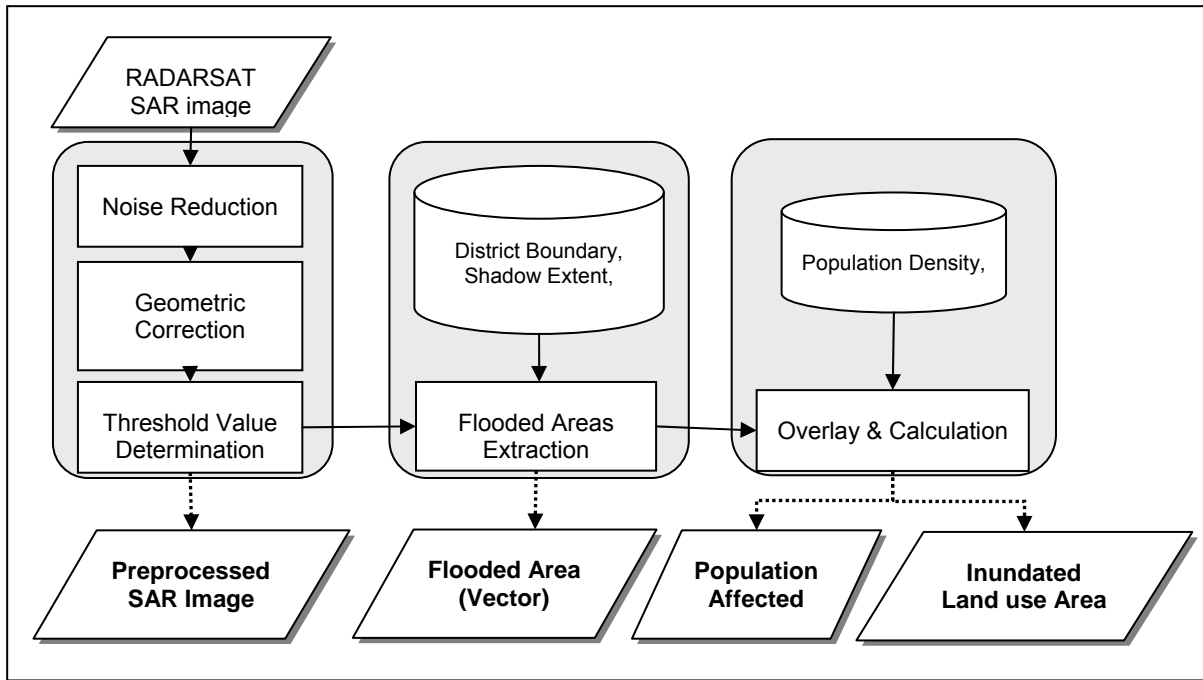


Figure 4: The flow of the flooded area extraction and flood damage estimation

2.2.4 Flooded Areas Extraction

The main input data for the flooded areas extraction includes the normal water extent, mountain shadow, and district boundary. The processed SAR image as an input file to the model was performed using threshold value, K to extract the water extent. The extracted water extent was then masked based on the district boundary to remove the unwanted areas. However, the masked water extent still included the shadow of mountains and the normal water extent (Cunjian et. al., 1999), so it must be removed from the water extent before the real flooded areas were identified. This shadow reduction was performed based on the mountain shadow mask delineated from mountain area especially in southern part of the study area, while the flooded areas was derived by subtracting the normal water extent. Then the result was converted to vector format to identify and calculate the real flooded areas by district boundary. Finally, the results were overlaid with district boundary, and normal water extent for flooded areas map production.

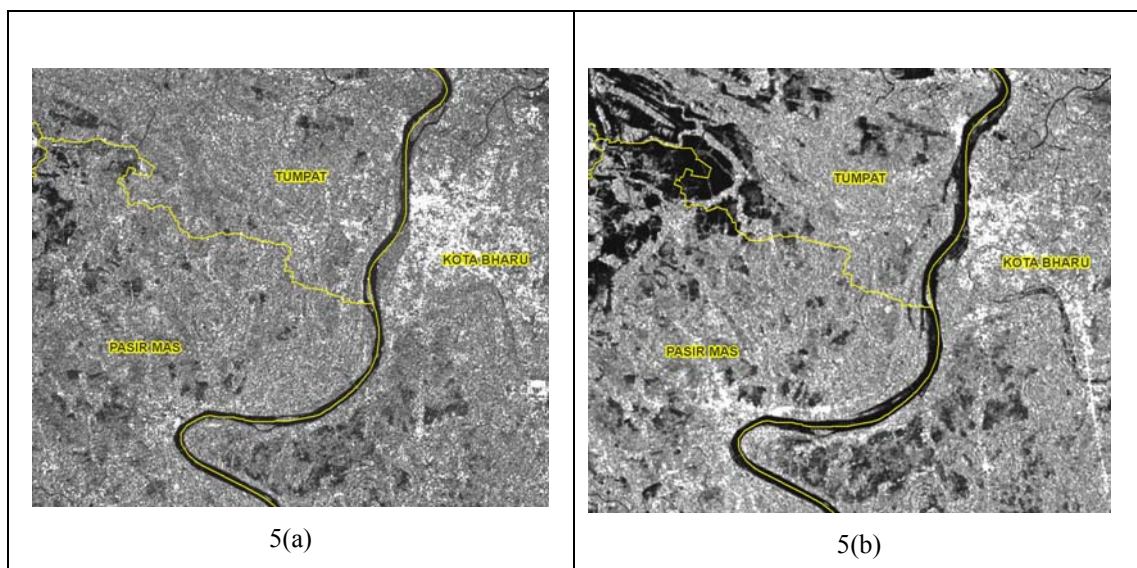


Figure 5 (a): RADARSAT SAR image dated 06 December 2003 for normal water extraction (before flood); Figure 5 (b): RADARSAT SAR image dated 14 December 2003 (during flood)

Based on the figure 5 (a), it was observed that most of the area of an SAR image acquired on December 6, 2003, before the start of the rainy season has not been inundated. In contrast, Figure 5 (b) shows a SAR image of the

same area acquired on December 14, 2003 during the peak of the flood where the flooded area (dark areas) was clearly discriminated from the non-inundated areas in the SAR image.

2.2.5 Flood Damage Assessment

When the flooded areas are identified, this information was combined with the population density data and land use data in order to assess and estimate the number of people in the affected built-up areas and land use types of the damaged areas. Built-up areas are not only centres of human activities but also make up the main portion of human properties that play a vital role in the flood damage assessment. The population information received from statistical department was used to estimate the number of people at the flooded areas. However, this census data just states the number of people registered in zone, sub-district and district basis, but does not reveal real spatial distribution of population. It is unrealistic to say that population density is uniform through out a given zone as the inhabited area could be a portion of the total land area of a district.

For assessment of the affected built-up areas in this study, an advanced segmentation technique, the eCognition software (Baatz, et. al., 2004), which follows an object-oriented concept, was initially used to extract and classify the land cover information (Water, Built-up areas, and others) from the pan-sharpened SPOT V satellite images which have a resolution of 2.5 m. Based on the extracted built-up areas, the population value is weighty distributed in the spatially built-up areas in order to obtain the population density in different mukim. This population density information was eventually used to calculate the number of people in the affected built-up areas during the flood event. Finally, the SPOT V satellite images were overlaid with the flooded areas vector to visualize exactly which built-up areas were flooded. In this study, the classification of land use map from the Landsat ETM image was performed using eCognition software. Ten classes of land use were classified including urban, lake, river, forest, mangrove, coconut, mixed horticulture, oil palm, paddy and rubber (Figure 7). This land use map was converted into vector format and overlaid with flooded areas to identify and calculate the amount of flood damage per land use class by districts as well as generate the land use inundated area map.

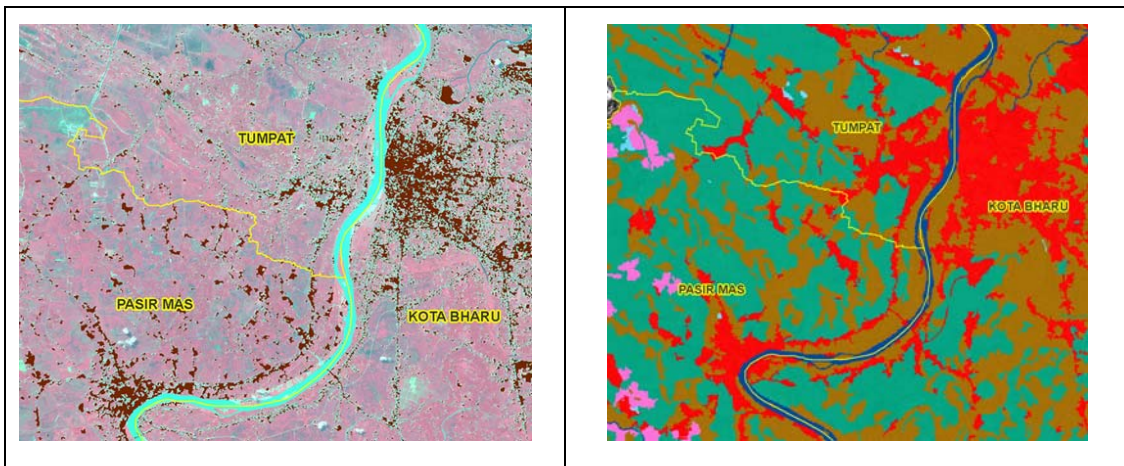


Figure 6: The classified built-up areas from SPOT V satellite images in dark

Figure 7: The classified land use map from Landsat ETM

3 Results and Discussion

In this study, a rapid and efficient Flood Inundation Model was developed using ModelBuilder in the ArcGIS software (Figure 8). This semi-automatic model was divided into three parts and consisted of variety processes. The first part of the model is to calculate the flooded areas and map it by district boundary. The second stage is the assessment of damage of flood including identification of the number of people affected in built-up areas and followed by the estimation of land use inundated areas.

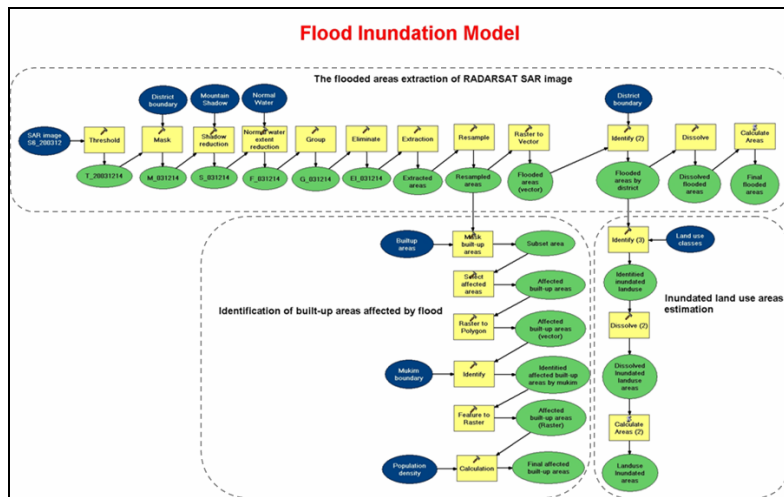


Figure 8: This model calculates and maps the flooded areas extracted from SAR images and overlaid with the population density data to estimate the number of people affected in built areas by flood and followed by assessing the damage of land use inundated area.

The RADARSAT images show a clear distinction between water and land due to a higher incidence angle. Therefore, it is easy to detect the flooded area by simply applying a threshold (Chen et. al., 1999). Figure 9(b) depicts the extracted flooded areas from SAR images where non-flooded areas are shown in grey tones, normal water in light blue and flooded areas in red. The final flooded area in district boundary was converted into vector format and overlaid with the normal water for the flooded areas map generation.

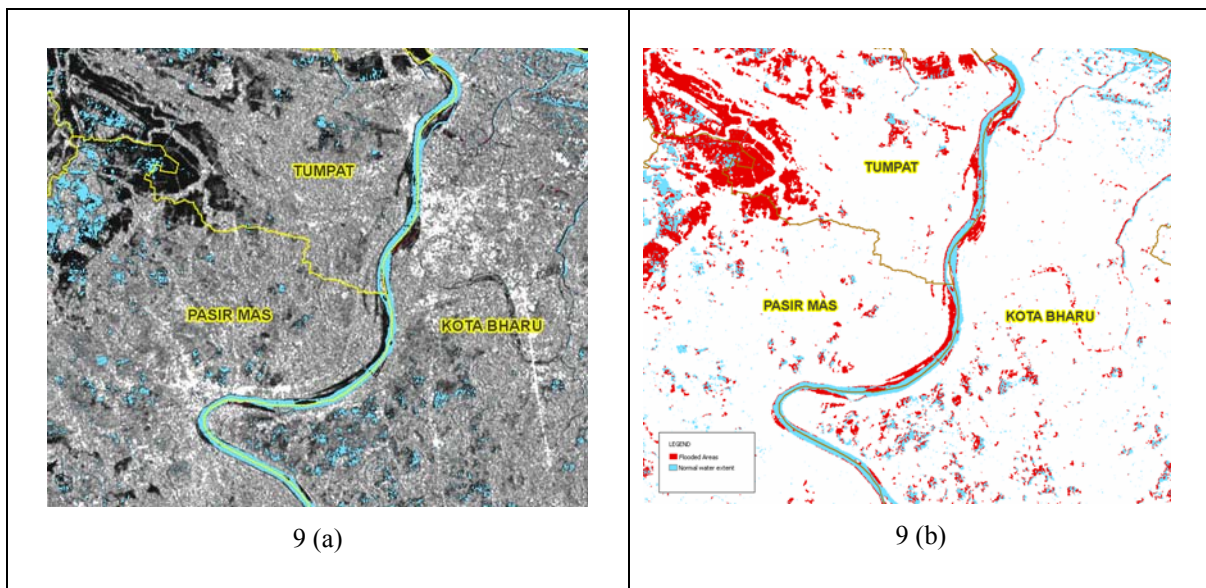


Figure 9 (a): The normal water extent overlaid with the SAR image; Figure 9 (b): The extracted flooded areas from SAR image on 14 December 2003

The identification of the population distribution according to the built-up areas affected by flood is shown in Figure 10. This population in flooded areas was estimated by using the population density by sum of the flooded areas by district zone. Then, the number of people affected by flood can be calculated. The other result from the model was the assessment of the land use inundated areas. By superimposing the extracted flooded areas on the land use map (2001), ten different land use inundated areas by flood by district dated on 14 December 2003 was calculated. Figure 11 displays the inundated land use areas that zoom in for Kota Bharu, Pasir Mas and Tumpat.

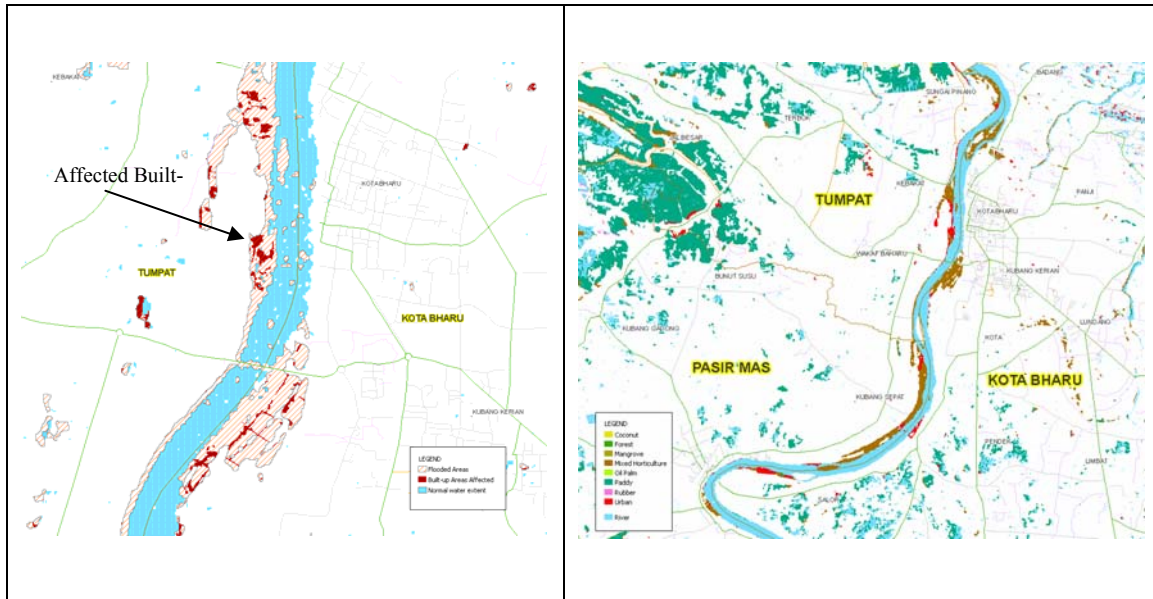


Figure 10: The affected built-up areas by flood

Figure 11: Different inundated land use areas by flood

4 Conclusion

Flood monitoring from satellite data proved to provide the opportunity to quickly and precisely overview flooded areas. In this study, through the integration RS and GIS technology, the timely and detailed situation information are required by the authorities to locate and identify the affected flooded areas and to implement corresponding damage monitoring and mitigation can be achieved. It was concluded that the created Flood Inundation Model was very useful and fast to extract the flooded areas from SAR images by applying threshold method. With the previously delineated shadow mask, the model is capable of reducing the effect of shadows in radar images. The derived flooded areas map was then overlaid with the population density data and land use map for flood damage estimation. It was found that this method only requires processed SAR image with threshold value and several input data and the processing time for the whole process just required several minutes. As a result, this model is capable of providing fast and accurate information on floods, i.e. flooded areas map, built-up areas affected by flood map and inundated land use areas map when the flooded SAR scene is provided in future flood occurrences.

Acknowledgments

Thanks are due to the Malaysian Center for Remote Sensing for providing the remote sensing datasets.

References

- Ahmad, A., Shafiee, M., Hassan, F., Yaakub, M., Sing, L.K., Dom, N.M., Osman, S., Hamzah, H., 2004. The Operationalization of Monsoon Flood Management System, MACRES Seminar 2004, February 22-24, 2004.
- Baatz, M., Benz, U., Dehghani, S., Heynen, M., Höljtje, A., Hofmann, P., Ingenfelder, I., Mimler, M., Sohlbach, M., Weber, M., Willhauck, G., 2004. eCognition User Guide, Definiens Imaging GmbH, Germany.
- Chenghu, Z., Yunyan, D., Jiancheng, L., 1996. A Description Model Based on Knowledge for Automatically Recognizing Water From NOAA/AVHRR, *Journal of Natural Disasters*, vol. 5, No. 3, pp. 100-108.
- Chen, P., Liew, SC., Lim, H., 1999. Flood Detection using Multitemporal RADARSAT and ERS SAR Data, *Proceedings of the 20th ASIAN Conference on Remote Sensing*, November 22-25, 1999, Hong Kong, China. <http://www.gisdevelopment.net/aars/acrs/1999/ps6/ps6044.shtml>

- Cunjian, Y., Chenghu, Z., Qing, W., 1999. Deciding the Flood Extent with RADARSAT SAR Data and Image Fusion, Proceedings of the 20th ASIAN Conference on Remote Sensing, November 22-25, 1999, Hong Kong, China. <http://www.gisdevelopment.net/aars/acrs/1999/ps3/ps3999.shtml>
- Giacomelli, M., Rosso, R., 1995. Assessment of flooded areas from ERS-1 PRI data: an application to the 1994 flood in northern Italy, *Phys. Chem. Earth*, Vol. 20, No. 5-6, pp. 469-474.
- Jeyaseelan, A.T. (1999), Droughts & Floods Assessment And Monitoring Using Remote Sensing And GIS, Crop Inventory and Drought Assessment Division, National Remote Sensing Agency, Department of Space, Govt. of India, Hyderabad, pp. 291-313
- Long, N.T., Trong, B.D., 2001. Flood Monitoring of Mekong River Delta, Vietnam using ERS SAR Data, Proceedings of the 22nd ASIAN Conference on Remote Sensing, November 5-9, Singapore.
- Long, N.T., Trong, B.D., 2001. Flood Monitoring of Mekong River Delta, Vietnam using ERS SAR Data, Proceedings of the 22nd ASIAN Conference on Remote Sensing, November 5-9, Singapore.
- McCoy, J., 2004. ARCGIS 9 – Geoprocessing in ArcGIS, ESRI, pp. 241-334.
- Pradhan, B. Pirasteh, S., Shafie, M., 2009. Maximum flood prone area mapping using RADARSAT images and GIS: Kelantan river basin. *International Journal of Geoinformatics*. Vol. 5(2), 11-23.
- Pradhan, B., and Shafie, M., 2009. Flood Hazard Assessment for Cloud Prone Rainy Areas in a Typical Tropical Environment. *Disaster Advances*, vol. 2(2), 7-15.
- Pradhan, B., 2009. Flood susceptible mapping and risk area estimation using logistic regression, GIS and remote sensing. *Journal of Spatial Hydrology* (In-Press)
- Zhang, J., Zhou, C., Xu, K., Watanabe, M., 2002. Flood Disaster Monitoring and Evaluation in China, *Environmental Hazards* 4, pp. 33–43
- Zhaoli, L. Fang, H., Linyi, L., Enpu, W., 1999. Dynamic Monitoring and Damage Evaluation of Flood in Northwest Jilin with Remote Sensing, Proceedings of the 20th ASIAN Conference on Remote Sensing, November 22-25, 1999, Hong Kong, China. <http://www.gisdevelopment.net/aars/acrs/1999/ps2/ps2233.shtml>

THE PROVISION OF DIGITAL ORTHOPHOTO MAPS IN COLOUR FOR LAND USE PLANNING AND MANAGEMENT UNDER THE LAND ADMINISTRATION PROJECT IN GHANA

Godwin Yeboah

Department of Surveying, Mapping and ICT, RUDAN Engineering Limited
156 Atomic-Haatsso Road, Box CT 828 Cantonments, Accra, Ghana
kojob2@yahoo.com, godwin.yeboah@rudanghana.net

KEYWORDS:

Provision of Orthophoto Maps, Mosaic, Land Administration Project, Ghana, Nordic Funds, Specifications, Methodology, Software, Equipment, Requirements, LAPU, Survey Department

ABSTRACT

During the last years, ways and means to obtain digital Orthophoto mosaics have become more varied in Ghana. Whereas former specifications tried to get a perfect product by specifying the input like flying height, photo quality, camera properties, Digital Terrain Model (DTM) spacing and many other input parameters, these specifications and performance requirements change the view to an output oriented approach where only the quality of the desired final product is specified, while the way to produce it is left to the technical skills and the economic assessment of the contractors. The Government of Ghana has received a credit from the Nordic Development Fund toward the cost of Land Administration Project and has offered to apply part of the proceeds of this credit to payments under the Contract for the Provision of Orthophoto Maps in Colour for Various Parts of Ghana (IFB No. NoCB MLFM/LAP 1/SD/06/01). The Services are the Provision of Digital Orthophoto Maps in Colour for Land Use Planning and Management under the Land Administration Project (LAP). This project is being undertaken by RUDAN Engineering Limited and FINNMAP International, to be abbreviated FR, in collaboration with Survey Department (SD), LAP Unit (LAPU) as well as the Ministry of Lands and Natural Resources (formerly called Ministry of Lands, Forestry and Mines – MLFM). This presentation will capture any known previous work and the current state of the project with respect to the methodologies being used, challenges and some conclusions and recommendations.

1 Introduction

1.1 Background

The Government of Ghana through the Ministry of Lands, Forestry and Mines (MLFM) now called Ministry of Lands and Natural Resources (MLNR) and with the support from some Developing Partners, namely; International Development Association (IDA), Department for International Development (DFID), Nordic Development Fund (NDF), Kreditanstalt für Wiederaufbau (KfW), German Technical Cooperation (GTZ) and Canadian International Development Agency (CIDA) is implementing the first phase of the three phased Land Administration Project (LAPU, 2009). The project seeks to address key issues identified in the National Land Policy document which include inadequate policy and regulatory framework, weak land administration system both customary and public, indeterminate boundaries of customary lands, multiplicity of land disputes which have choked the court system, general indiscipline in land use disposition and development. The provision of Orthophoto maps in colour for Land Use Planning and Management falls under the third component of the four components of Phase 1 of the Land Administration Project in Ghana (LARBI, 2008). The advantages of digital ortho images and terrain models over conventional maps (line or vector maps): much higher visual information content, faster production and lower cost has made Land Use Planners and Management approach to planning more associated with the use of orthophoto maps. This approach is often good to meet time constraints in such projects and where necessary further work could be done for the production of vector maps. During the last years, ways and means to obtain digital orthophoto mosaics have become more varied. Whereas former specifications tried to get a perfect product by specifying the input like flying height, photo quality, camera

properties, DTM spacing and many other input parameters, these specifications and performance requirements change the view to an output oriented approach where only the quality of the desired final product is specified, while the way to produce it is left to the technical skills and the economic assessment of FR. This paper generally discusses the objective and specification requirement, methodology, challenges and makes some conclusions and recommendations.

1.2 Objective and Specification Requirement

This section elaborates requirements as specified in the Request For Proposal (RFP). It covers photo qualities, Aerial Triangulation (AT), Digital Terrain Model (DTM), Orthophoto qualities as well as deliverables.

1.2.1 Photo Qualities Required

- To obtain colour orthophotos for the target scale 1:2500, the Service Provider is to choose a flying altitude and focal distance of his camera so as to achieve a 20 cm ground sample distance (GSD, formerly called pixel size).
- With a view to the special weather conditions in Ghana, a priority list of areas to fly first was set up by the Employer. Generally, existing and sufficiently recent satellite images or not outdated topographical maps were given the Consultant (FR) by the Employer to enable detailed planning of missions with regard to urban centres and settled areas as well as to corridors, at the target scale of 1:2500.
- The pictures are to be free of clouds or smoke, but 5% is allowed. Very dark and long sunshades are not acceptable. The Employer is to inspect all these characteristics visually before accepting the aerial photography and issuing the order to proceed.
- Raw data/material to be delivered for inspection include:
 - the original film, or the raw data in GeoTIFF or TIFF, in case of digital photography
 - one set of contact prints in case of analogue photography or one set of prints in approximate scale of 1:10000 in case of digital photography
 - the flight index in digital format (ArcGIS), from which the necessary overlap (60 % forward and 20 - 30 % side lap) can be controlled.
- Because the Employer may desire to produce digital line maps later on, he must be able to view the stereo-images 3D in a digital photogrammetric plotter and to use the orientation results from aerial triangulation.
- The Employer may choose to use for orthophoto production only a part of the aerial photography flown and to be content with the raw materials for the other parts.

1.2.2 Aerial Triangulation

- All co-ordinates are to be in the new National Geodetic Reference System (GRN). The Employer expects Survey Department (SD) to place at least one survey pillar apt for GPS observation within a maximum distance of 10 km to each orthophoto block. The height given for this point is to be the reference height for the block.
- The Service Provider is to decide on how to achieve acceptable results from aerial triangulation, which is expressed for each block in a mean square error (or error ellipse) of the control points and of the positional precision of a minimum of 4 (four) other points observed on the ground, but not used for aerial triangulation. A report is to be delivered in which it is to be proven that the obtained accuracy guarantees the required final positional and height accuracy of the final product. Then, the Employer is to issue an order to proceed.
- The Service Provider is to place 2 (two) survey pillars according to SD specifications in the neighbourhood of 2 of the 4 points mentioned above and determine their co-ordinates (in the GRN) by GPS.

1.2.3 Digital Terrain Model

The DTM is generated in a manner and density as to guarantee the positional accuracy defined below, and to allow drawing 2-m contour lines in areas not densely built-up. In densely built-up areas spot heights with an accuracy of +/- 30 cm is to be placed on roads and other free spaces.

1.2.4 Orthophoto Qualities Required

The Employer is to check the final quality of the orthophoto rigorously:

- A perfect geometric and radiometric matching is to be visually checked on-screen,

- The positional accuracy on the orthophoto is to be controlled applying a field check (using differential GPS) of well-defined points in strategic and critical positions, like on slopes. For target scale 1:2500 the following maximum error margins are allowed:
 - The limit for absolute accuracy is 4 times GSD (80 cm), across a map sheet (40 by 80 cm).
 - The limit for relative accuracy is 2 times GSD (40 cm) between two neighbouring well-defined points.

1.2.5 Deliveries

The following deliveries are required:

- digital flight index, target scale 1:50000, three times printed and as a file
- co-ordinates of ground control points and of new survey pillars (including a description) in the GRN system, also indicating the method with which they were measured, as a file and 3 times printed text
- 3D co-ordinates of all DTM points and breaklines in GRN system, as a file in ArcGIS
- a layer with 2m contour lines and spot heights to be super-imposed on the orthophoto map sheets, as a file in ArcGIS
- a layer for location, street and place names; the information for this is to be collected authoritatively by TCPD and/or Survey Department
- index map for each block to indicate the map sheet pattern, in a scale fit to be printed in A1 format, with the orthophoto-mosaic as a background, three (3) sets of prints and as a file
- TIFF file for each orthophoto-mosaic of a block and for each single orthophoto map sheet
- three (3) sets of colour prints of each orthophoto map, with contour overlay, neglecting those with less than 10% content.
- to save costs, further printing of these deliveries (including the orthophoto sheets) might be done at the Employer's premises, but a certain quantity in addition to the quantities specified herein (later to be fixed in the contract) could be ordered. Therefore, a quantity-related unit price for prints of the orthophoto map sheets with contour overlay only has to be part of the financial offer.

2 Previous Work

A catalogue of orthophotos as well as aerial photographs for the entire coastline of Ghana has been available since 2008. The product was launched by the then Minister of Tourism (Ghana News Agency, 2008).

3 Methodology, Equipment and Software

The entire photogrammetric production in FR is based on the photogrammetric production line of Inpho GmbH, Stuttgart Germany. The production line, beginning from AT till time of printing, consists of the following software modules:

- ApplicationsMaster 5.1
- Match-AT 5.1
- Match-T 5.1
- DTMaster 5.1
- OrthoMaster 5.1
- OrthoVista 4.3
- OrthoVista Seamline Editor 4.3

Other software modules are started and mastered by ApplicationsMaster, but OrthoVista and OrthoVista Seamline Editor are still standalone products. Each work phase with methodology and software descriptions are described below in their own sub-sections.

3.1 Pre-Marking of Ground Control Points

The positions of the ground control points were determined from the flight diagram for each block obtained from the flying company. To locate the position of each point on the ground, all the coordinates of the chosen points were determined and converted into values in the World Geodetic System (WGS84) so that they could be located on the ground by Navigational GPS. The points were located on the ground and the signal was built into the ground in concrete placed in situ according to specification in the bid document.

The coordinates of the control points were extracted from the digital copy of National topographic map sheets of scale 1: 50,000, covering the project area. The coordinates were keyed in the Navigational GPS, which acts as a pathfinder to help locate the approximate positions of the points on the ground. The immediate surround of points to about 10m radii were cleared of weeds and other obstructions and pre-marked with concrete pillars and flagged for easy identification on the photographs. These points were numbered using the Regional Numbering System stated in the contract. The scaled WGS84 coordinates of the points selected on the topographic sheets were tracked and located on the ground using the Navigational GPS. Besides the Navigational GPS, features such as streams, hills, valleys, tracks and footpaths were some of the landmarks used to facilitate the identification of the control points from the digital topographic sheets. Concrete in-situ pillars (9”x 9”x 27”) were constructed at the center of the arranged legs. The three-leg beacon size was adopted. Each leg is 1.6m x 0.4m. To avoid canopy cover, trees and weeds within some distance around the points were cleared. The diagram below illustrates the arrangement of legs of the Pre-marked points (see Figure 1 & Figure 2).

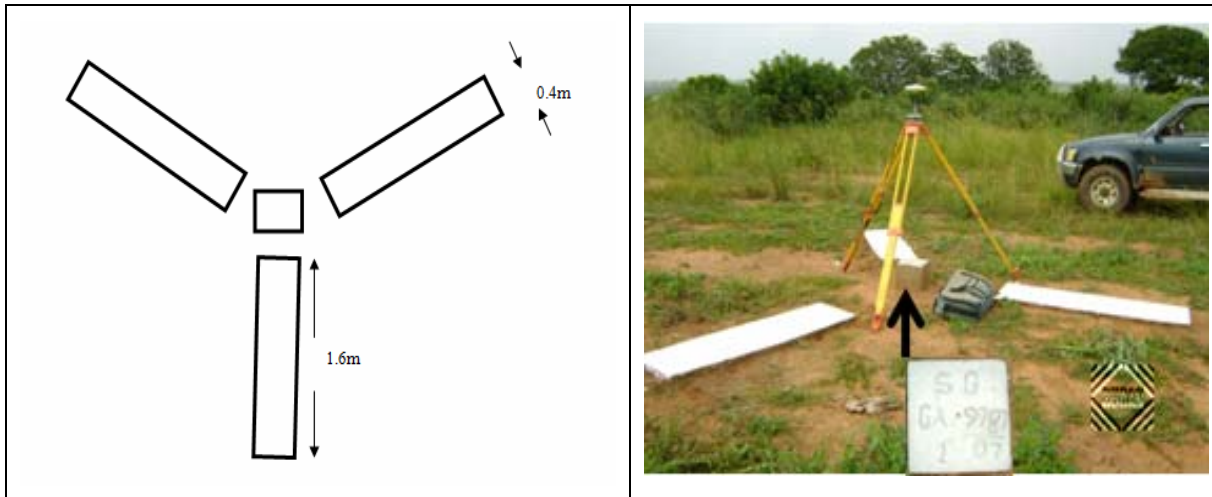


Figure 1: Schematic diagram of pre-mark point

Figure 2: Actual pre-mark point in Prampram block. Area View of point inserted.

3.2 Ground Control Survey

In this project it is mentioned that:

“All co-ordinates shall be in the new National Geodetic Reference System (GRN). The Employer will order Survey Department (SD) to place at least one survey pillar apt for GPS observation within a maximum distance of 10 km to each orthophoto block. The height given for this point shall be the reference height for the block.”

The Global Positioning System (GPS) survey for providing the required ground control network for the aerial photography blocks in the new national system started immediately GRN Phase one project report was received. The main objectives of the new GRN are to establish Geocentric Reference Network which include four (4) permanent stations and seventeen (17) other stations in and around the Golden Triangle of Ghana, provide Transformation parameters, and provide at least a fundamental station in Ghana that will serve both as an International GNSS Service (IGS) station as well as a station for the African Reference Frame Station (AFREF) (Poku-Gyamfi, 2008). The GRN Phase 1 was carried out in collaboration with the Institute of Geodesy and Navigation of the University FAF – Munich of Germany, SD of the MLFM under the LAP.

The new system and official transformation parameters were officially released in October 2008 (public announcement in *Ghanaian Times* newspaper on October 14 2008). In the announcement it was mentioned that the new system, GRN was adopted from January 1 2009. However, there still persists a serious problem, because these transformation parameters are to be used only inside the “*Golden Triangle*”, i.e. area inside the triangle formed by Kumasi, Accra and Takoradi. More than half of the LAP Orthophoto blocks are outside of this area.

The current old imperial system of geodetic network being replaced by the new GRN is a mixture of triangulation points established during the early 1900’s through the establishment of control for the topographic mapping of the whole country in 1974 (Dotse, 2008).

3.2.1 GPS Measurement

Sokkia Radian Dual Frequency Global Positioning System was used to provide the x, y, and z coordinates of the entire controls forming the network for the towns.

3.2.2 Testing of existing Ground Control Points

Two GRN pillars were located in the respective project block area. These pillars were tested for reliability. Pillars were measured from each other to check their coordinates from each other. The result obtained in one of the block area was a difference of -0.541m in Northing(Y)-coordinate and -0.166m in the Easting(X) - coordinate.

3.2.3 Testing of Base Control Points

To ensure reliable and higher accuracy in the coordinates, observation was carried out using two base and two rover stations forming a triangular network of observations at each rover station. This resulted in two sets of coordinates for a point and ensured that gross error in fixing a point can be easily identified and rectified. The diagram below gives an illustration of the arrangement carried out for the measurement.

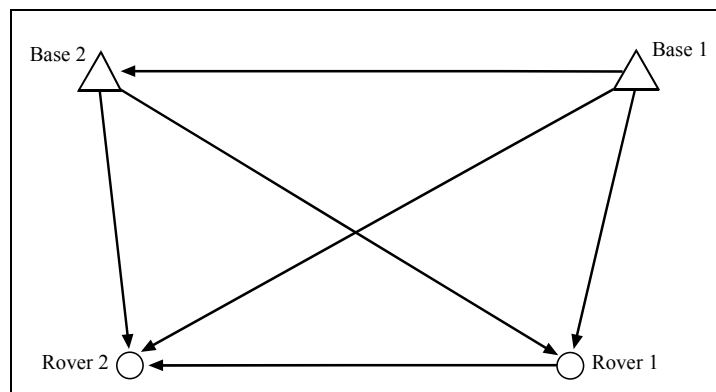


Figure 3 : Base and Rover stations

3.2.4 Observation Planning

Spectrum Survey Planning Module (software), a pre-survey tool was used to determine the most appropriate date and time to collect GPS data. Variety of satellite graphs indicating satellite visibility and geometry were generated and analyzed to determine adequacy of satellite coverage.

The Satellite Elevation graph plots the elevation of the satellite versus time. The elevation mask of 10^0 is represented at the bottom of the graph. This helped in the choice of location of points for less canopy cover.

Although weather conditions have no direct influence on data collected during observation, the planning was scheduled such that rainy and stormy conditions were avoided during the observation. Strong windy conditions could affect the stability of the GPS antenna thereby affecting readings being taken during measurement.

3.2.5 Network Design

A well-structured network was designed comprising the existing controls in the project area and those fixed with the navigational GPS. Each solution point was observed and processed from one of the known control points. Solution points were carefully chosen for adequate view of satellite and to avoid canopy cover. Reflective surfaces such as metal structures were avoided to prevent multipath error although the post processing software corrects it. This is radio interference caused by satellite signals that have traveled different paths to reach the receiver. Observation times were scheduled such that enough overlap of time is realized between base stations and corresponding rover stations.

3.2.6 Observation and Processing Parameters

The following parameters were set or ensured before and during observation to obtain a good quality:

- Geometric Dilution of Precision (GDOP): **Not greater than 4**
- Observation time at a station: **Not less than 30 minutes**

- Elevation mask set for observation: **+10°**. (This was to model terrain obstruction since points selected were free of buildings, trees and mountains.)
- Minimum log satellites before recording of epochs: **4**

The Elevation Mask of 10° was set to clear obstacles around the antenna for optimum tracking of satellites. Points were also chosen to be clear of buildings, mountains, trees and other features.

The following parameters were set during processing of the data collected to ensure accurate results: Troposphere correction: **Measured**, Ionosphere correction: **On**, Ambiguity resolution: **Search**, Rejection criteria: **3 x rms**, Epoch period: **Begin to End**

3.2.7 GPS Data Processing

Spectrum Survey Version 3.5 GPS post-processing software was used to find the unknown coordinates of the survey points by differentially processing data concurrently collected by the four GPS receivers. Carrier phase difference techniques were applied to the GPS observable acquired at different positions. Differential processing started by establishing a baseline vector between two survey points on which the GPS receivers acquired data simultaneously. The software automatically generated these baselines by comparing overlapping epochs from the receiver data collected on each point. One end of the baseline was held as fixed, and relative positioning was used to solve the coordinates for the other end.

3.3 Aerial Photography

3.3.1 Preparations

Ghana has two main Flying-Window (FW) often used for aerial photography namely February-April Window (FAW) and August-December Window (ADW). Despite this, the specifics for each year are depended on the forecasts of the Department of Ghana Meteorological Services. Like in this project, it has been quite difficult getting a good weather. Two main airports at Kumasi and Accra are being used for the photography. An average photo scale of 1 in 10 000 was chosen to achieve the 1: 2500 scale required.

3.3.2 Mapping Areas and Flight planning

Sixty-four (64) blocks amounting to fifteen thousand (15 000) square kilometers are being flown. These blocks cover various parts of Ghana.

3.3.3 Equipment

The equipment used for aerial photography in this project comprises Piper Aztec PA-23-250, Rockwell International 690B, two Leica RC30 aerial survey cameras with 153 mm focal length lens cone 15/4 UAGA-S, two Tracker Navigation Systems, and two Javad LGGD dual frequency receivers.

3.4 Film Processing and Photo Products

3.4.1 Equipment and Material used

All laboratory work is being done in aerial photo laboratory in Bangkok, Thailand. The laboratory is equipped with modern automatic processors both for development of film and production of photo prints and diapositives.

The equipment and material used in the project comprises Kodak Aerocolor III 2444 colour negative film, Hope Color, automatic film processor as developing machine, Spek 25 dodging printers such as ZBE Chromira.

3.5 Scanning

3.5.1 Equipment

Two units of Vexcel UltraScan 5000 photogrammetric precise scanners are available for the project. Both scanners are equipped with automatic roll winder. Before scanning, each of the film rolls are cleaned with SCANATRON CLEAN-1000 professional aerial film cleaner. The film cleaner CLEAN-1000 has been specially designed for a very high efficient removal of dust and particles and neutralization of electrostatic charges from all types of films. The assembled film is passing first a pair of smooth cleaning rollers and after a pair of accurate ionizer bars with an integrated air-knife. The cleaning rollers remove most of particles and dust. After the

neutralization of electrostatic charges with the ionizer bars, the air-knife blows off any remaining dust. Applying this kind of cleaning and electrostatic neutralization before scanning a film, results to digital imagery as free of dust as possible.

3.6 Aerial Triangulation

3.6.1 Software

The software used for aerial triangulation of all photography blocks is Match-AT by Inpho GmbH, Stuttgart, Germany. In the software package a bundle block adjustment program is integrated which is based on the world famous Pat-B block adjustment program. BINGO 5.6 bundle block adjustment software is available in FR for further analysis of the adjustment.

3.7 Digital Elevation Model

3.7.1 Equipment and Software

As the project is big the editing of Digital Elevation Model (DEM) is very laborious, a lot of capacity for this work phase has been reserved. The method is a mixture of newest digital technology and a little bit more traditional technology such as use of SD2000. Fully digital method includes automatic DEM extraction based on image correlation, and DTM editing and additional breakline digitizing with stereo softcopy plotters. The more traditional method consists of digitizing breaklines and spot height with analytical stereo plotters like SD2000. Which method is used, depends on the nature of the terrain. Digital method is faster in a more open terrain with sparse vegetation and housing and in areas with very dense vegetation or in densely built up urban areas analytical method is more feasible.

Below are listed the equipment and software used in the project:

- Analytical plotters: Leica SD2000 analytical plotter, 5 units available
- Automatic DEM extracting: Match-T software by Inpho GmbH, 3 licences available
- Digital DEM editing: DTMaster software by Inpho GmbH, 12 licences available
- Data compilation: Autodesk Map 2007, several licences available

3.8 Orthorectification and Mosaicing

3.8.1 Software

For orthorectification and mosaicing OrthoMaster (Inpho GmbH, 3 licences), OrthoVista by Stellacore Corp (3 licences), and OrthoVista Seamline Editor (6 licences) have been used.

3.9 Contour Generation

3.9.1 Software and Methodology

Contours with 2 meter intervals are generated using the newly produced DTM and break lines collected in DTM editing process. It is important to include the break lines in contour generation for accurate and detailed contour presentation. The most important break lines are those representing hydrology (streams, rivers, shorelines etc.). Depression contours are represented by appropriate symbols. Collection of spot elevations to be shown on the final maps is done with outmost care. It's important that the elevations showing the lowest and highest points in valleys and mountains are carefully selected by elevation, not just by placing them in the middle of area limited by lowest/highest contour line. This kind of height analysis is done using for example ArcView software. Same approach as analyzing spot heights are used in detecting and classifying depression contours.

3.10 Mapsheet Size and Printing

The dimension for the map sheet is one kilometer by two kilometers (1km by 2km). The printing of the map sheet is being done using an appropriate plotter for production considering the size and huge number of sheets to be produced.

The final maps are to have a layer for location; street and place names (see 1.2.5 above). The writer believes that the little observation so far suggest that it is more appropriate to have included such an exercise in the entire project. This is because the FR team is already in the field and could have used the opportunity to collect street and place names. TCPD and or SD could still check the quality authoritatively. As of the time of writing this paper, FR has to submit maps (orthophoto maps with contour overlay) for street and place names to be collected by another before it comes back for final printing. In effect, two teams would have visited the areas twice.

4 Challenges and Intended Solutions

Two aspects should be mentioned:

- The new National GRN project completion. Ground control surveys of the project area (equalling to approx. 10,000 sqkm) is carried out now, but most of them are not yet connected to the new national grid system GRN due to missing base points that should have been provided by the Survey Department. The main concern of FR is the areas / blocks outside of the “Golden Triangle.” As a solution, the Employer is making preparations to complete the GRN project for the entire country to make sure the FR team gets access to the base points.
- Unfavourable weather conditions. As mentioned, the weather has been really unfavourable for aerial photography during the period February, March, April and May; September and October 2008, when the flight crew was on stand-by in Ghana. This is however an issue that is beyond any human action. The main thing is that the FR teams are ever ready to utilize any clear skies coming over Ghana.

5 Conclusions and Recommendations

The following are some conclusions and recommendations

- The total area of the project is fifteen thousand square kilometers (15 000 sq. km).
- This project is undertaken by FR, in collaboration with SD, LAPU as well as the MLFM.
- The use of Digital Workstations is faster than using analytical plotters such as SD2000 for DTM generation. However, for a highly dense area the analytical plotters are often useful.
- It is recommended that in future works field completion (checking names and features) services in such a big project be given to same team instead of launching different bid for it.
- It is recommended that funding should be found for the production of aerial photographs, orthophoto maps as well as vector maps for the entire country.
- It is recommended that local and international partnership be encouraged in Ghana to enhance information sharing in this so-called global village.
- It is recommended that a complete online geospatial portal for the entire country is established for data availability on time.
- The project is still ongoing at the time of writing this paper.

References

- Dotse, J. (2008). *GSDI Capacity Building Requirements of National Mapping Agencies In Developing Countries*. Tenth International Conference for Spatial Data Infrastructure. St. Augustine, Trinidad, p. 3.
- Ghana News Agency, 2008. *Tourism Ministry Launches Map On Coastline*.
http://www.ghana.gov.gh/ghana/tourism_ministry_launches_map_coastline.jsp(accessed 01 Mar. 2009)
- LAPU, 2009. *Progress Report March 2008-March 2009* “Implementation Support Mission (ISM) 15th -30th April 2009”, Accra, Ghana.
- LARBI, W. 2008. *FIG Commission 7 Annual Meeting 2008 and Open Symposium on Environment and Land Administration "Big Works for the Defence of the Territory"*. Verona, Italy, pp. 4-7.
- Poku-Gyamfi, Y., 2008. Final Report (Phase 1). Provision of Implementation of Consultancy Services for Geodetic Reference Network. Accra: Land Administration Project. Ministry of Lands, Forestry and Mines.

COLOR CHARACTERIZATION FOR AERIAL CAMERAS

Susanne Scholz

Microsoft Photogrammetry, Anzengruebergasse 8/4, 8010 Graz
susannes@microsoft.com

KEYWORDS:

Color characterization, Digital camera, Radiometry, Calibration, ICC-profiles

ABSTRACT

Global image coverage and virtual 3D globes are booming. The two companies Microsoft and Google are competing in presenting the biggest and most actual database of satellite, aerial and streetside images. As it is inevitable to use images from different sources for these kinds of projects, the topic multisensory image fusion becomes more important. The color and radiometry of images is besides the geometrical fusion one essential subject in the matter of image fusion technologies. The main interest is to get well balanced image mosaics out of different kind of images without seeing any color shifts or problems.

This paper focuses on the radiometric sensor fusion and presents possibilities for creating ICC profiles for input devices as digital cameras. Methods for adjusting images which can be applied on multiple images from multiple sensors will be discussed. First results of a lookup table (LUT) - transformation will be shown. The main aim is to present methods and concepts in color theory which can be applied in the field of sensor fusion and remote sensing to improve the workflow for color adjustment for blocks of images.

1 Introduction

In the last years Nasa, Microsoft, and Google started creating virtual 3D globes. Microsoft and Google are still competing in presenting the most actual and largest scale (up to streetside) data. Virtual Earth, the platform of Microsoft, presents 3D views and especially birds eye images. Google Earth, Google's platform, presents streetview images and has a large community, who are creating additional content in KML format (keyhole markup language). Both services need to fuse images of different scales and sensors.

This paper gives a conceptual overview how to color characterize an aerial camera and with this be able to use all the advantages of standardized color spaces and methods suggested by color theory to adjust the colors of several images. The necessary background information about aerial sensor fusion, color theory and color profiles is given in chapter 2. Chapter 3 comprises the connection between aerial fusion and color theory and chapter 4 will describe first results with a LUT transformation. The last chapter will summarize and give a future outlook. The idea presented in this paper combines research results from color theory with techniques in remote sensing, in order to improve already available image (sensor) fusion and mosaicking methods.

2 Background

2.1 Radiometric Sensor Fusion of Satellite, Aerial and Streetside Image Data

Photographing the earth's surface can be done by different kind of sensors. No matter if the sensor is mounted on a satellite or aircraft platform, or in the recent developments even on a mobile platform as a car, it is always necessary to adjust the recorded images radiometrically. Flight missions of cities or other areas usually produce several hundreds or thousands of images. The different illumination situations, when flown on different days or different sun angles (flying over a complete day) results in color differences. Even the atmosphere influences the radiometry of aerial images (e.g. haze in images). This makes it necessary to adjust colors of a complete flight mission. At the moment several algorithms as for example histogram matching, statistical matching or linear correlation are implemented in image mosaicking software. All these algorithms work quite well as long as the differences in colors are not too big.

To fuse images from different sensors, with different radiometric response and behavior, different sunlight and illumination situations make it even more difficult to adjust blocks of images. Figure 1 shows an example for such a sensor fusion problem. As Microsoft and Google started to get in on aerial image processing this research area got more and more importance over the recent years.



Figure 1: Screenshot of Virtual Earth - sample for problems with image data fusion, especially problems arise in homogenous regions (source: <http://maps.live.com>, accessed on 2009/04/30)

2.2 Color Theory

Each device, no matter if it is an input device, as a scanner or digital camera, or an output device, as a LCD screen or a printer, is producing colors in a specific color space. Each device can (re)produce colors, but these colors vary from device to device. The range of colors which can be (re)produced by a device is called the gamut.

The devices even produce colors in different color spaces. Input devices as well as display devices typically use the RGB color space, whereas output devices work with the CMYK color space. Both color spaces have the problem that they are device dependent. In color theory several other color spaces have been developed which are independent of any device. The most common device independent color spaces are the XYZ- and LAB color space (Reinhard, 2008).

The transformation of a device color gamut into a device independent color space opens the possibilities to use well defined methods for changing the colors of an image in a standardized way. Figure 2 shows the gamut of the device independent color space XYZ in 2D, also called chromaticity diagram, and the gamut of the sRGB-color space transformed into XYZ color space. A defined transformation back into a color space of an output device guarantees an output with the same colors as the input device has recorded, as long as the color gamut of the two devices is similar.

The main advantage of a device independent color space is that techniques for color adjustments and improvements can be performed independently from any input or output device. Those techniques are for example gamut mapping, color transfer or white balancing.

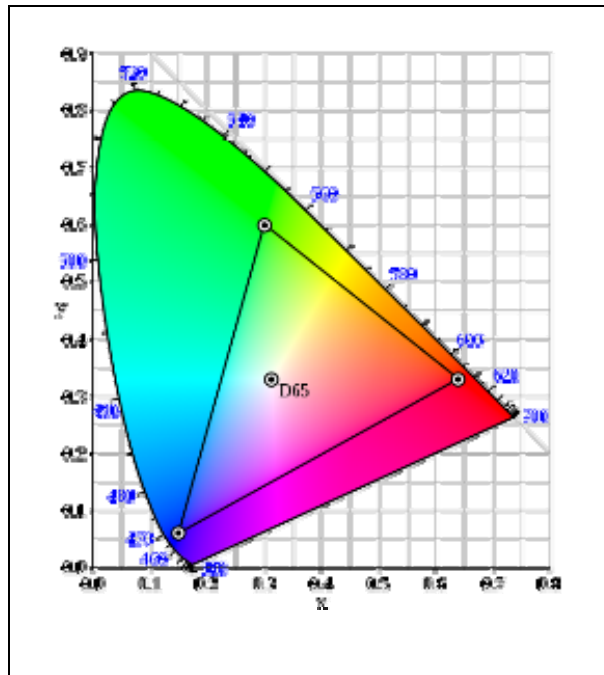


Figure 2: Chromaticity diagram of XYZ-color space, with limitations of sRGB color space and D65 white point (source: http://en.wikipedia.org/wiki/SRGB_color_space, accessed on 2009/04/30)

2.3 International Color Consortium

The International Color Consortium (ICC) is an industry consortium which was established in 1993. The ICC has developed a standard for describing the color gamut of a device, the so called ICC-profiles and a workflow for working with standardized colors.

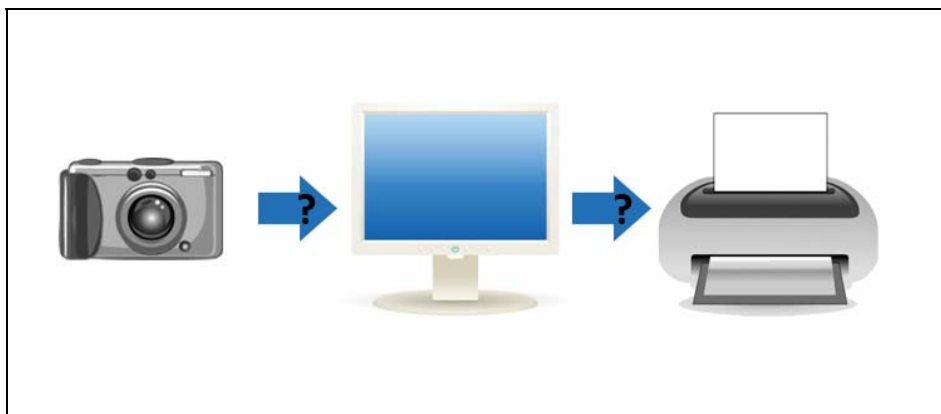


Figure 3: A typical workflow for taking and printing photographs

A usual image production workflow for photography and printing is presented in Figure . The standard hardware driver and color adjustment is used for displaying a recorded image on an LCD display. In the further step the recorded image is printed, without having a focus on color management. This leads in most cases to a different representation of colors in every new device of the workflow.

To avoid those unexpected color problems when working with more devices, the ICC has developed a standardized workflow, which uses a device independent color space (profile connection space - PCS) and a profile for each device in the workflow to transform specified colors (figure 4).

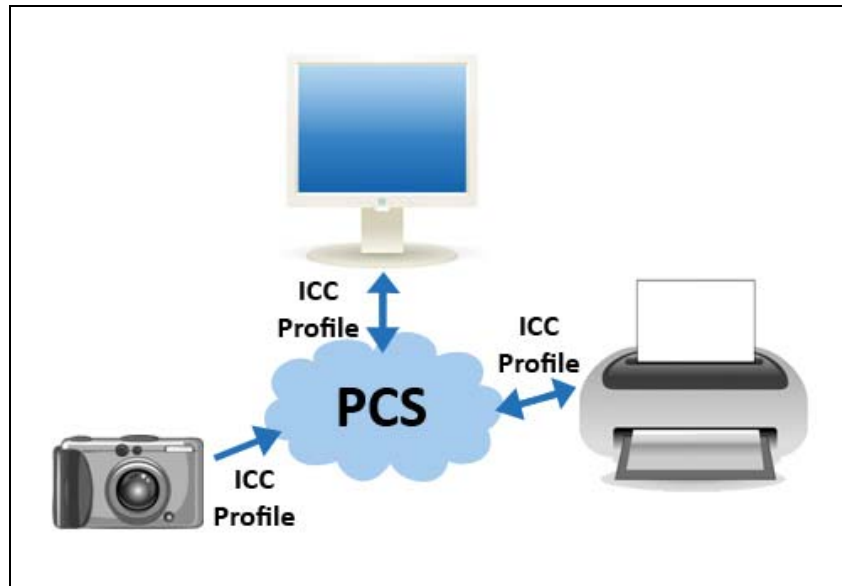


Figure 4: Standardized color workflow suggested by ICC

The transformation into the device independent color space is defined in the ICC profiles. This profile contains information about the transformation parameters (or Look up Table - LUT), additional information about the device color space (RGB or CMYK) and, if necessary, information about the transformation from the PCS back to the device color gamut.

2.4 Camera Calibration

To calibrate a digital camera by means of color calibration and for the creation of the ICC-profile it is inevitable to use a color target (figure 5) with known color values and a specified light source. Figure 5c shows a self-defined color target. This target was created for further analysis. The color patches have been chosen, as they represent the main colors in the RGB- and CMYK-color spaces. From each color there are 6 different intensity levels up to white. The seven white patches in the lowest row and the gray border can be used to determine if the light source illuminates the target equally.

To be accurate, it is inevitable to use a spectrophotometer to measure the color values with this calibrated device during the recording of the images. Out of these recordings it is possible to derive transformation parameters or a LUT for the conversion of the RGB values into an independent color space as XYZ or LAB. This process is also called camera characterization.

When characterizing digital cameras all images recorded with these cameras can be transformed into the device independent color space and this opens new possibilities in adjusting multiple images from multiple sensors. In addition, the transformation back to an output color space is specified as long as the output device is also calibrated and defined by an ICC-profile.

Different illumination situations during photographing bring up problems when using the derived transformation. But there are several possibilities to avoid this problem. Reinhard et al. (2008) suggests making multiple color target recordings with different illumination situations and using them to approximate the lightning situation during image taking. Another approach described by Reinhard et al. (2008) is to estimate the lightning situation and adjust according to the estimation the transformation parameters. An intelligent white balancing algorithm (no matter if done in the device color space or already in the independent color space – Sharma et al., 1998 and Jang et al., 2005) can also be used for adjusting to the correct chromaticity coordinates.

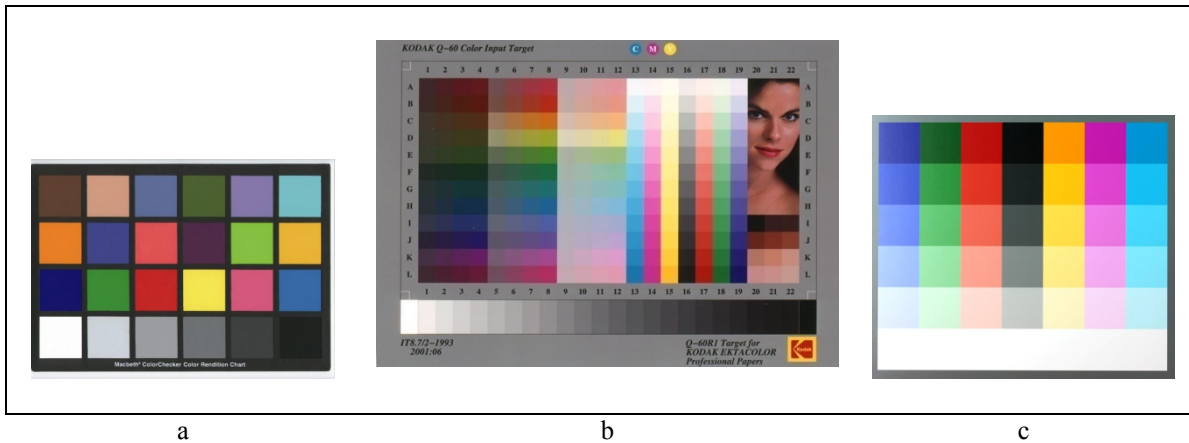


Figure 5: color target for camera characterization, a) Gretag MacBeth Color Checker, b) Kodak IT8 color target, c) self-defined color target for investigations

3 Combining Color Theory and Aerial Sensor Fusion

The integration of techniques of the ICC and color theory in remote sensing will bring miscellaneous advantages for color image processing of aerial photos and satellite images. One very important issue is the correct color representation on different output media. With the creation of ICC profiles a more accurate representation of color through the complete production workflow can be guaranteed.

Furthermore it is of interest to evaluate methods developed in color theory to adjust blocks of images, even from different sensors to result in even image mosaics without color shift problems. Three methods are described below. Further investigations in near future will show which of these method will suit best for the radiometric image fusion application.

3.1 White Balancing

White balancing is a widely known approach in photography. It describes the technique of finding the appropriate color balance in an image, with the result that a white area, like for example a bright roof, also represents a white area in a photo. This means, that the red, green and blue channel have values of exactly 255 DN in a 24bit image. During recording this is usually not the case because the illumination is always different. Consumer cameras have an auto white balancing algorithm implemented or more sophisticated users can white balance the camera for a specific lightning scene by photographing a white surface. In addition, there is always the possibility to adjust the images in post processing.

Due to the fact that aerial image sensors need to be post processed the white balancing happens usually in this step and not already during recording. Several algorithms, like the gray world assumption or component stretching, are well known white balancing techniques (Bianco et al., 2006).

3.2 Gamut Mapping

Gamut mapping describes a technique where the gamut of a device can be mapped into a gamut of another device. The mapping is necessary for example when a picture has been scanned and shall be printed in a next step. The two device gamuts of the scanner and printer are typically different. For this reason a mapping between those two gamuts must be found to be able to reproduce colors from the scanner as accurate as possible with the colors of the printer. This is not always a trivial issue, as the color spaces of different devices can vary strongly. As long as the gamuts are overlapping this is not the problem, but the tricky part of the task is to find color matches when the gamuts in the XYZ color space do not overlap. More details on how to solve these problems in gamut mapping can be found in Vrhel et al. (1999).

This technique can be used to map the color gamuts of different aerial image sensors. When the sensors have been characterized the gamut of the device is well known and can be used to map into a gamut of another sensor.

3.3 Color Transfer

Color transfer describes the process of analyzing the statistics of an image and modifying another image so that the statistical properties are similar to the reference image. The correlation between color channels is very helpful. Usually this technique uses the principal component analysis (PCA) to decorrelate the data (color channels) and treat the channels completely independently. This is performed in another color space than RGB, which is more adequate for working with uncorrelated data. In a next step the statistical properties (mean and standard deviation) are fitted and in a last step the images are transferred back to RGB color space.

The color transfer method would allow a transfer of the colors of one sensor to images of another sensor and thus would aim in a similar result as the gamut mapping, which is the main goal to adjust images of different sensors by using techniques out of color theory.

4 First tests and setup

For an initial test the digital aerial cameras UltraCamXp, and UltraCamL, products of Vexcel Imaging GmbH, were used. The color concept of the two cameras is different. UltraCamXp uses 3 separate color cones whereas the UltraCamL uses a Bayer pattern CCD. The RGB image produced by the UltraCamXp consists of three monochrome grayscale images with color filters (red, green and blue), which are registered to each other in postprocessing. On the contrary to this produces the UltraCamL just a single image with a Bayer pattern CCD where the missing information is interpolated with demosaicking algorithms (similar to consumer cameras as e.g. the Canon EOS 40D).

A color target with well defined color values has been recorded in the calibration lab. The illumination was given by 4 HEDLER D04 HDI lamps with even, specified 5600K daylight. Image series with different aperture and exposure time settings have been recorded. The image series with the same settings have been averaged and used for further investigations.

Figure 6 shows the reference target, an image of a digital SLR camera (Canon EOS 40D) and the image of the color target taken with the monochrome sensors and with the Bayer pattern sensor. When checking the images visually, differences to the reference target can be seen in all three cases. The difference in the image of the consumer SLR camera is smaller than the differences of the reference target to the UltraCam images. The reason for this is that the SLR camera already has a color management implemented and the images recorded with the UltraCam cameras have no specific color post processing applied. All photographs of the color targets have been white balanced manually.

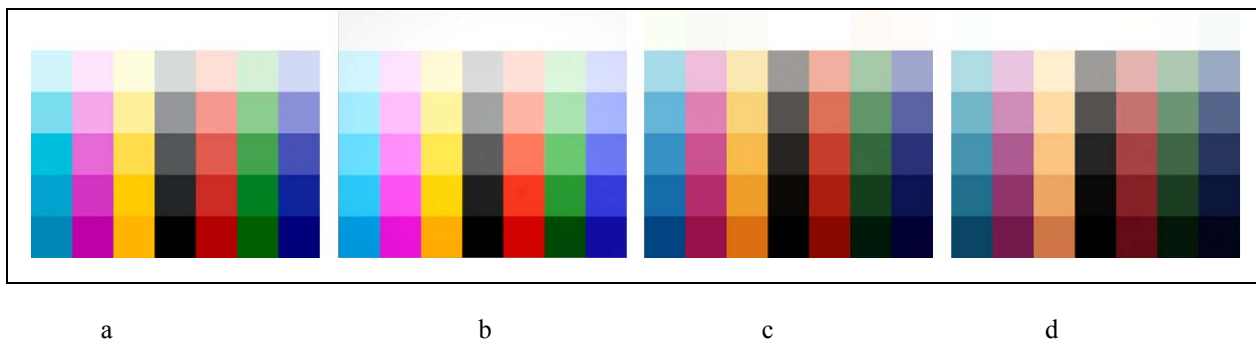


Figure 6: Comparison of color targets, a) Reference target, b) Photo taken with Canon EOS 40D, c) Averaged image of monochrome image sensor (UltraCamXp), d) Averaged image of Bayer pattern sensor (UltraCamL)

The initial test to fit colors has been performed in RGB color space. The gray level color patches of the reference image and the target image are displayed on a 2D diagram and values in between are interpolated with a spline function. The resulting LUT is used to compute the new colors in an image recorded with this sensor. The spline function for the monochrome RGB sensor is shown in figure 7.

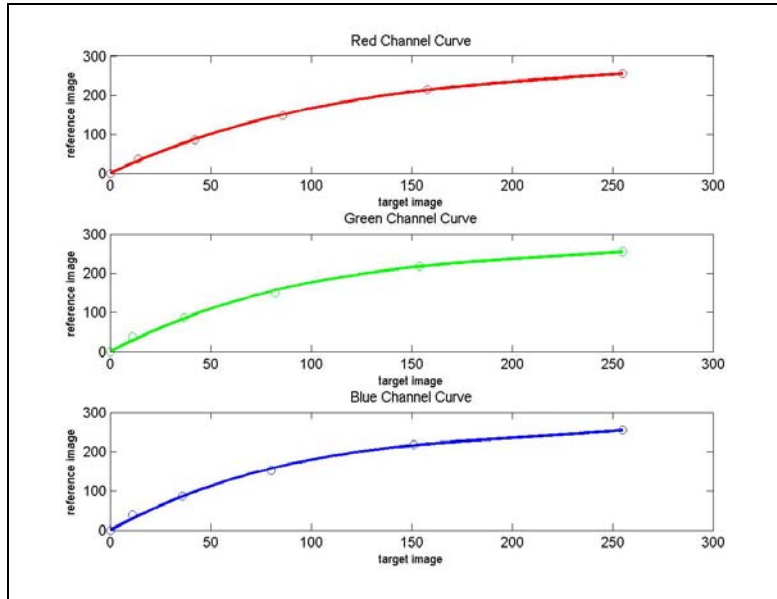


Figure 7: Diagram of the color patches from black to white from the reference image confronted with the target image, including the interpolated spline function

Figure 8c shows a first result. The reference target image can be seen on the left side (figure 8a), the original monochrome sensor image in the middle (figure 8b) and the adjusted image where the LUT of figure 8 was applied, is displayed on the right side. The red rectangle indicates the color patches used for the creation of the LUT. The adjusted image fits visually better to the reference image than the original sensor image.

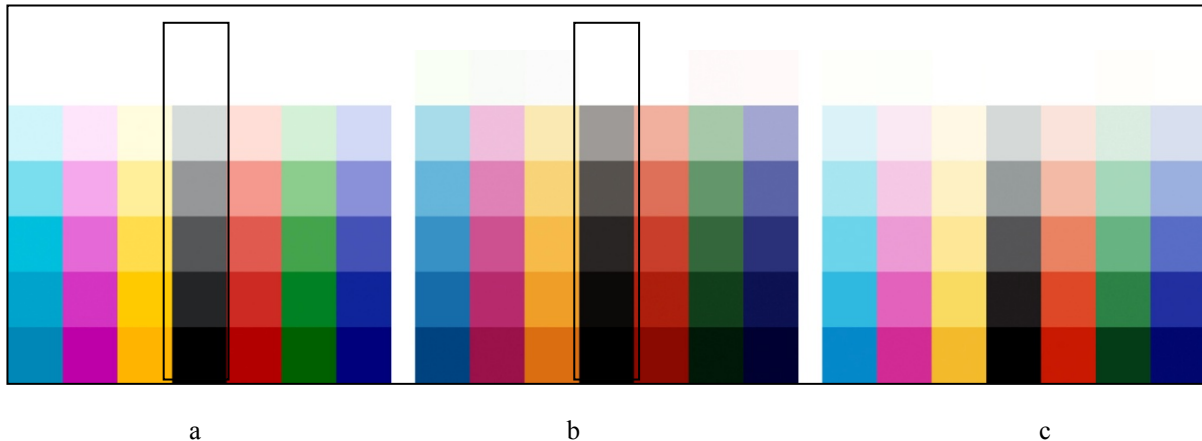


Figure 8: Reference color target (a), original UltraCamXp image (b) and LUT adjusted UltraCamXp image (c), the red rectangle indicates which color patches have been used to create the LUT

In figure 9 the LUT adjusted image is confronted with the reference image to check the quality of the LUT adjustment. The perfect fit would result in a straight line. The shape of the spline function is straighter than before in figure 7, which confirms the visual impression in figure 8.

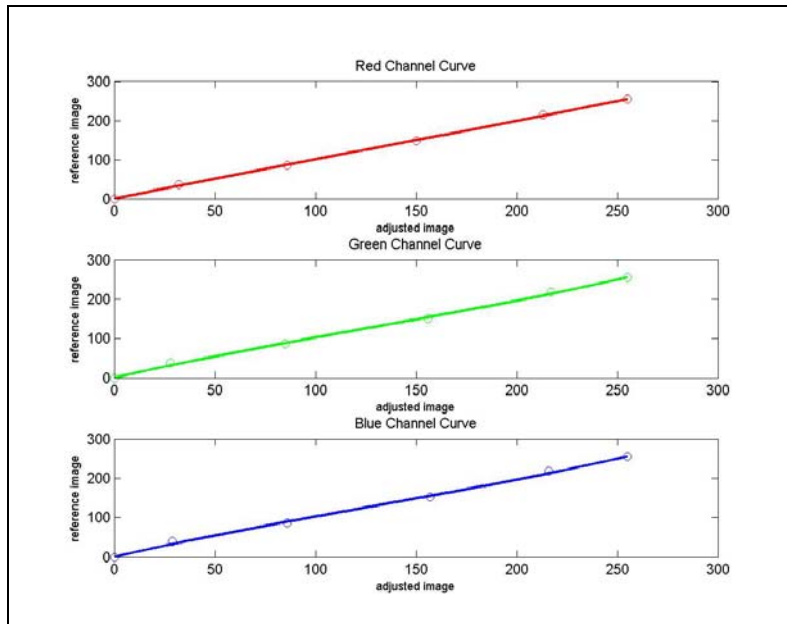


Figure 9: Diagram showing the reference image compared with LUT adjusted image

When applying this LUT onto real image data from the monochrome sensor the results are also very promising as it can be seen in figure 10. The colors appear to be more natural and have no gray and brown color cast anymore.



Figure 10: Comparison of monochrome sensor image, a) original image, b) LUT corrected image

5 Summary and outlook

This paper gives a short introduction how methods and standards (ICC) of color theory can be applied to aerial images to improve color problems when fusing images of different camera sensors. Basic background information about color theory is given and three methods are explained. The advantages of standardized colors and a standardized color workflow are discussed. A method for camera characterization is presented and first setups and tests with two different image sensors of digital aerial cameras are described. First tests and calibration setups are shown in chapter 4. A first LUT has been computed to map the colors of the reference image to a sensor image.

The next steps in this investigation will be the useful derivation of parameters for the transformation into XYZ-color space. Different methods are evaluated, which can be used to create this transformation. A lookup table and a least squares polynomial fitting method will be created to check which method brings the most accurate transformation results. The methods will also be evaluated with 16bit images to be able to exploit the full capacity the images from the sensors and to be able to make the transformation more accurate. Furthermore,

when the correct transformation has been evaluated, further analysis with methods described in chapter 3 will be performed.

References

- K. Barnard & B. Funt. "Camera Characterization for Color Research" *Color Research and Application* 27 (2002), 152-163.
- S. Bianco, F. Gasparini & R. Schettini. "Combining strategies for white balance", *Proc. Digital Photography III, IS&T/SPIE Symposium on Electronic Imaging, Vol. SPIE 6502* (R.A. Martin, J.M. DiCarlo, N. Sampat eds., 2006, pp. 650208D-1-9
- International Color Consortium Specification. Tech. Rep. ICC.1:2004-10, International Color Consortium, 2004. Available online (<http://www.color.org>)
- S.W. Jang, E.U. Kim, S.H. Lee & K.I. Sohng. "Adaptive Colorimetric Characterization of Digital Camera with White Balance." *ICIAR 2005*, Springer Verlag, 712-719.
- M.H. Kim, J. Kautz. „Characterization for High Dynamic Range Imaging." *EUROGRAPHICS 2008*, Volume 27 (2008), Number 2
- E. Reinhard, E.A. Khan, A.O. Akyuz. „, Color Imaging: Fundamentals and Applications." Wellesley: AK Peters, Ltd., 2008.
- G. Sharma, M. J. Vrhel, & H. J. Trussell. "Color imaging for multimedia." *Proceedings of the IEEE*, 86(6):1088, Jun. 1998
- M. J. Vrhel, H. J. Trussell: "Color Device Calibration: A Mathematical Formulation." *IEEE Transactions on Image Processing* 8:12 (1999), 1796-1806.

CREATING CADASTRAL MAPS IN RURAL AND URBAN AREAS OF USING HIGH RESOLUTION SATELLITE IMAGERY

M. Alkan and M.A. Marangoz

Department of Geodesy and Photogrammetry, Engineering Faculty Zonguldak Karaelmas University, Zonguldak, Turkey
mehmetalkan44@yahoo.com

KEY WORDS:

GIS, Remote Sensing, Object Extraction, Cadastre

ABSTRACT

Nowadays, remotely sensed images are used for various purposes in different applications. One of them is the cadastral application using high resolution satellite imagery. In this context, a comparison of extraction results from these images and existing vector data is the most important issue. The goal here is to show the advantages and disadvantages of the QuickBird and IKONOS imagery for making cadastral maps. In this study, high resolution IKONOS and QuickBird images of rural and urban test areas in Zonguldak and Bartın have been chosen. Firstly, pan-sharpened IKONOS and QuickBird images have been produced by fusion of high resolution PAN and MS images using PCI Geomatica v9.1 software package. The parcel, building and road network objects from these datasets have been extracted automatically by initially dividing it into segments and then being classified by using the spectral, spatial and contextual information in eCognition v4.0.6 software package. On the other hand, these objects have been manually digitized from high resolution images using ArcGIS v9.2 software package.

These vectors produced automatically and manually have been compared with the existing digital cadastral maps and reference vector maps (scale 1/5000) of the test area. The success of object-oriented image analysis results was tested by GIS software; the results have been presented and commented. Therefore, making GIS-based analysis and comparisons with raster and vector data of the test area has crucial importance in terms of putting forth the recent situation.

1 Introduction

The availability of high resolution optical imagery appears to be interesting for geo-spatial database applications, namely for the capturing and maintenance of geodata. Recent works show that the geometry of QuickBird or IKONOS imagery are accurate enough for mapping purpose up to scale 1:5000 (Büyüksalih and Jacobsen, 2005). High resolution satellite imagery data has a lot of advantages and can be used for updating the available maps. This can be applied specifically to follow the road networks and verify them in the topographic database.

Nowadays, developments in remote sensing and image processing technologies have specifically provided the opportunity of determination of large areas in detail and in this respect, production of reliable, extended and recent data quickly. Thus, the fast developments in urban areas can be followed and strategies of directing those developments can be formed. In this respect, automatic object extraction have recently become necessary for large-scale topographic mapping from the images, determining the changes of topography and revising the existing map data. For mapping from high resolution imagery or GIS database construction and its updates, automatic object-based image analysis have been generally used for remote sensing applications in recent years. Besides, as the products obtained by automatic object-based extractions are GIS-based, they can be integrated to GIS. In this way, queries and various strategic analyses can be made.

In this study, automatic object-based classification of buildings, parcels and roads in the Zonguldak and Bartın study area of Turkey has been realized by eCognition v4.0.6 software. The Classification procedure has been implemented using pan-sharpened QuickBird images of the interest area. Such an image can be easily formed by the pan-sharpening module of PCI Geomatica 9.1.1 system. Several tests have been carried out to match with the successful segmentation. Then the classification is done by entering different parameters to the used software. In addition, based on the previous studies, road networks from pan-sharpened IKONOS images of the same area

have been extracted using Halcon v7.0 software and the extraction results have been interpreted. Aim of this study is to test feature extraction capacity of these high resolution images for using in GIS. The results obtained have been changed into vector format and integrated to a database. These vectors, produced automatically, have been compared with the reference vector maps (scale 1/5000) of the study area and with the results acquired from on-screen manual digitizing method. The success of object-oriented image analysis was tested by GIS software.

2 Zonguldak, Bartin Testfield and Datasets

The Zonguldak testfield is located in the Western Black Sea region of Turkey. It is famous with being one of the main coal mining areas in the world. Although losing economical interest, there are several coal mines still active in Zonguldak. The area has a rolling topography, in some parts with steep and rugged terrain. While partly built city area is located alongside the sea coast, there are some agricultural lands and forests in the inner part of the region. Figure 1 shows the QuickBird imagery of the testfield taken in May 2004. Bartin testfield is located in close of Zonguldak, but Bartin topography is smooth. Bartin test area was selected from the city center and its close vicinity of Bartin. The different structures and densities of vegetation also will be practiced approach of object-based classification.



Figure 1: QuickBird image of Zonguldak testfield.

In the upper part of the image, the Black Sea is lying down and other parts of the image include central parts of the Zonguldak city, which covers nearly 15x15km area with the elevation range up to 450m. When the images have been received, they were analyzed for selecting suitable Ground Control Points (GCPs). As a result of this determination, 43 distinct GCPs were measured by GPS survey with an accuracy of about 3cm. Since those natural GCPs can be seen very well on the images, they were selected as building corners, crossings, etc. Because of the fine resolution of QuickBird imagery, many cultural features can be identified and used as GCPs. The manual measurements of GCPs' image coordinates were carried out by GCP Collection Tool under PCI Geomatica-OrthoEngine software package. After geometric correction of QuickBird imagery (Jacobsen et al., 2005), it was enhanced by applying a pan-sharpening method (Wang and Zhang, 2004) used in PCI system. This method makes it possible to benefit from the sensors spectral capabilities simultaneously with its high spatial resolution.

In this study, a subset of pan-sharpened images which include the buildings and road features were planned to be used for the automatical extraction. The characteristics of this area, shown in Fig. 2, are a variable topography and a more urbanized area in Zonguldak. Fig. 3, is a Ikonos image, which shows urban areas and the city center of Bartin. Besides, figure 3 shows after classification of Bartin testfield. Looking at the image in detail, there are lots of buildings with different shapes and road network without any order. It can be seen that some of the building roofs are different from each other and some of the road network is shadowed by building features and vegetation. Depending on this reasons, determining parcels is not useful for Zonguldak city area. Besides, in the

urban area the determination of parcels, roads and buildings is much easier than in city areas. This situation is given in figure 3.



Figure 2: Subset of Pan-sharpened QuickBird Image of Zonguldak Study Area

3 Object-Based Feature Extraction

Object-based image analysis comprises an image segmentation and object-based classification phase in eCognition v4.0.6 software. This software offers a segmentation technique called Multiresolution Segmentation (MS). Because of the MS is a bottom-up region-merging technique, it is regarded as a region-based algorithm. MS starts by considering each pixel as a separate object. Subsequently, pairs of image objects are merged to form bigger segments (Darwish et al., 2003).

The merging decision is based on local homogeneity criteria, describing the similarity between adjacent image objects. The pair of image objects with the smallest increase in the defined criterion is merged. The process terminates when the smallest increase of homogeneity exceeds a user-defined threshold (the so called Scale Parameter – SP). Therefore a higher SP will allow more merging and consequently larger objects, and vice versa. The homogeneity criterion is a combination of color (spectral values) and shape properties (smoothness and compactness). Applying different SPs and color/shape combinations, the user is able to create a hierarchical network of image objects (e-Cognition, 2004).

Image segmentation phase is followed by the classification of the images. eCognition software offers two basic classifiers: a nearest neighbour classifier and fuzzy membership functions. Both act as class descriptors. While the nearest neighbour classifier describes the classes to detect by sample objects for each class which the user has to determine, fuzzy membership functions describe intervals of feature characteristics wherein the objects do belong to a certain class or not by a certain degree. Thereby each feature offered by eCognition can be used either to describe fuzzy membership functions or to determine the feature space for the nearest neighbour classifier. A class then is described by combining one or more class descriptors by means of fuzzy-logic operators or by means of inheritance or a combination of both. As the class hierarchy should reflect the image content with respect to scale the creation of level classes is very useful. These classes represent the generated levels derived from the image segmentation and are simply described by formulating their belonging to a certain level. Classes which only occur within these levels inherit this property from the level classes. This technique usually helps to clearly structure the class hierarchy (Marangoz et al., 2006).

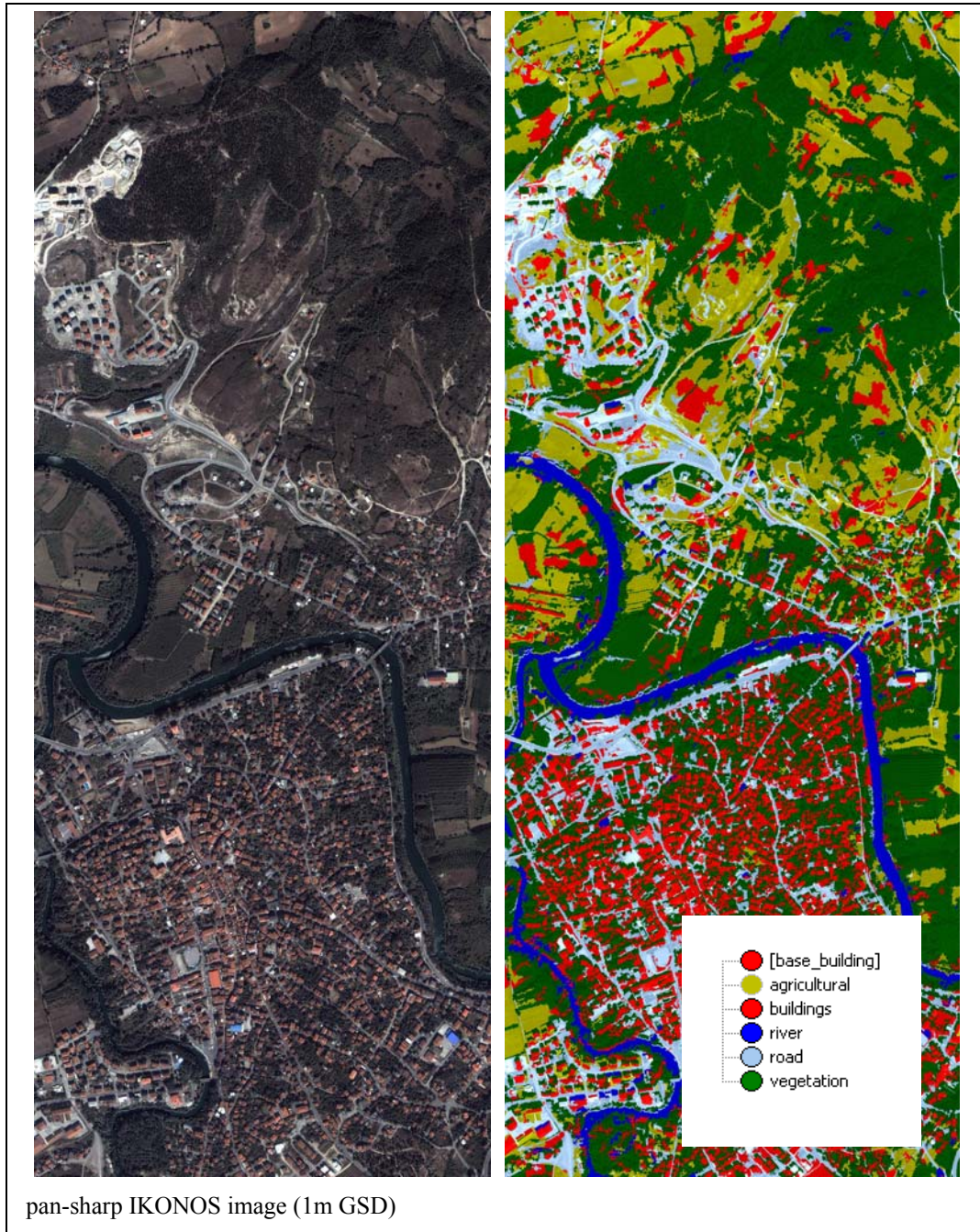


Figure 3: Ikonos imagery of Bartin and object based classification results

4 Comparison of Feature Extractions with Reference Vectors

Automatic object-based feature extraction results and manual on-screen digitizing results were compared with reference vectors from 1:5000 scale topographic maps using GIS software.

4.1 Comparison of Object-based Feature Extraction Results with Reference Vector

Firstly, vector results of object-based feature extraction of buildings and road network from images were compared and superimposed with reference vectors (Fig. 4a and 4b).

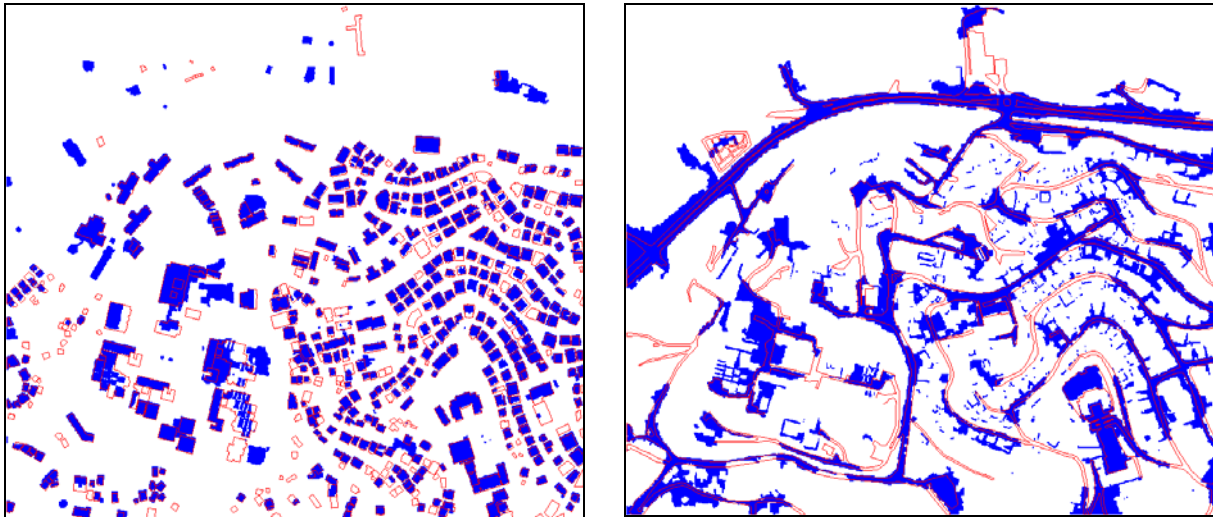


Figure 4: GIS-based analysis of object-based results of buildings (a) and road (b) network from QuickBird using reference vector (Red: Reference vector, blue: Object-based results)

By counting the extracted buildings in the study area using GIS software, it was seen that 85% of buildings were extracted automatically. In the segmentation phase of object-based feature extraction, most suitable segmentation results were selected and therefore, this situation caused more success results of buildings extractions.

The extracted buildings are good shaped and similar to their real forms. Looking at Figure 4a in detail, it can be recognized the some new buildings were constructed and some buildings were demolished.

By comparing the center lines of road network of reference vector and object-based results, it was seen that, 70% of road network was extracted automatically. The reason of this low value is shadow problems caused from buildings in this image and the proximity of the buildings. The other reason is low extraction capability of linear objects of eCognition software package (Marangoz, et al., 2007).

4.2 Comparison of On-screen Manual Digitizing Results with Reference Vector

Secondly, on-screen manual digitizing vector results of buildings and road network were compared and superimposed with reference vectors (Fig. 5a and 5b).

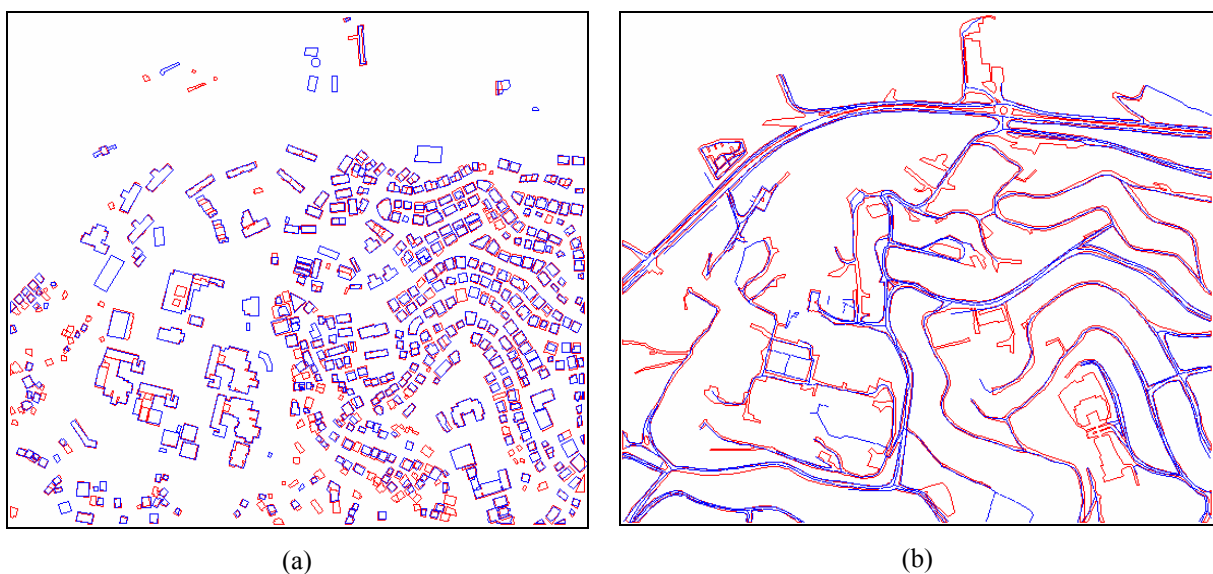


Figure 5: GIS-based analysis of on-screen manual digitizing results of building and road network from QuickBird image using reference vector (Red: Reference vector, blue: Manual digitizing)

Manual digitizing of buildings from QuickBird image were extracted with correct shape by using the advantage of 0.60m GSD. This image has a sun elevation angle of 65° and a sun azimuth angle of 139°, therefore, small buildings and the street lines located in shadows could be identified easily. By counting the digitized buildings in study area using GIS software, it was seen that, 90% of buildings were digitized manually. Looking at Figure 5a in detail, some new buildings were constructed and some buildings were demolished as automatic method.

Main problem of the road extraction from pan-sharpened QuickBird imagery are the trees which prevent extracting the objects under them. Some of the roads could not be extracted because of the blur, operator errors, operator ignorance and shadow effects. They are the other important obstacles in extraction of roads. However, it was seen that, 85% of the road network of study area was digitized manually (Marangoz, et al., 2007).

5 Conclusions

In this study, the capacity of object-based classification approach to identify parcels, buildings and road networks of city and urban test areas from Ikonos and Quickbird imageries was examined. In the urban area buildings and road networks can be detected with a high percentage. However, parcel objects are not extracted very good from high resolution imagery. Besides, urban area gives a good result at all of the objects. Based on the acquired results, the following conclusions were reached.

- For extraction of parcels from the high resolution images, object-based algorithm was used. By using this algorithm parcel objects were extracted successfully which above 85% in urban area. But city area results are not good enough for creating cadastral maps (figure 3., figure 6., table.2.).
- IKONOS imagery is not suitable for automatic feature extraction on this study area especially parcel features.
- QuickBird image produced suitable mapping results. The main problems in the study area are the shadows of neighboured buildings. Besides, QuickBird image produced non-suitable mapping results for parcels objects in city area.
- Some items e.g. atmospheric conditions, sun elevation and incidence angle and detail contrast of the images affects the information contents to identify the objects.
- All six classes were created which contains Base_building class for Ikonos imagery. Base_building class was created to separate Buildings and Agricultural classes in city center which can not contain Agricultural objects. For this purpose, homogeneous distributed building objects were selected to create a buffer zone by 250m radius which specifies the agricultural objects out of city center. In classification phase, an inverted membership function was created to separate agricultural objects from city center which can not be in this buffer zone produced from the Base_building objects (figure 3.).
- Manual on-screen digitizing method process is slower than the automatic one but it has more close results as the real feature forms.



Figure 6: Results of Object-Based Classification of Ikonos Image in Bartın city center

Class Name	Producer's Accuracy %	User's Accuracy %	Kappa Statistic
Agricultural	83	86	0.78
Buildings	84	89	0.75
Vegetation	100	100	1.00
River	100	100	1.00
Road	100	73	1.00

Table 1: Accuracy results for classified pan-sharpened ikonos from object-based image analysis

Feature in Study Area	Manual Digitizing	Automatic Extraction
Parcel (city)	%15	%10
Parcel (Urban)	%90	%85
Buildings	% 90	% 85
Road Network	% 85	% 70

Table 2: Capability of manual on-screen digitizing and object-based extraction approaches using reference 1:5000 scale topographic maps

References

- Büyüksalih G., and Jacobsen K., 2005. Optimized Geometric Handling of High Resolution Space Images. In: ASPRS annual convention, Baltimore, p.9
- Darwish A, Leukert K., and Reinhart W., 2003. Image Segmentation for the Purpose of Object-Based Classification. Proceedings of IGARSS. 2003 IEEE, Toulouse, France.
- eCognition, 2004. User Guide 4, Definiens Imaging GmbH, Munich.
- Jacobsen K., Büyüksalih G., Marangoz A. and Sefercik U.G., and Büyüksalih İ., 2005: Recent Advances in Space Technologies (RAST). Istanbul
- Marangoz A.M., Karakış S., and M. Oruç. 2006. Analysis of object-oriented classification results derived from pan-sharpened landsat 7 ETM and Aster images. ISPRS workshop on topographic mapping from space.
- Marangoz, A. M. Alkış, Z., Karakış, S., 2007. Evaluation of Information Content and Feature Extraction Capability Of Very High Resolution Pan-Sharpended QuickBird Image. Conference on Information Extraction from SAR and Optical Data, with emphasis on Developing Countries, 16-18 May 2007 ISTANBUL
- Wang R., and Zhang Y., 2003. Extraction of Urban Rural Network Using QuickBird Pan-Sharpended Multispectral and Panchromatic Imagery by Performing Edge-Aided Post-Classification. ISPRS Joint Workshop on Spatial Temporal and Multi-Dimensional Data Modeling and Analysis. October, 2-3, 2003, Quebec, Canada.

A REGION BASED APPROACH TO IMAGE CLASSIFICATION

Lonesome M. Malambo

Alumni - University of Applied Sciences Stuttgart
mmalambo@gmail.com

KEYWORDS:

Image classification, Object based, Image analysis, Image segmentation, Region growing, Mahalanobis distance.

ABSTRACT

This paper presents a region based approach for doing image classification. An attempt is made to use both spectral and spatial information of an input image. The procedure first divides the image into several groups (in the spectral space) based on a selected sample set using the Mahalanobis distance as a measure of similarity. The result is then segmented into regions using region growing segmentation. The region growing process also incorporates edge information to avoid growing over vital inter-region boundaries. Each region is defined by a number of measurements or attributes such as the unique ID, the list of all its member pixels, the mean intensity and covariance matrix of the spectral values in that region.

The extracted regions are classified using a minimum distance decision rule. Several regions are selected as training samples for region classification. Each region is compared to the training samples and is assigned to its closest class.

The procedure has been implemented using MathWorks MATLAB software. It has been tested on a number of images including Landsat TM, ASTER and ADS40 imagery. The procedure significantly reduces the mixed pixel problem suffered by most pixel based methods.

1 Introduction

Image classification approaches have evolved over the years. This development has partly been driven by the need for higher accuracies in the classified result. The other driving force has been the emergency of high resolution imagery such QuickBird and IKONOS which pose a challenge to most image classification methods (Baatz, 2004; Yu, 2006).

At the moment image classification methods may be grouped into two main categories depending on the image primitive used viz. pixel based and object based methods. Pixel based methods classify individual pixels without taking into account any neighborhood or spatial information of the pixel. Only the spectral patterns are used. On the other hand, object based methods attempt to group pixel into objects by an image segmentation process based on a chosen similarity (e.g. texture, color, intensity) and then use the spectral, spatial and contextual information inherent in these objects to classify the whole image (Navulur, 2007; Baatz, 2004).

Object based image classification has emerged as a superior way of doing image classification (Araya et al., 2008; Manakos et al., 2000; Hay et al., 2006). One of its strength is the ability to extract real world objects, proper in shape and accurate in classification (Baatz, 2004). It eliminates the mixed pixel problem suffered by most pixel based methods. This is because the image is classified on an object level and usually more information is used. Object based methods are also able to handle high resolution imagery which aggravates the classification process for most pixel based methods (Yu, 2006).

The object based image analysis approach has been implemented in a number of commercial software packages such as Definiens eCognition Developer and ENVI. Despite this more research is required in this relatively new field in remote sensing (Hay, et al., 2006).

In this paper, a region-based approach for doing image classification is presented. The main goal is to develop an alternative procedure for a doing object-based image classification. The procedure has been implemented using MATLAB 2008a. The conceptual view of this approach is covered in the section 2. The MATLAB implementation is covered in section 3.

2 Method

In this procedure an attempt is made to use information from both the spectral and spatial domains for image classification.

The first step of the procedure is spectral grouping. This is done by determining the closeness of each image pixel to each of samples selected from the image. The pixel is assigned to its closest sample. Samples are selected based on the expected number of classes in the image. The Mahalanobis distance D , as defined below, is used as a measure of closeness or similarity.

$$D = \sqrt{(x - \mu) \sum^{-1} (x - \mu)^T} \quad (1)$$

In (1), x is the pixel spectral vector, μ is the mean spectral vector of a sample in a multiband image, \sum is the covariance matrix of the sample, T denotes the transpose of the matrix.

Once spectral grouping has been achieved, spatial grouping then follows. Here the spectral groups are further organized into regions in the spatial domain. This is accomplished by region growing image segmentation. Prior to the region growing edge pixels are extracted using the canny edge operator. Seed pixels are also extracted. Seed pixels are taken as local minima in the gradient image created from the input image.

The image segmentation is essentially a two step process. Firstly, region growing is done on all non-edge image pixels. This step is taken to prevent the process from growing over vital inter-region boundaries. Secondly, all the un-grown pixels (mostly edge pixels) are merged to their closest neighboring region (using the Euclidean distance) to realize full image segmentation.

The extracted regions are then classified using a minimum distance decision rule. The mean intensity of each region is the basis for classification. Several regions are selected to serve as training samples for region classification. Each region is compared to the training samples and is assigned to its closest class.

3 Implementation

The programming has been done in MATLAB 2008a. However, the code developed is also compatible with older versions down to version 2007a. The Image Processing toolbox is required to run the code. An outline of the steps involved is given next.

The image data is loaded using MATLAB's `imread` function. To facilitate floating point calculations the RGB is converted to double format. Optionally, the image is smoothed using a Gaussian filter to reduce noise. This is achieved by using the `fspecial` command together with the `imfilter` command.

Samples are then selected from the image. The samples are the basis for spectral grouping. MATLAB's built in function `roipoly` is used to select the regions of interest. Once this has been done, statistics of the samples (mean and covariance) are calculated. MATLAB provides `mean` and `cov` functions for calculating the mean and covariance respectively. These functions have been arranged in a user-defined function to calculate the statistics at once. Mahalanobis distances are then calculated using a user-defined function (Mahalanobis, Gonzalez, et al., 2004) between each pixel and each instance of the sample set. All pixels closest to the same sample are assigned same sample ID. The result is an image composed of sample IDs. This constitutes spectral grouping.

The next step is spatial grouping. The image created from the spectral grouping is the input. This makes region growing easier because only equal IDs are grown. The algorithm shown in Figure1 has been coded into a region growing function. It uses a modified flood fill approach (Eddins, 2008) with 4-neighbor connectivity. Edge and Seed information is extracted as explained in section 2. The growing starts at any seed pixel and continues until all seed pixels have been used up. The remaining un-grown pixels are merged to their closest neighboring region. A structure is used to hold all the segmentation information. A Structure is a MATLAB array with named "data containers" called fields or attributes (MathWorks, 2009). Each region is assigned a unique ID, list of member pixels, mean and covariance of intensities in the region. A region label image which comprises region IDs is also created. Fig 3-1 shows the flow chart for the region growing process.

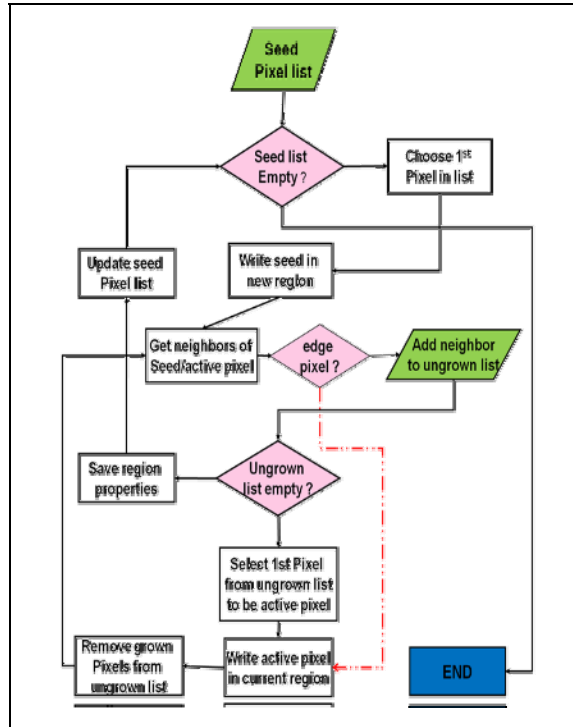


Figure 1: Region growing algorithm.

The last step is region classification. Region classification uses the minimum distance criterion. This means that an image region is classified based on its distance to a training sample. Training samples are selected using MATLAB's `getpts` function. The function enables the selection of set of points in the image using the mouse. Coordinates of the mouse click are then matched with a region ID in region label image. To aid the selection, region boundaries are overlaid on the image. A MATLAB structure is also used here to hold training sample information. For each training sample set the name and ID of the class are saved. Each sample in the training set is also given a unique ID and its object ID from the region label matrix is saved. The classifier computes distances (Euclidean) between each region mean and the mean of each of the training samples. The region is assigned to the class to which it is closest.

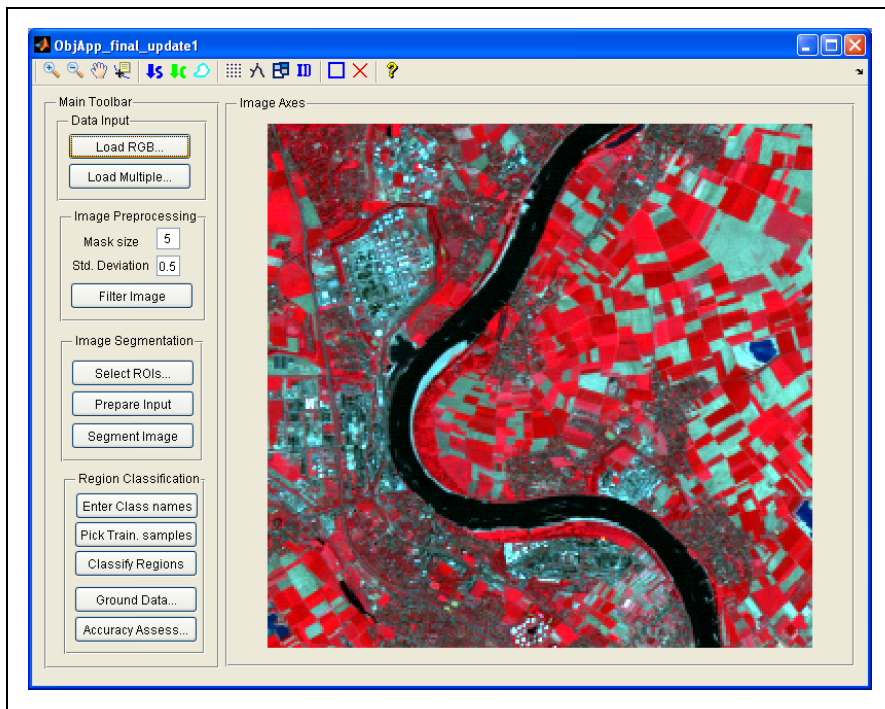


Figure 2: Region growing algorithm.

All the MATLAB functions used in these steps have been arranged into a graphic user interface (GUI) designed using MATLAB's GUI layout editor (see Figure 2). A compiled version is available for sharing.

4 Results

The procedure has been tested on a number of images. The procedure significantly reduces the mixed pixel problem suffered by most pixel based methods. Figure 3 shows one result obtained from a Landsat image. Training samples are marked by blue stars on the left image. In the classified image, water is shown in blue, vegetation in green, open fields in beige, and bare land in gray.

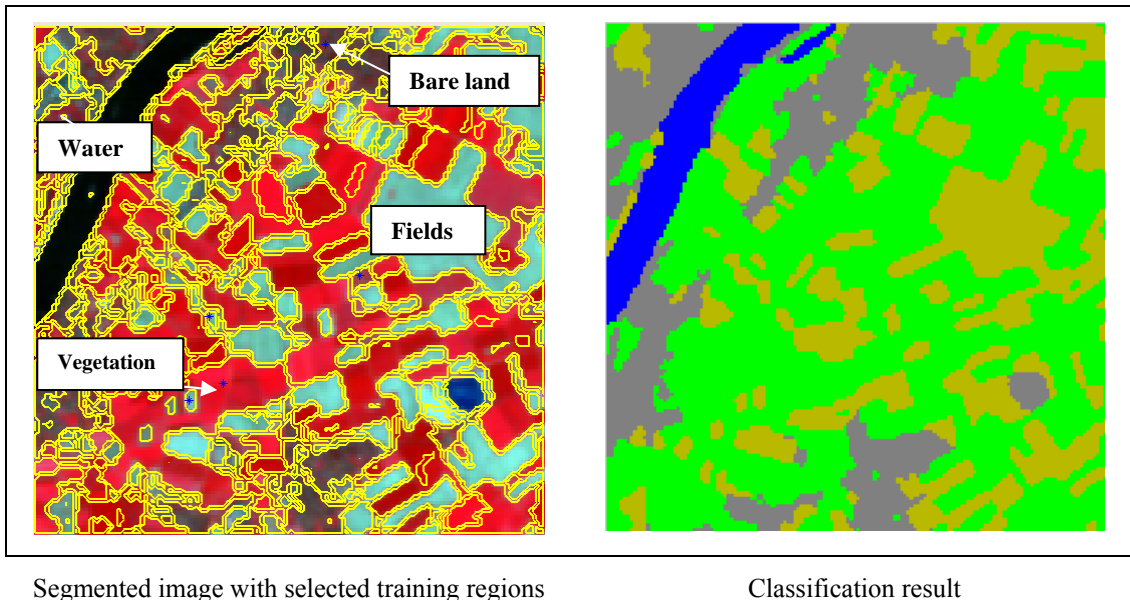


Figure 3: Region based classification

5 Conclusions

Good results have been obtained by using this procedure. However, more testing is required to establish the full strengths and weaknesses of this approach. The main strength of this approach is the reduction of the mixed pixel problem suffered by most pixel based methods. The result of the classification is much cleaner so post processing such majority filtering is avoidable. The procedure is also interactive and has few tuning parameters to set.

The classification result is influenced by the samples (also number of samples) used either for segmentation or classification. Samples selected for spectral grouping have an effect on the image segmentation result. When fewer samples are used for the spectral grouping, this causes under-segmentation. Conversely, when too many samples are used an over-segmented result is produced. The under-segmentation problem is easily solved by selecting more samples especially in regions the problem occurs. Smoothing the image prior to selecting samples lessen the over-segmentation problem. It is important that an acceptable segmentation is achieved before proceeding to the classification stage. On the whole, this approach has demonstrated the strength of classifying images on an object level.

References

- Manakos I., Schneider T. and Ammer U. *A comparison between the ISODATA and the eCognition classification methods on basis of field data*. Amsterdam : International Society for Photogrammetry and Remote Sensing, 2000. XIXth ISPRS Congress. Vol. XXXIII.
- Araya H.Y. & Hergarten C. *A comparison of pixel and object-based land cover classification: a case study of the Asmara region, Eritrea*. Southampton. WITPress, 2008. 3rd International Conference on Evaluation, Monitoring, Simulation, Management and Remediation of the Geological Environment and Landscape. Vol. III.

- Baatz M. et al. *eCognition Professional User Manual*. Munich : Definiens Imaging GmbH, 2004.
- Oruc M., Marangoz A.M. & Buyuksalih G. *Comparison of Pixel-based and Object-oriented Classification Approaches Using Landsat-7 Etm Spectral Bands*. Istanbul, Turkey. International Society for Photogrammetry and Remote Sensing(ISPRS), 2004. XXth ISPRS Congress, 12-23. Vol. Commission 4.
- Eddins, Steve. Steve on Image Processing. *MathWorks.com*. The MathWorks Inc, 2008. [Cited: December 5, 2008.] <http://blogs.mathworks.com/steve/2008/02/25/neighbor-indexing-2/>.
- Gonzalez Rafael C, Woods Richard E, Eddins Steven. *Digital Image Processing Using MATLAB*. London : Pearson Prentice Hall Inc, 2004.
- John, A. Richards & Xiuping, Jia. *Remote Sensing Digital Image Analysis: An Introduction*. Heidelberg : Springer-Verlag, 1999. Vol. III.
- MathWorks. Image Processing Toolbox 6.2. *MathWorks.com*. MathWorks, 2009. [Cited: January 18, 2009.] <http://www.mathworks.com/products/image/>.
- MathWorks. *MATLAB Online Help*. MathWorks Inc., 2009, Vol. 2008a.
- Navulur Kumar. *Multispectral Image Analysis Using Object Oriented Paradigm*. New York : Taylor & Francis Group, 2007.
- Yu Q. *Object-based Detailed Vegetation Classification with Airborne High Spatial Resolution Remote Sensing Imagery*. 2006, Photogrammetry Engineering & Remote Sensing, Vol. 72, pp. 799-811.
- Hay G. J. & Castilla G. *Object-based image analysis: strengths, weaknesses, opportunities and threats (SWOT)*. [ed.] Thomas Blaschke & Elisabeth Schöpfer Stefan Lang. Salzburg, Austria. Commission VI, WG VI/4, 2006. 1st International Conference on Object-based Image Analysis (OBIA 2006).
- Qiming Zhou & Robson Marc. Background on Spectral Signatures. *Virtual Laboratory for GIS and Remote sensing*. Hong Kong Baptist University, December 5, 2000. [Cited: Feb 12, 2009.] http://geog.hkbu.edu.hk/virtuallabs/rs/env_backgr_refl.htm.
- Sabins Floyd F. *Remote Sensing: Principles and Interpretation*. New York : W.H. Freeman and Company, 1997. pp. 280-287. 0-7167-2442-1.
- Supichai T. Image Classification. Faculty of Science Chulalongkorn University, January 20, 1999. [Cited: October 12, 2008.] <http://www.sc.chula.ac.th/courseware/2309507/Lecture/remote18.htm>.

Acknowledgements

This paper is an extract from my master thesis work and as such I would like to thank my supervisors Prof. Dr. M. Hahn and Prof. Dr. E. Gülch for their guidance throughout the course of my thesis work.

HISTORICAL DOCUMENTATION IN SAN AGUSTIN (HUILA), COLOMBIA, WORLD HISTORICAL HERITAGE USING CLOSE RANGE PHOTOGRAMMETRY TECHNIQUES: A CASE STUDY OF THE STATUE "TRIANGULAR FACE"

W. Barragán^a, A. Campos^b and J. J. Martínez^c

^a Department of Topography Engineering, Natural Resources and Environment, Distrital University "Francisco Jose de Caldas". Cra 7 40 53, Bogota, Colombia
wbarraganz@udistrital.edu.co

^b Department of Cartography, Agricultural Sciences, Cundinamarca University Diagonal 18 20 29 Fusagasugá, Cundinamarca Colombia
camposorjula@unicundi.edu.co

^c Department of Cartography, Agricultural Sciences, Cundinamarca University Diagonal 18 20 29 Fusagasugá, Cundinamarca, Colombia.
johnjmartinez@unicundi.edu.co

KEYWORDS:

Close range photogrammetry, heritage conservation, virtual 3D model, archeology, digital image.

ABSTRACT

The development of the Digital and Analytic Photogrammetry has facilitated the utilization of not metric cameras as devices of images acquisition in Photogrammetry projects. This work shows an application of close range Photogrammetry in the geometric documentation of Statue "Triangular Face" in the archaeological park of San Agustin (Huila), Colombia, utilizing a digital camera of 5 Mega Pixels.

The project was developed in 3 phases:

- 1. Calibration of the digital camera (reconstruction of the internal geometry of the camera).*
- 2. Development of a pilot test with a statue of similar geometry to the one in San Agustin; in order to determine the efficacy of the proposed methodology.*
- 3. Field work and restitution of the generated models, to integrate the Digital Model of Land and the Virtual Model of the Statue.*

1 Introduction

San Agustin is the main archaeological park in Colombia. International scientific community recognizes its importance highlighting the Augustinian Statuary as the most important one of the South American Pre-hispanic world, and by his ancient culture, even greater than the Aztec or Inca's cultures. Although several theories of diverse anthropologists present discrepancies on the same town and on some aspects of chronology, Carbon-14 tests registers the oldest Augustinian antecedents further back to the year 3,000 B.C. what would represent antiquity of about five thousand years. Almost six hundred megaliths, some of them, five meters height and carefully carved with anthropomorphous motives have been found in a nearby region of approximately 500 square Kilometers.

The statues attain very various symbolic, formal, and thematic features. In their vast majority they were of funeral character and remained underneath land for a millennium or more, until the 18th century when most of the tombs were excavated and plundered (Llanos, 2006).

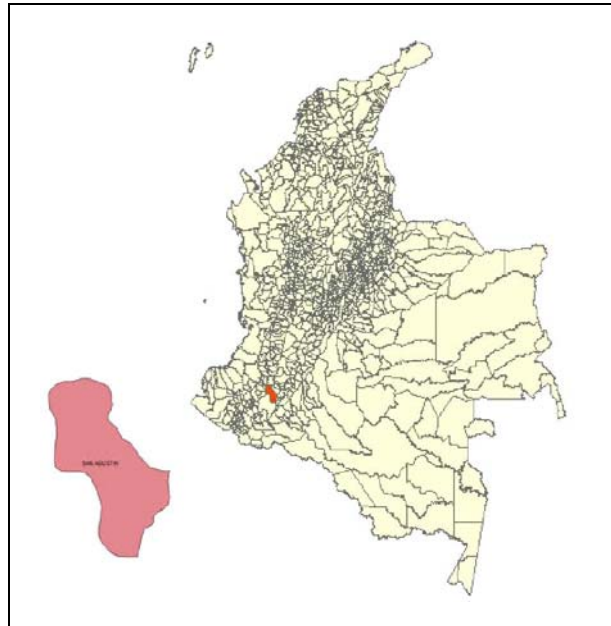


Figure 1: Locating of the area of study (San Agustín - Huila) south of the Colombian Territory.

Human heritage conservation has lately become a priority in Colombia, what has enabled an interaction among the population in general, by means of promoting archeological tourism.

There is a need to generate and use alternate methods for the archaeological documentation in San Augustine, as a primary background source for understanding Colombian and world cultural and archeological inheritance.

Survey and documentation are two processes in which close range photogrammetry is applied, as a suitable instrument that contributes to the conservation of this “world heritage” as declared by UNESCO (1995).

In conclusion, the virtual model generated as final product of the photogrammetric restitution leads to obtain information on the state of the object at the moment of taking the photographs (construction techniques, styles, material used, geometry and state of conservation). In such a way it is possible to generate a suitable approach for handling such statues by people with minimum knowledge in the area. This is the way the objective presented for the formulation of this project is reached: *“to implement photogrammetric techniques to enhance conservation and promotion of archaeological inheritance”*.

2 Equipment

In the development of the project the following equipment was used:

- A 5 Mega pixels digital camera - Sony Cybershot DSC-P73. Considered as a Medium Quality camera for photogrammetric purposes.
- Total Station TOPCON GTS 212. This is a surveying instrument with an accuracy of $\pm 3\text{mm} + 5\text{ppm}$ for distance, and of $5''$ for angular.
- Tripod. Due the stability it provides, the utilization of a photographic tripod is recommended.
- Digital Monoscopic Photogrammetric Station. The use of this system for generation of 3D model is recommended, due these are perfectly integrated with CAD systems, what makes it easier to be used in several applications.
- Software Photo Modeler 5 was used, due its compatibility with Windows. It allows to measure and shape objects and scenes from the real world through the use of photographs. This software is an analytic program for close range Photogrammetry developed by Eos Systems Canadian Company.

3 Methodology

The project was developed in three phases. In the first one, the Camera was calibrated and a pilot test was developed to tune up with the methodology. In the second phase, called field work, Photographic and Topographical information capture was done in the archaeological park for further analyses. In the third phase,

called lab-work, all data collected in the previous phase was processed to develop three-dimensional -3D- models of the target object.

3.1 First Phase

3.1.1 Calibration of the Camera.

The purpose of the Calibration is to determine the geometric parameters of the camera by means of analytic methods. The calibration was carried out with a specify model for this purpose in the Photo-Modeler software. A minimum of eight photographs was used in order to calibrate the camera by the auto-calibration method. At the end of the mathematical process, we draw a table with the following information of the camera: focal length calibrated distortions of the lens (3 parameters of radial distortion and 2 parameters of tangential distortion), coordinates of the main point and the size of the CCD.

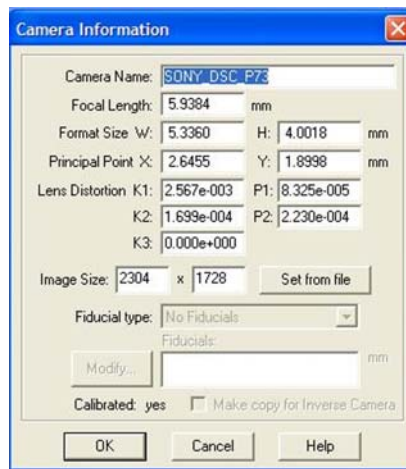


Figure 2, Results after calibration process.

3.1.2 Pilot test after Camera's calibration

Once the camera was calibrated we chose a figure with similar geometric characteristics to the target one in the Archaeological Park. Upon carrying out this pilot test we intended to master the methodology for the capture of information as well as photogrammetric restitution process.

After taking the photographs (keeping in mind the given parameters described in the phases field- and lab-work) Virtual Reality Model - VRML – was generated.



Figure 3: Virtual Reality Model - VRML, generated alter photogrammetric restitution with Photo-Modeler Software.

3.2 Second Phase – Field Work.

In this phase the following processes are distinguished:

3.2.1 Suitable methodology

Suitable methodology was defined and evaluated so as to reach the objectives concerning the documentation of the statue "God of the Sun or Triangular Face", located in the small "MESETA B" inside the Archeological park.

3.2.2 Image Acquisition

The photographs were taken with a 5 Mega Pixels digital camera. The pictures were taken seeking for adequate lighting in order to avoid shadows taking into account the so called 3x3 rule, by means of taking the photographs from different points around the studied statue (Arias, 2003). For the development of the photogrammetric work small marks were used to establish topographical checkpoints and to facilitate the allocation of common points in adjacent photographs.

It is necessary to keep in mind that each common element must be present in a minimum of three photographs, and the overlap among them should be of at least a 50% and the surface of the object subject to model must cover the most of the photography.

3.2.3 Topographical rise

Generation of the Digital Model of the place (landscape) where the Statue is located is suggested as necessary to improve the view of the actual Statue 3D Model. The area of execution for the Digital Model of the place was of 8X7m. A netting or grid of 50 cm² is constructed; to each vertex of such netting coordinates are determined by means of using the method of simple radiation, like a kind of micro-topography work. They were obtained a total of 458 points for the generation of the MDT observed in Figure 4. Upon finalization error of closing in angle and distance was verified to ensure topographical work quality.

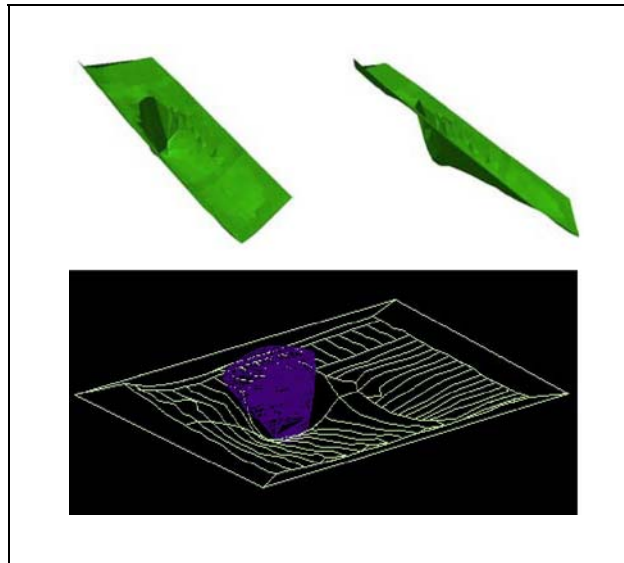


Figure 4: Digital model of the place (Landscape)

3.3 Third Phase – Lab-work.

Lab-work was carried out for processing the information previously collected. In this phase, the three-dimensional models are created in order to reproduce the original structure to a fixed scale, so as to generate models in format CAD and VRML. The Quadratic Medium Error (RMS) of the specific coordinates obtained from the Checkpoints was of 3 mm for coordinates in X, and Y; and of 3.3 mm for the coordinates in Z.

3.3.1 Models Restitution

Once the information contained in the photography is escalated and oriented, a surface of the Statue is generated by utilizing the tools that the software offers.

Subsequently a Model of Virtual Reality VRML was generated as to obtain a virtual recreation of the statue, which fuses with the information in format CAD, what produces the model of the Statue with the MDT. This allows contrasting the statue with the original landscape where it is found at present (Figures 4 and 5.).



Figure 5: Model of Virtual reality – VRML



Figure 6: 3D Model (Renderized)

4 Conclusions

This is a methodological proposal for the geometric documentation of the archeological patrimony was carried out, by means of using close range photogrammetry techniques for statue "God of the Sun or Triangular Face", located in the archaeological park of San Agustin - Huila.

At the moment of taking the photographs, is important to use a camera with a minimum of 8 mega pixels of resolution, due some physical properties of the rocks in which the sculptures are carved do not permit an easy identification of homologous mark points.

In order to achieve a better orientation of the photographs, for those pictures where the target sculpture does not cover most of the photography due their geometry or locating, it is recommended to have a stiff structure. Such structure must have a series of checkpoints well defined and differentiated so as to permit easy identification in other photographs.

Alternative methods in the presentation of cartographic products were implemented, which at the same time permit a more effective diffusion of the patrimony (Model of Virtual reality VRML).

As further suggestion it is recommended to implement this type of documentation in the rest of the archaeological parks of the country, due it leads towards a prompt source for analysis of the archaeological

inheritance. At the same time it creates spaces for social reflection around the importance of cultural inheritance and enhances tourism to national and international level.

References

- Arias, P., 2003. "Fotogrametría de objeto cercano por métodos simples. *Aplicación al estudio de las construcciones agroindustriales tradicionales*". PhD Thesis, Vigo University, Pontevedra, España.
- Atkinson, K.B., 1989. Close Range Photogrammetry and Machine Vision. Department of Photogrammetry and Surveying. University College London.
- Cubillos, J., Digital Publication. "*Arqueología de San Agustín, Biblioteca Luis Ángel Arango del Banco de la República*", Bogota, Colombia. <http://www.lablaa.org/blaavirtual/publicacionesbanrep/bolmuseo/1978/bol2/bof7.htm> (accessed 08 Jan. 2009)
- Fundación de Investigaciones Arqueológicas Nacionales., 1980. *Arqueología de San Agustín, El Estrecho, El Parador y Mesita C.*, Banco de la República de Colombia, Bogotá.
- Fundación de Investigaciones Arqueológicas Nacionales., 1983. *Arqueología de San Agustín. Exploraciones y Trabajos de reconstrucción en las Mesitas A y B.*, Banco de la República de Colombia, Bogotá.
- Fundación de Investigaciones Arqueológicas Nacionales., 1988. *Arqueología de San Agustín, Alto de Lavapatas.*, Banco de la República de Colombia, Bogotá.
- Hernandez T, Tello H., Digital Publication. "*Estudio Geológico de San Agustín (Huila), Biblioteca Luis Ángel Arango del Banco de la República*", Bogota, Colombia. <http://www.lablaa.org/blaavirtual/publicacionesbanrep/bolmuseo/1978/bol2/bof8.htm> (accessed 05 May. 2009)
- Herraez, J, Lorenzo, H, Ordoñez, C., 2004. "*Control of structural problems in cultural heritage monuments using close-range photogrammetry and computer methods*". Elsevier Ltd. Computers and Structures, Madrid pp. 83-86.
- Llanos H., Digital Publication. "*Algunas consideraciones sobre la cultura de San Agustín: Un proceso histórico milenario en el sur del alto Magdalena de Colombia*", Biblioteca Luis Ángel Arango del Banco de la República, Bogota, Colombia. <http://www.lablaa.org/blaavirtual/publicacionesbanrep/bolmuseo/1988/22/boe4.htm> (accessed 08 May. 2009)
- Lorenzo, E, Arias, P., 2005. "*A Methodology for Rapid Archaeological Site Documentation Using Ground-Penetrating Radar and Terrestrial Photogrammetry*". In: Ge archaeology an International Journal, Vigo, Spain, Vol. 20, No. 5, pp. 521-535.
- Ordoñez, C, Lorenzo, H, Herraez, J, Armes, J., 2004. "Low-cost documentation of traditional agro-industrial buildings by close-range photogrammetry". Elsevier Ltd. Building and Environment, pp. 120-129.
- Pineda R., Digital Publication. "*Etnohistoria del bajo Caquetá Putumayo (siglos. XVI - XVII - XVIII - XIX)*", Biblioteca Luis Ángel Arango del Banco de la República, Bogota, Colombia. <http://www.lablaa.org/blaavirtual/publicacionesbanrep/bolmuseo/1978/bol2/bof9.htm> (accessed 08 May. 2006)
- Vázquez, S, Lorenzo, H, Rego, T., 2002. "*Photogrammetric survey in traditional rural constructions in Galicia, Spain*". In: International XVIII Symposium, CIPA, Potsdam, Germany, pp. 188-195.

Acknowledgements

Gratitude goes to Dr. Pedro Arias, Educational and external advisor Area of Geodesic, Cartographic Engineering and Photogrammetry, Department of Engineering of the Natural Resources and Environment. University of Vigo, Spain. Ing. Mauricio Cortés Henao, GIS specialist and Mauricio Soler González Cartography technology from Cundinamarca University. Finally, to Mr. Isidro Ortega, Director of the Archaeological Park of San Agustín.

TERRASAR-X'S DIGITAL SURFACE MODEL GENERATION BY SAR INTERFEROMETRY

Ahmad Sanusi bin Che Cob ^a and Mohamad Halmi bin Kamaruddin ^b

Universiti Teknologi MARA, Faculty of Architecture,
Planning and Surveying, Shah Alam, Malaysia

^a sanusi@jupem.gov.my

^b halmi@salam.uitm.edu.my

KEY WORDS:

Space-borne satellites, Repeat-pass interferometry, Digital surface model

ABSTRACT

Synthetic Aperture Radar (SAR) technology is fast gaining world wide recognition for various environment resource management applications such as geology, hydrology, forestry, seismology etc. These two dimensional applications can be further enriched and enlivened by their respective third dimensional data which are basically their elevation data. Intrinsicly, these Z-values information are obtainable within SAR technology itself. By switching to interferometric mode (InSAR), Digital Surface Model (DSM) of the area can be produced. It is the intention of this article to highlight the repeat pass space-borne interferometric technology available for such application. A pair of two overlapping images was acquired by TerraSAR-X satellite of a chosen test site over Tanjung Malim area with moderate slope variation in both 15km by 50km ascending radar scenes. The article reports the preliminary results obtained in the project.

AERIAL SURVEY WITH A GYROCOPTER

A. Miraliakbari ^a, M. Hahn and ^b J. Engels ^c

Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany

^a alvand.miraliakbari@hft-stuttgart.de

^b michael.hahn@hft-stuttgart.de

^c johannes.engels@hft-stuttgart.de

KEYWORDS:

Aerial Image, Aerial Triangulation, Gyrocopter, Mosaic, Orthophoto

ABSTRACT

Recording digital aerial images using an airplane or helicopter equipped with a digital camera system, a gyro-stabilized platform and a GPS receiver is state-of-the-art of aerial survey mapping services. This equipment is expensive in acquisition. But also the running expenses, in particular the expenses for the flights themselves carry considerable weight. The consequence is that the products of aerial survey like orthophotos, DTMs and others are on a high price level. A way to reduce costs is to use more economical air vehicles and equip it with highly efficient SLR cameras.

Gyrocopters are lightweight aircrafts of great simplicity, high mission readiness and low acquisition and maintenance costs. With the increasing availability of Gyrocopters on the market the idea was borne to develop a Gyrocopter based aerial imaging system. The paper presents our prototype system for recording aerial images and shows first results of successful image flights. A test covers the downtown of Stuttgart. The results of the aerial triangulation, orthophoto generation (using LiDAR data as DSM) and orthophoto mosaicking are presented and discussed.

1 INTRODUCTION

The first aerial image was taken in 1858 in the French village of Petit-Bicêtre from a balloon at 80 meters above the ground. In 1906 the first aerial photo using a system of kites and wires was recorded over San Francisco. In 1909 Wilbur Wright took the first photography from an airplane over the town of Centocelli, Italy [1]. Since then, the equipment changed tremendously. Digital large and medium sized cameras and the use of a gyro-stabilized platforms, GPS receivers and flight planning tools is nowadays state of the art of aerial imaging systems. Those systems are highly productive in recording large areas but for smaller projects this leads to considerable costs which exceed often budget limits of those projects. To capture aerial images on a high photogrammetric quality level by using a Gyrocopter is the challenge of this research. Compared to airplanes and helicopters the Gyrocopter is a cheap aircraft. Flights with the Gyrocopter are not more expensive than touring with a car with the consequence that this opens new opportunities for creating low cost services based on aerial survey. In particular developing countries may benefit from such a system, but it offers also excellent prospects to enter the aerial survey market for small and medium sized companies in Europe.

The Gyrocopter was invented by Juan de la Cierva already in the twenties of the last century, but military applications favoured the development of the helicopter. The Gyrocopter was registered for air transport in Germany only in 2004 and in most other European countries in 2005. Like a helicopter, the Gyrocopter has horizontal rotor blades, but compared to the former, these blades are not activated by a motor, but only driven by the air flow. The propulsion of the vehicle is achieved by a propeller drive. The advantages of the Gyrocopter are: 1) its high stability and security (there is no breakaway of the airflow if the velocity goes below a certain limit; even a motor fail does not necessarily let the vehicle crash) 2) low acquisition prize 3) low consumption of fuel and 4) the possibility to use normal fuel as gasoline.

The main idea of using a Gyrocopter in this research is to investigate low cost instruments (camera and GPS receiver) mounted on a low cost platform. We intend to compete with traditional systems and find out the strengths and weaknesses of using small size and low cost systems of aerial photography.

In the following sections we discuss the experimental setup of our low-cost system and show first results.

2 IMAGE FLIGHT AND PROCESSING

As with all projects of aerial photogrammetry a Gyrocopter based aerial mapping project has to be planned carefully which includes flight planning, flight navigation, acquiring and processing aerial photographs.

2.1 Planning of the flight

By means of maps the starting and ending point of each strip is determined. Depending on the camera parameters, the required scale (or resolution) of the images and the required overlap, the flight height and the distance between the strips are defined. The speed of the Gyrocopter can be as slow as 80 km/h. With an exposure time of 1/500 sec or 1/1000 sec only a moderate motion blur effects the images, and the exposure frequency can be relatively low. This is beneficial in particular if a low cost camera and a standard computer are used, since the storage of the images on the memory card or on the computer directly represents a bottleneck in the data flow. The coordinates of the strip end points are inserted into the navigation tool. Due to the manoeuvrability of the Gyrocopter, the reversing track loops can be small.

2.2 Flight navigation

Simple navigation tools are available in order to guide the Gyrocopter along the strips. Not offered so far are autopilot solutions for Gyrocopters. For triggering the exposure points of time of the camera by the GPS position, we have found it helpful to carry along a laptop. In this case, both GPS receiver and camera are connected to the computer in order to control the camera shooting.

2.3 Aerial photography

As a serious problem of the aerial photography with Gyrocopters we expected vibrations of the vehicle. We therefore mounted the camera inside a padded camera box, which on its part is attached on the undercarriage of the Gyrocopter, see figure 5. We have encountered this kind of mounting as fully sufficient as no blurring due to vibration was found. The camera box should be attached exactly horizontally on the undercarriage in order to ensure vertical camera viewing during the flight.

2.4 Aerial Triangulation, Orthophoto and Mosaic Generation

Aerial Triangulation, Orthophoto and Mosaic Generation can be performed in the familiar way. Although coordinates of the projection center of each image are estimated by the navigation tool, the use of ground control points for aerial triangulation is necessary. They can be provided by GPS measurements on the ground or by using other existing references (for instance maps or LIDAR points). If a low cost camera is used, particular care should also be dedicated to the calibration of the camera parameters.

3 INSTRUMENTS, SOFTWARE AND DATASET

3.1 Instruments

With the intention of this research to use low cost instruments we decided to utilize equipment which is available in our photogrammetric lab. Our first prototype system consists of a Canon EOS 350D SLR camera and a handheld GARMIN GPS receiver 12XL. Anuar Ahmad from the University of Technology of Malaysia has investigated a similar camera, the Canon EOS D30 SLR camera, and mounted it on an airplane. 30 aerial images were taken from this camera in order to make a comparison with the large format aerial photographs. He reported about a successful experiment and emphasized the need of a carefully calibrated camera [3].

3.2 Software

3.2.1 EDSK2.5 API

EDSDK stands for EOS Digital Camera Software Development Kit. This application programming interface allows the control of the camera from a host PC, in particular the exposure and the download of images to the PC [4]. In this research the EDSK2.5 is used to control the start, end and frequency of the camera shooting. The exposure interval can be less than 1 second. The images of a strip have been buffered on the memory card and stored on the PC before recoding the images of the next strip.

3.2.2 GPS track maker

“The GPS Track Maker program allows bi-directional data communications between GPS receivers and your computer, including full data editing and storage options” [5]. This software establishes a connection between the GPS receiver and the computer. It monitors the precalculated tracks as well as the observed GPS tracks in real time on the screen. Utilizing the software has two main benefits: Firstly, the strips or the waypoints, respectively, are visualized on the monitor together with the current position; therefore the navigation and real time control of the flight path will be easy. Secondly the tool stores GPS positions with time stamps related to the camera exposure time.

3.2.3 INPHO’s photogrammetric system

Various components of Inpho’s photogrammetric system, in particular the ApplicationsMaster, MatchAT for the aerial triangulation, OrthoMaster for orthophoto generation and OrthoVista for mosaicking are used for photogrammetric processing of the images.

3.3 Dataset

LiDAR data are used to provide a DTM for the orthophoto generation and to extract suitable ground control points, in particular height control points. The existing orthophoto of the city center of Stuttgart is utilized as further source for collecting ground control points.

The GPS tracks recorded with the Garmin GPS 12XL are used to get approximate values for the coordinates of the projection centers. The geographical coordinates are converted to UTM coordinates. The aerial images taken by the Canon camera have a size of 3456 * 2304 pixels which corresponds to a sensor size of 22.2 * 14.8 mm²; hence the pixel size is 6.42 micron. The area on the ground covered by an image is significantly smaller than the area covered by professional medium and large format aerial cameras.

4 EXPERIMENTAL INVESTIGATION

Up to now we have performed two test image flights over the city centers of Kirchheim unter Teck and Stuttgart, Germany. Figure 2 shows the generated orthophotos derived from two strips of Kirchheim unter Teck. The orthophoto mosaic (figure 3) shows that the first flight was already quite promising.



Figure 1: Derived orthophotos of Kirchheim

Figure 2: Derived orthophoto mosaic of Kirchheim

The second flight covered four image strips of the city center of Stuttgart. A flight height of 700 meter above ground was chosen for this flight. The focal length of the lens is 70 mm, hence the image scale is around 1:10.000. For testing purposes a high length overlap of 75% and a side lap of 50% were chosen. With a projected speed of the Gyrocopter of 100 km/h the time interval between two exposures was between two and three seconds. Figure 3 shows the projected strips together with the waypoints and the actually flown tracks (GPS

tracks) as monitored by the GPS track maker. The figure shows that even with low cost equipment a very reasonable flight navigation could be achieved. The horizontal deviations between the flown tracks and the projected strips are all within 10 m.

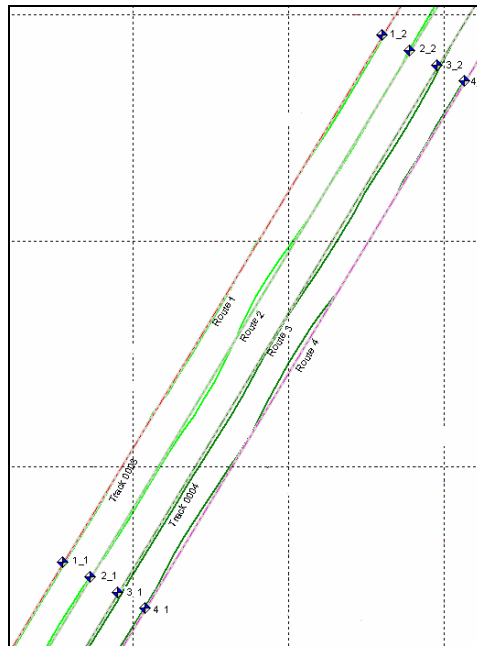


Figure 3: Position of the waypoints of the strips and the GPS tracks

But the GPS track maker monitored relatively large deviations of 20 to 50 meters between the scheduled and the actual track in the vertical direction, probably due to the strong wind and the limitations of the flight navigation tool. Visual inspection of the images (Figure 9) shows a good overall image quality.



Figure 3. Mounting the camera box

Figure 4. Further impressions

For the aerotriangulation with MatchAT the GPS coordinates of the camera positions were introduced as approximate location of the exterior orientation parameters. Approximate κ values are derived from the recorded tracks. The other two angles are approximated by zero. Including further parameters like the interior orientation parameters the automated aerial triangulation was carried out. The block configuration is shown in Figure 5.

As mentioned before some ground control points have to be measured in order to estimate the exterior orientation reliably. Figure 6 shows a sample from the LiDAR data set which was used together with an orthophoto to digitize ground control points. The horizontal coordinates are taken from the orthophoto the height from the LiDAR data.

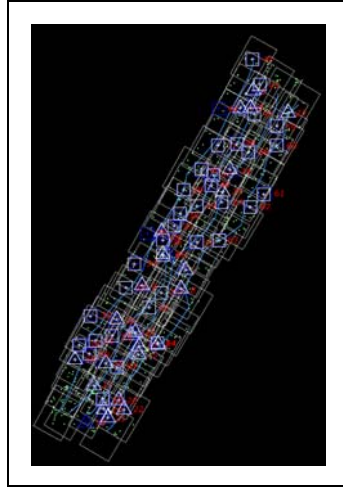


Figure 5: Whole block with GCPs and tie point shown in MatchAT

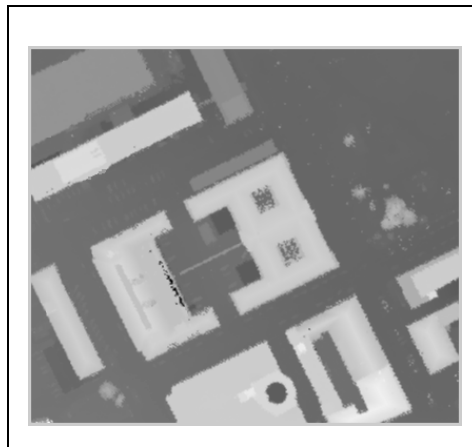


Figure 6: Sample of LiDAR range data used in this research

Figure 7 shows an example of a ground control point which was measured in three aerial images.

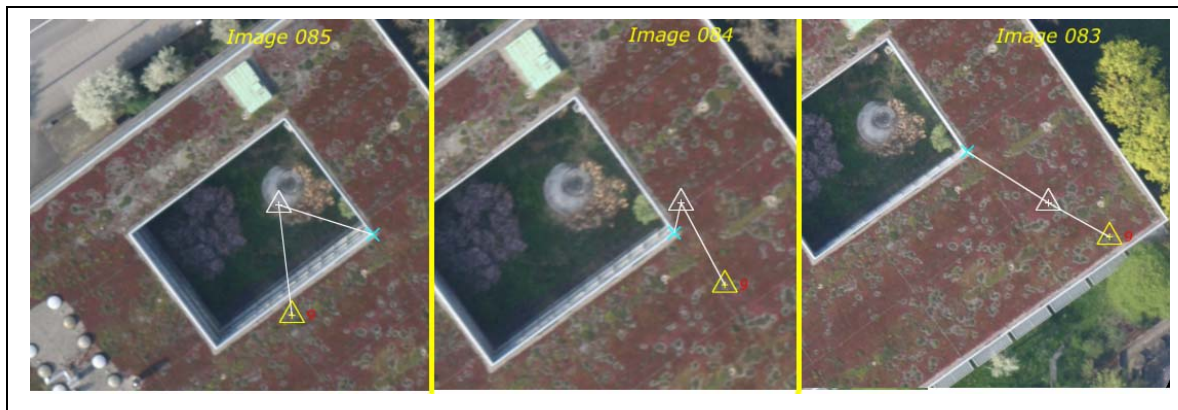


Figure 7: Example of a ground control point measured in three images

For tie point extraction and matching in this project a 3 by 3 tie point pattern was used. The automated aerial triangulation with five pyramid levels was running well with the aspired σ_0 of 2.1 micron (One third of the pixel size which in this project is 6.4 micrometer). An example of extracted and matched tie points is shown in Figure 8. In an urban environment the extraction of well defined features is not a problem at all.



Figure 8: Sample of automatically extracted tie points

For the orthophoto generation, it is necessary to introduce a height model of the block. The interpolation of the available LiDAR point cloud to a regular grid is done with OrthoMaster using a grid increment of 1 m. It is important to know if there are gaps in the LiDAR data. In this case the acceptable maximum distance between the grid points and LiDAR can be adapted. Otherwise there will be gaps in the orthophotos. The pixel size of the orthophoto was defined as 10 cm.

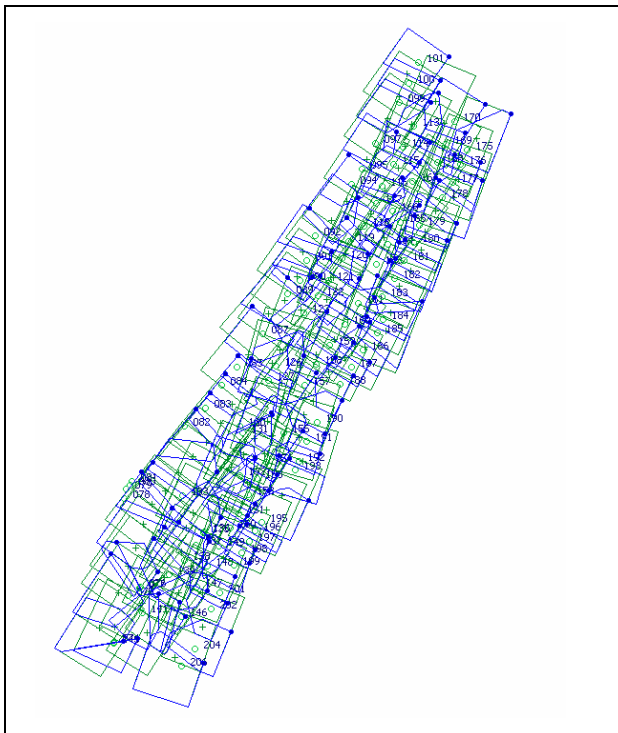


Figure 9: Footprint of the orthophotos



Figure 10: Orthophotos introduced to OrthoVista

Footprints of the generated orthophotos are shown in Figure 9. The orthophotos are introduced to OrthoVista to create one seamless orthoimage mosaic with 10 cm ground pixel size. Because the weather conditions were not changing (it was a sunny day without clouds) during the photography of the block, the adjustment option can be set to default. The image group adjustment is selected as global tilting adjustment in order to avoid radiometric differences between the images. [8]



Figure 11: The generated orthomosaic, Stuttgart



Figure 12: University of Applied Sciences (HFT) Stuttgart

The final result of the generated orthophoto mosaic is shown in Figure 13. The zoomed window shows some buildings of the University of Applied Sciences.

5 CONCLUSION

The main purpose of this research was to start the development of a low-cost prototype system for aerial survey and show that a photogrammetric product like an orthophoto with a 10 cm ground resolution can be acquired and generated with low cost equipment mounted on a Gyrocopter. Even though the quality investigation with the derived orthophoto is left for the future, the first results shown in Figure 13 are quite promising. Errors in the orthophoto which can be noticed at the boundaries of the buildings are a consequence of the interpolated LiDAR data. No errors have been observed along seamlines which indicates that the images acquired from the Gyrocopter with a low-cost SLR camera have the potential to compete with professional photogrammetric equipment. Visual inspection shows further that colors and sharpness of the generated orthoimage mosaic are equivalent the standard orthoimages. Due to its low acquisition prize and low fuel consumption, the Gyrocopter is a very economic platform for image flights.

References

- 1 - Aerial arts, 2005. History of aerial photography, <http://www.aerialarts.com/History/history.htm>. Access on June 2, 2008
- 2 - Gyroplanes, Gyrocopters and Autogyros. <http://en.wikipedia.org/wiki/Autogyro>. Access on June 8, 2008
- 3 - Ahmad, A., 'Digital Photogrammetry: An experience of Processing Aerial Photographs of UTM acquired using a Digital Camera'. Universiti Teknologi Malaysia. http://eprints.utm.my/490/1/Anuar_Ahmad_fksg.pdf Access on June 15, 2008
- 4 - Reference manual , 2008, Canon EOS Digital SDK EDSDK2.5 API Programming Reference.
- 5 - Reference manual,2007, GPS track maker.
- 6 - Reference manual,2008, MatchAT, Inpho GmbH.
- 7 - Reference manual,2008, Ortho Master, Inpho GmbH.
- 8 - Reference manual,2008, OrthoVista, Inpho GmbH.

RECENT TRENDS IN PHOTOGRAMMETRY

Josef Braun

INPHO GmbH, Smaragdweg 1, 70174 Stuttgart, Germany
Josef.Braun@inpho.de

KEYWORDS:

Photogrammetry, LiDAR, Aerial Triangulation, Digital Terrain Model

ABSTRACT

This presentation outlines current developments in the field of Photogrammetry and neighbouring fields. Small, medium, and large Frame Sensors are evaluated as well Pushbroom Sensors. Data of different sensors systems have to be combined using sensor fusing techniques. The trend towards digital systems is still increasing. The new digital sensor systems put new demands on processing systems, but allow a higher degree of automation.

In a further part, the new software versions of INPHO are presented which are developed for meeting these demands, especially for larger projects. MATCH-AT 5.1 supports fully automated digital Aerial Triangulation combining automatic tie point measurement and robust bundle adjustment. MATCH-T DSM supports fully automatic DTM/DSM generation. Interpolation and Management of Terrain Models can be done with SCOP++ and TopDM.

The software packages emphasize that INPHO's portfolio covers the entire workflow of photogrammetric projects, including aerial triangulation, stereo compilation, terrain modelling, orthophoto production and image capture. In addition, INPHO offers innovative software solutions for processing digital terrain models, including advanced filtering and editing of LIDAR data. Since its foundation in 1980 by Prof. Fritz Ackermann, INPHO has gained excellent credit as a provider of first-class software products offering supreme quality, high degree of automation and unsurpassed productivity.

Spatial Data Infrastructures, E-Cadastre

DETERMINING SPATIO-TEMPORAL REQUIREMENT FOR A CADASTRAL TEMPORAL GEOGRAPHIC INFORMATION SYSTEM (TGIS) OF TURKEY

M. Alkan^a and C. Cömert^b

^a Department of Geodesy and Photogrammetry, Engineering Faculty Zonguldak Karaelmas University,
Zonguldak, Turkey
mehmetalkan44@yahoo.com

^b Department of Geodesy and Photogrammetry, Engineering Faculty Karadeniz Technical University, Zonguldak,
Turkey
ccomert@ktu.edu.tr

KEYWORDS:

Land title and cadastral data; Temporal analyses; Cadastral TGIS

ABSTRACT

The nature of land title and cadastral (LTC) data in the Turkey is dynamic from a temporal perspective. Functional requirements with respect to the characteristics are investigated based upon interviews of professionals in public and private sectors. These are; Legal authorities, Land Registry and Cadastre offices, Highway departments, Foundations, Ministries of Budget, Transportation, Justice, Public Works and Settlement, Environment and Forestry, Agriculture and Rural Affairs, Culture and Internal Affairs, State Institute of Statistics (SIS), execution offices, tax offices, real estate offices, private sector, local governments and banks. This needs not only updated but also temporal data. The investigations ended up with determine temporal analyses of LTC data, traditional LTC system and tracing temporal analyses in traditional LTC system. In the traditional system, the temporal analyses needed by all these users could not be performed in a rapid and reliable way. The reason for this is that the traditional LTC system is a manual archiving system. The aims and general contents of this paper: (1) define traditional LTC system of Turkey; (2) determining the need for temporal analyses of cadastral and land title data; (3) explain the temporal analyses in traditional LTC system (4) explain problems of temporal analyses in the traditional LTC Systems. As a results of temporal analysis needs, new system design is important for the Turkish cadastral system. Designing and realizing an efficient and functional cadastral Temporal Geographic Information System (TGIS) is inevitable for the Turkish traditional LTC system. Finally this paper outcome is creating infrastructure for design and develop cadastral TGIS of Turkey.

1 Introduction

LTC data has two components; Land title data and cadastral data. Land title data includes such information as the owner and ownership rights. Whereas, cadastral data defines the location, shape and size. In Turkey these two components are handled by land title and cadastre offices which are separate state departments. Therefore, a real estate is legally defined by its “registered” information maintained by both departments. LTC data is a very dynamic nature. It ever changes in time for a number of reasons. Rapid urbanization in Turkey is one of the reasons. That is, more and more buildings, apartments, and offices are built every day. Another reason is the fact that real estates have always been amongst the most popular investment instruments in Turkey and the country has a very dynamic economy. That is, every single day and hour people buy and sell real estates. Similarly, subdividing or combining parcels geometrically when applying zoning plans or changing the ownership rights when setting a mortgage on a land parcel are amongst everyday transactions in a land title office. Either land title or cadastral data changes at the end of some transactions.

Real estate data has a great variety of users; legal authorities, various state organizations, private sector companies, local governments, owners and many others need this data. This need is not only for updated but also for “temporal data” which mean the data concerning the past or history of real estates. What is meant by “temporal analysis” is an analysis which is able to work on temporal data. An example would be “all the real estates owned by person “X” as of August 19, 1990”. Person “X” may not own anything today but say some

land parcels in the past. Therefore, to be able to carry out a temporal analysis historic data is needed. In this work, many examples of temporal analyses needed in practice by various user communities were identified. A thorough examination of these examples has shown that they are of two general types. This matter is explained in objective of the research for temporal query needs section.

Traditional LTC system enables temporal analyses. Nevertheless, in most of the cases performing an analysis may be a tedious, time consuming, and error-prone task. One of the reasons of this is that temporal analyses may be rather complex. Consider for instance the case of a zoning plan application by law, which is a very common in Turkey, was objected by the owners and the court had decided to cancel the application. These applications are for producing land parcels meeting zoning plan specifications from cadastre parcels. At the end of such applications, cadastre parcel owners are “distributed” new parcels which may be different in size, shape, and location compared to the cadastre parcels which he/she owned before the application had been effected. In addition new parcels are drawn on cadastral map sheets and are “registered” to land title registers by their new owners. In many cases these applications are objected and taken to courts. Unfortunately courts cannot decide quickly and in the meantime additional changes in the status of the new parcels may happen. In most of the cases courts decide on the cancellation of the application. What happens in this is a “nightmare” since what is involved is the “establishment” of a “past” status from the “current” status in a manually maintained archiving system.

What are needed are the computerized database systems which would enable “quick” and “reliable” temporal analyses. Current database systems and popular Geographic Information Systems (GIS) have adopted some solutions. For instance, Arc/Info employs its versioning system to trace temporal changes. Intergraph uses a similar approach (Esri, 2002; Roux, 2003). Although there is no commercial system in the marketplace yet, temporal database systems and Temporal GIS are very active research areas at the moment. There is a great amount of literature on the topic (Peuquet, 2001). The main problem, at the moment, is the lack of a widely accepted “spatio-temporal” data model. Therefore, only prototype systems, which are geared towards a specific application area, have been proposed up to date (Narciso, 1999; Pang, 1999).

First traditional LTC system is studied and explained. With the objective of specifying LTC data, some investigations are performed in government foundations, private sector companies, courts, banks and citizens. Determining the need for temporal analyses of LTC data is thus accomplished. It is explained how temporal analyses are implemented in LTC system. Finally, problems encountered at the realization step of LTC step are addressed.

2 Current Cadastral and Land Title Systems

In the current land title and cadastre system of Turkey, real estates such as land parcels, buildings, apartments, business offices etc. are defined with two general types of information. These types are named as “land title data” and “cadastral data” in this article. Land title data involves ownership identities such as name, last name, father name of the owner. The date and transaction via which the ownership was obtained is also involved. In addition, ownership rights and responsibilities such as mortgages on the estate, rights of third parties on the estate are components of land title data. Cadastral data, on the other hand, determines the location in a coordinate system and the shape of the estate. At the moment, cadastral data is maintained in either analog or digital medium. In Turkey, both types of data are handled by two separate state organizations; land title offices and cadastre offices which are operated under the General Directorate of Land Registry and Cadastre belongs to the Ministry of Public Works and Settlement.

Various technical documents were produced via property cadastre and transaction of changes LTC data in the cadastre offices. Cadastral documents were archived in cadastre offices as a result of property cadastre. Other technical documents were archived in land title offices. In this part, cadastral document were explained on the cadastral archives.

Parcel Files: Parcel files were produced case of district or villages. Information paper was produced first section number start from 1 for each village or district. Thus, determine which parcel belongs to which section. Information of section, area and after and before data of parcels was shown parcel files. Parcels geometrical changes were traced via parcel files. This means that first record between last record information was also determined by parcel files.

Table for Cadastral Block Monitoring: It is a table constituted to monitoring changes in sections. District based block numbers and sheet data of sections in concerned district are hold in these tables.

Parcel Dossier of Property Cadastre: It consist of boundary and survey sketches, calculations and benchmarks of triangulation points and traversings, surveys of cadastral parcels produced in property cadastre works. Parcel dossier of property cadastre is archived as district/village and section based.

Parcel Dossier of Change Procedures: It includes all change projects produced after cadastral work and required official registration. Change projects are archived in parcel dossiers of change procedures as district or village based. One copy of these projects is also archived in the district office and in the land registry office.

Cadastral maps: These are the plans in which cadastral parcels is drawn in a specified scale.

There exist a number of registers in a land title office. Land title data has to be registered in these registers to become legally valid. These registers, shown on Table 1., are named as “main” and “auxiliary” registers. These registers are currently maintained manually. The function of each register is shortly explained below.

Main registers	Auxiliary registers
Land title register	Owners register
Real estate register	Representatives register
Transactions register	Corrections register
Legal documents	Public owned lands register

Table 1: Land Title Registers (Ayan, 2000; Karagöz, 1999)

In Turkey, land parcels are registered in the land title register while buildings, apartments, and business offices which are commonly called “independent parts” are registered in the real estate register. There is a separate page for each real estate in these registers. If the page is full then the registration goes onto another page which is maintained by a number. Land title register includes parcel and owner information and ownership rights and responsibilities. In addition to these, real estate register includes the share of the estate on the parcel it was built, and page number of the parcel in the land title register. To track the previous and next states of the real estates, there also exist “Previous” and “next” page numbers in these registers. Land title register and real estate registers are archived by district names.

Transactions register is for keeping the track of the transactions on the basis of hour and minute of the transaction. That is, any transaction on a real estate is recorded in this register by its time. Recorded information are the transaction number, the type of transaction, the hour and minute of transaction, the name and address of the person for whom the transaction is committed, the general location of the real estate, and the number of legal documents concerning the transaction. There is only one transaction register in a land title office. And transaction numbers start from “1” for each year.

Legal documents are deeds, plans, court decisions etc. related to the land title transactions. These documents are archived by district names, land title and page numbers. Owners register shows all the real estates which belong to an owner. There is a separate page for each owner. Through this, it is possible to see the previously and currently owned estates of an owner. Owners register is archived by owner’s last name. Representatives register is for monitoring the legal validity of a representative of an owner at the time of a transaction. Corrections register is for correcting the errors which may occur during registration. Public lands register is held for the lands which are subject to common use.

3 Objective of the Research for Temporal Query Needs

To determine the need for temporal analyses on land title and cadastral data, the needs of the related state and private sector organizations were investigated. Some of these organizations are government foundations, courts, banks and private sector were taken into account. One of the areas where the need for temporal analyses is rather critical is the cases taken to courts. A great many of these cases require a backward analyses and in Turkey a great many of the cases are related to land and real estates. The entire interview results were identified next subsections.

3.1 Preliminary Research, Questionnaire and Personnel Interview

Preliminary research on the all the target groups was conducted through a literature review on their business processes and job specifications. It started with finding out what these groups do with temporal LTC data and whether the business processes can be translated in the current framework. The study came up with a list of

functional requirements for a spatio-temporal aspect. As a consequence of the findings, the writer created a survey questionnaire (Appendix). Because a personnel interview was planned, the questionnaire does not really follow the rule of short or simple supporting a 30–120 min interview. Twenty five professionals in all target groups were interviewed and audio was recorded for the future analysis. A personnel interview is time consuming in comparison with medium-based surveys such as letter, telephone, and e-mail; however, the interviews were very fruitful from the perspective of confirming what the personnel do with spatio-temporal aspects of LTC data. Based on the findings, the functional requirements are summarized and categorized at the table 2. Therefore, these cases were also investigated. As a result, a great variety of temporal analyses were identified (Appendix).

3.2 Classification of temporal LTC data

Temporal analyses of real estate data may be classified differently depending on the classification scheme. ”. Langran (1993) has classified temporal analyses as “simple temporal query”, “simple spatio-temporal query”, “temporal range query” and “spatio-temporal range query”. In his Ph.d. thesis, Al-Taha (1992) has classified temporal analyses as “point-based” and “interval-based

In this work, Al-Taha classification is used. Results of temporal queries according to selected classifications are given below.

3.2.1 Point – Based Temporal Analysis

This type of analyses queries the status of real estates at a given “point” in time such as March 12, 2001 or 10:30 am on May 19, 1980. Although many examples of this type may be given, some of which given below would suffice:

- In an inheritance case a court may request all the real estates which were owned by the dead person before the date of the death.
- Determining of current property ownership in a court case. (i.e. ascertaining whether the plaintiff owns the property on the date of court trial)
- In Turkey, real estate taxes are determined with respect to owner declarations. Since it is not easy to control owner declarations by traditional means, real estates are either not declared or declared with a much lower tax. Therefore, up to 70% tax losses are reported (Cömert & Akıncı, 2002). For many controls in taxing a temporal analysis is needed since by the controls are done, real estates might have undergone many land title transactions. As an example, determining missing declarations of an owner for a given date in the past can be considered.
- Mortgage offices, banks or courts may request all the “mortgaged” real estates of an owner at a given date.
- Checking the real estate before and after the property cadastre whether it is owned by the General Directorate of National Estates (GDNE) against any miss registration.
- Checking the real estate that is supposed to be registered for GDNE after the property cadastre on the claim of citizens.
- Getting of real estates’ LTC data for property cadastre rejection courts.
- Municipalities, courts and other user needs snapshot of a selected area for any time.

3.2.2 Interval – Based Temporal Analysis

This type of analyses queries the status of real estates for a given “interval” in time such as the one between April 30, 1974 and June 15, 1976. Like point-based analyses, there may be many examples of this type, some of which are given below:

- All the real estates sold by the state in the last 10 years. This may be needed in determining, for instance, “who the buyers of state land were”.
- In an inheritance case, upon heirs appeal, a court my need to determine all the real estates “sold” by the death person at a given period.
- Tax offices control the income tax of real estate owners.
- All the real estates which were subject to any kind of transaction during the past month. This is needed by tax offices to check the taxes collected by land title offices.
- All the real estates which had changed its owner by such transactions such as sale in a period of less than four years. This is needed by the ministry of budget to charge value added taxes.
- Determining of real estates of those who exposed to execution.
- Investigation by banks for mortgage records of their customers.

- Tracing of real estates belongs to foreign owners.
- Determining statistical data of real estates.
- Scrutinizing property ownership of civil servants.
- In a land privatization case, a court may need to examine a land parcel’s various qualities such as its area before the privatization.
- Similarly, in a land consolidation or land rearrangement case, a court may need to examine a land parcel’s various qualities such as its location, share holders before the application.
- All the real estates which were owned by the ministry of culture in the past 20 years. This may be needed in determining the illegal uses of cultural heritages.
- All the state owned forests which had gone through private ownership via some transactions between 1961 and 1981. This is needed by the ministry of forests to determine illegal uses of state owned forests.

With respect to classification, functional requirements are also summarized in Table 2:

Functionality	1	2	3	4	5	6	7	8	9	10	11	12	13
Temporal topology			X					X	X				
Snapshot			X			X						X	X
Retention of historic data	X		X				X						
Temporal query of LT data	X		X	X	X		X			X	X		
Temporal query of LTC data	X		X					X	X			X	
Spatio-temporal query of LT data	X		X	X	X								X
Spatio-temporal query of LTC data	X	X	X			X		X	X			X	X

1) Courts, 2) GDNE, 3) LT and Cadastre Offices, 4)Ministry of Budget, 5) Banks, 6) Private sector and organizations, 7) Executive offices, 8) Municipalities, 9) Ministry of Environment and Forestry, 10) SIS, 11) Internal Affairs, 12) Ministry of Culture and Tourism, 13) Other private organizations.

Table 2: Summary of User Need Assessment

4 Temporal Analyses in the Current Cadastral and Land Title Systems

In the traditional system both updated and historic data are manually archived. There are several mechanisms of this archiving system to enable temporal analyses. One of them is that the updates are done such a way that the “old” information will not get lost. As mentioned above, in updating the land title data, the old information is lined over by a red pen so that it can still be read. Cadastral updates are done in a similar way by marking old data as invalid rather than erasing it totally. The other mechanism is page numbering; there are “previous” and “next” page numbers in the land title registers to track down temporal changes. Finally, every transaction is registered by its hour and minute to the transaction register. Workings of these mechanisms are given below via the steps of registering a “consolidation” operation. A consolidation operation involves consolidation an existing parcels into one new parcels geometrically. This operation requires updates on both cadastral and land title data.

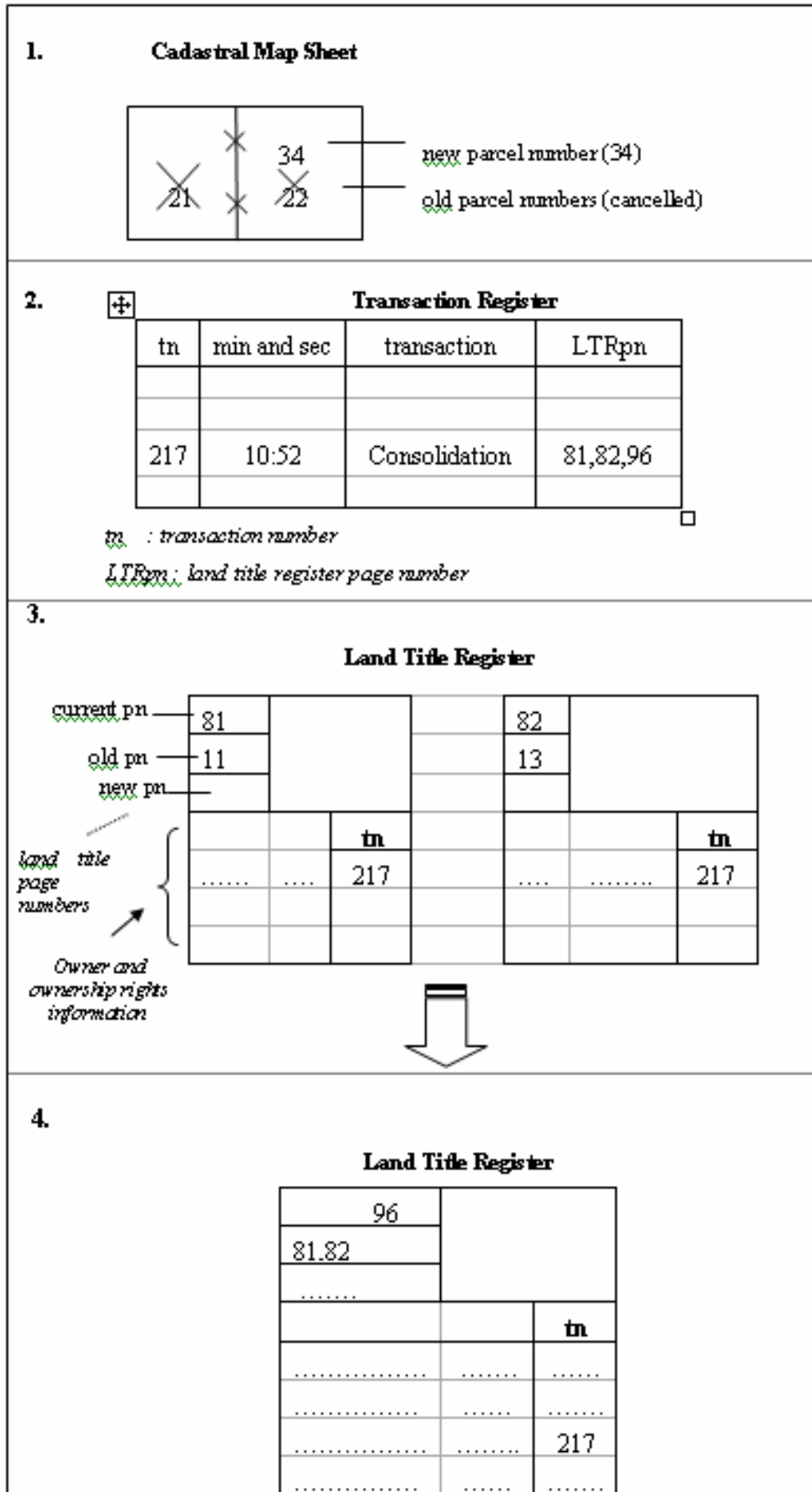


Figure 1: Illustrates the steps of these updates.

Figure 1 Steps of land title and cadastral updates after a “subdivision” operation on a land parcel.

- Cadastral update is done in the related map sheet by drawing the new parcel with their new number and lining over the original parcel number.
- Transaction is registered to the transaction register by its type, hour and minute with a transaction number. Related page numbers of land title register are also written on the same page of the transaction register.
- The page of the land parcel in the land title register is canceled and new page for the new parcel are opened. In addition, new page number is written on the canceled page as “next” page numbers.
- Owner information and ownership rights of the new parcels are registered to the newly opened page of land title register. Land title page number of the original parcel is written down on each new page.

5 Problems of Temporal Analyses in the Traditional Land Title and Cadastral Systems

It is possible to carry out temporal analyses in the traditional archiving system. Nevertheless, the traditional system has some problems due mainly to the fact that it is maintained manually. The problems can be classified as “response time”, “reliability of results”, “weakness of service quality” and “economical loss” which are explained below.

5.1 Response time

Temporal analyses may be rather slow in the traditional system since required data are retrieved sequentially. Let the analysis of the states of all the real estates sold by an owner for a given period of time is taken as an example. Such an analysis is needed, for instance, in determining to whom the state owned lands are sold in the last 10 years. State owned lands approximately %50 percent of Turkey (URL-2, 2004; URL-3, 2004).

The steps of performing such an analysis in the traditional system are as the following:

1. Transaction registers of the last 10 years have to be searched for “sale” transactions by the “state”. For all such transactions, transaction numbers, and the page numbers of the real estates in the land title register (LTR) and real estate register (RER) are recorded manually. Here, transaction registers are searched sequentially row by row. Therefore, the time needed for this search depends on the number of transaction registers to be searched.
2. LTR and RER pages of each real estate are reached via the page numbers and related district names obtained in the first step. Afterwards, at each LTR and RER page, a search of the raw with the corresponding transaction numbers found in step “1” must be done. This may require searching many LTR and RER pages. Because LTR and RER are archived by district names and there may be more than one register for a district since each register has only 100 pages. Therefore, although it may not be so intensive as the step “1”, this is a tedious search as well. And the time needed will mainly depend on the number of the real estates to be checked.

5.2 Reliability of the results

As explained in the example in before, analyses are performed by manual means in the traditional system. This means that all the searches and manual recordings are error-prone. In addition, since temporal analyses are rather complex operations, controlling procedures are at least as complex as the analysis itself. Therefore, the reliability of the analyses cannot be guaranteed in the traditional system.

In fact, there are some mechanisms to speed up searches and to help ensuring reliability. For instance, all the real estates owned by an owner currently can be obtained directly from the owners register. However, due to the facts that updates are done manually and there are no “auto-control” mechanisms in the system, information in some of the registers such as the owners register may not be reliable.

Because of the fact that the temporal analyses are time consuming and result may not be reliable, many organizations prefer doing the job by their own. For instance, the project of determining state owned real estates is undertaken by the related General Directorate itself. This means a waste of resources and a great loss of revenues on behalf of both land title and cadastre other organizations.

5.3 Weakness of service quality

procedures in current related regulations, the institutions and organizations requiring land registry and cadastre data could be getting these data in long period of time. This situation leads to delay in services of these institutions and organizations. For instance, as a result of delay in some processes like “transaction”, “mortgage”, etc., clients apply to illegal ways to fulfill their processes.

Non-updated address information of real estate owners is another issue originating from deficiency of current system. In some ex-officio applications like land readjustment, expropriation, selling of sequestered real estates, etc., notification is sent to the real estate owner’s address in accordance with land registry records. In such cases, because of the non-updated address records, some real estate owners could not be aware of the application. Therefore, real estate owners could not use their rejection rights to these applications and this leads to damnification of them.

5.4 Economical loss

Accuracy and rapid level of traditional land registry and cadastre system lead to economical loss. An important reason of delays of real estate related suits is insufficiency of traditional land registry and cadastre system. Prolongation of suit processes makes courts busy and this also leads to rising of physical burdens of natural and legal persons. Only 35-40% of the land registry and cadastre related suits could be concluded in the same year (URL-1, 2004). For example, long suit time for a rejection to an officially registered zoning plan application retains the landowners from disposing on their new development parcels. An another sample, when a debtor real estate owner want to sell his real estate and to pay his debt, he could not sell it, so, that real estate could be sold with low price as a result of sequestration. Also, the contractors and the real estate owners carrying on building construction leave the construction in court process and so deprive from economical gain. In case of cancellation of the application, new additional economical losses will arise. If buildings have been constructed on such areas as school, mosque, gendarme station, municipal service area, these buildings lost their legal situations when the application is cancelled. The legal situation could be established only with a new application. If cancellation also comprises the official buildings, the same land can not be allocated to the official buildings. Because of the already constructed buildings, government has economical loss. As a result of allocation, the buildings constructed on development parcels could be registered as condominium to land registry. After cancellation of application, in new case, there could be need for the same type allocation of these buildings’ parcels and re-registration to land registry. Thus, the contractors who have unsold independent parts, only at the end of this process could be carrying out these processes. So, they have economical loss in the in this period.

Another example for economical loss is the one due to restricted access of state organizations to the traditional LTC data. Rapid access to LTC data is therefore not possible and each organization produces its own data. This leads to delayed execution of public works from state organizations and this in turn causes also economical losses. An organization may not track its asset of real estates and further their use changes in time. As a result of the absence of appropriate tracking, organizations may not rent, sell or use their real estates for building facilities and they are exposed to economical losses (URL-4, 2004).

On the other hand transactions conducted by LTC Offices such as sell, mortgage and zoning plan applications are 2 million per year in average (DİE, 2001). Transactions in traditional LTC system like transition, condominium, share-out are requested in low rate because of long execution time of them. Charge income from transactions in 1995 amounts to 160 M\$ and 280 M\$ in 2000 (DİE, 2001; TKGM, 1997). Low transactions rate causes low income charge values for the state. Raising the number of transactions will lead to increase in charge values and taxes and state economy will profit from it.

6 Conclusion and Future Works

In this research, the target groups for the cadastral TGIS to fit with the nature of the Turkey cadastre were identified: government foundations, private sector companies, courts, banks and citizens. Interview with the user who needs temporal LTC data, all the temporal analyses which are required by the user have been determined. The functional requirements were classified through interview and discussion with professionals in the target groups for cadastral TGIS requirement and implementation. Besides, temporal queries example was explained in the traditional LTC system. Temporal analyses could be executed in the traditional LTC system, but there are problems with it. These problems were classified and detailed clarify. As a result of this needs, new system design is important for the temporal LTC data. Finally, designing and realizing an efficient and functional cadastral TGIS system is inevitable for the Turkish traditional LTC systems.

APPENDIX: Questionnaire Surveys

- a. What is the name of current organization or department you belong to?
 - Cadastre office
 - Land title office
 - Courts
 - GDNE
 - Municipality
 - Tax office
 - Executive office
 - Others (please describe it)
- b. Does your organization use temporal LTC data Yes/No
- c. If yes to question 2, what kind of temporal LTC data please answer the other queries.
- d. Snapshot (e.g., produce a parcel coverage (both of spatial and attribute data) at August 28, 1998).
- e. Basic time query – asking when (e.g., what is the information of Ahmet AYAR own parcel?)
- f. Attribute query—asking what (e.g., what was the owners and owners lot of the parcel on July 20, 1997?)
- g. Temporal lineage (e.g., list all attribute of the parcel and graphic positions)
- h. Space query – asking where (e.g., where is the parcel owned by Ahmet AYAR on April 01, 2001)
- i. Space and time query – asking where and when (e.g., where are the parcels ever owned by Ahmet AYAR and when did he own them?)
- j. Attribute change detection (e.g., mark all the parcel for which owners were changed between January 1, 1995 and January 1, 2003)
- k. Others? (please describe it)

References

- Al-Taha, K. K. (1992). Temporal Reasoning In Cadastral Systems. PhD thesis, The Graduate School, University of Maine, USA.
- Ayan M., 2000. Eşya Hukuku I, Zilyedlik ve Tapu Sicili, Mimoza Yayıncılık, Konya, 2000.
- Cömert, Ç. and H. Akıncı. 2002. Application Development in an Interoperable GIS Environment: A new System for Real Estate taxation in Turkey. Proceedings of 3rd International Symposium on Remote Sensing of Urban Areas, 11-13 June, Istanbul, Vol. I, pp.200-205.
- D.İ.E., 2001. Türkiye İstatistik Yıllığı, Devlet İstatistik Enstitüsü, Yayın No, 2690, Başbakanlık Basımevi, Ankara.
- Esri., 2002. Modeling and Using History in ArcGIS, Technical Paper, United States of America.
- Karagöz M., 1999. Haritacılıkta Taşınmaz Hukuku, Pub. By Union of Chambers of Turkish Engineers and Architects, Chamber of Surveying Engineers, Ankara, Turkey.
- Langran, G., 1993. Time in Geographic Information Systems, Taylor & Francis, London; Washington, DC.
- Narciso, F.U., 1999. A Spatial Data Model For Incorporating Time in GIS (GEN-STGIS). PhD Thesis, Graduate School University of South Florida, Tampa.
- Pang, Y.C., 1999. Development of Process-based Model for Dynamic Interaction Process in Spatio-Temporal GIS. Ph.D. Thesis, The Hong Kong Polytechnic University.
- Peuquet, D. J., 2001. Making Space for Time: Issues in Space-Time Data Representation. *Geoinformatics*, 5:1, 11-32.
- Roux P., 2003. White Paper, Versioning, Lineage, Timestamps and Temporal Database, Intergraph corporation. <http://www.intergarph.com/whitepapaers> (accessed by 11 Sep. 2003).
- TKGM., 1997. TKGM Faaliyet Raporu, TKGM Yayınları, Ankara, 1997.
- URL-1, 2004. Mali İstatistikler. <http://www.die.gov.tr/istTablolar.htm#bil>, (accessed by 14 January 2004).
- URL-2, 2004. Milli Emlak Genel Müdürlüğü. http://www.milliemlak.gov.tr/_mesaj/mesaj.asp. (accessed by 10 May 2004).
- URL-3, 2004. Türkiye'nin Yarısı Devletin Mülkü. <http://www.anadoluajansı>. (accessed by 17 May 2004).
- URL-4, 2004. Yalova'da İşgal Edilen Hazine Arazileri Beş Yıllığına Kiralanıyor. <http://www.kenthaber.com/Sayfalar/haberDetay.asp?ID=4745>. (accessed by 09 April 2004).

REGISTRATION DATABASE FOR SURVEYING AND LAND MANAGEMENT COMPANIES IN MONGOLIA

Tserensangi Dashzevge

Property Rights Project, Millennium Challenge Account-Mongolia
Room #404, Government Bld.-12, Barilgachdyn talbai - 3
Ministry of Roads, Transportation, Construction and Urban Development
Ulaanbaatar-15171, Mongolia
dashzevge@mca.mn

KEYWORDS:

GPS, Total Station, Database, Surveying, Geodesy, Cartography, Land Management, Cadastre

ABSTRACT

Currently, over one hundred private firms are operating with special licenses for surveying, mapping, land management and land rehabilitation activities in Mongolia. In order to monitor human resources and surveying equipments from licensed companies, it is required to develop a unified registration database.

Main requirements for the surveying licenses are that the firm must have geodetic specialists with a working experience of at least three years and their own surveying equipments, including GPS, Total Station, level and etc. In order to have the license for land management and land rehabilitation the company must have following specialists: land manager, botanist and soil specialists.

The license is issued by the Ministry of Roads, Transportation, Construction and Urban Development.

A registration database was created with MS Access for the purpose of managing licensing activity, which has ten linked tables containing all kind of license related data as well as four look-up tables. Here, company registration numbers were used as a reference in order to link all the tables. User interfaces are developed for data entry and maintenance.

1 Introduction

1.1 Overview

In Mongolia, all kind of surveying, mapping, and geo data collection activities are performed only by private licensed companies. Governmental authorities are responsible for policy making, planning, and standardization of geo-spatial data, geo data collection and maintaining it on a nationwide level.

Since 2001, when the Law in Licensing was approved, a number of business activities have been included in the list for requirements of licensing, in order to carry out topographic and cadastral surveying as well as land management and land reclamation activities. According to this law, companies have to apply at the Ministry and they have to submit all required documents; together with other supporting documents like company registration information, human resources and the company's equipment.

The Ministry of Roads, Transportation, Construction and Urban Development (MRTCUD) issues the licenses for the aforementioned activities and signs a collaboration agreement with the licensed companies, which is crucial for the coordination of all licenses and its extension or the withdrawal. For this purpose it is necessary to create a database to manage all information related with these licenses, like company information, company's equipment and human resources. This database will help to manage the day-to-day work on licensing as well as for policy making on mapping, geo-spatial data collection and processing of the data.

Need of a License Database

According to the law, there are two different types of licenses issued for the topographic and cadastral surveying, land management, and land reclamation activity. The first license is the so-called "special permission" for

geodetic and cartographic activities and production, and for cadastral surveying. The second one is called “professional rights” for land management and cadastral activities.

Companies that require “special permission” should have geodetic (surveying) specialists with three years of working experience and surveying equipments e.g. GPS, Total Station, etc. For the company’s request for the “professional rights” licence, they must have specialists for soil, land managers, and botanists.

Since 2003 the number of applicants requesting a license is increasing rapidly. If companies fulfill all the requirements for the licenses, MRTUCD issues the “special permission” and/or the “professional rights” accordingly. The validity of the licenses is three years and can be extended depending on the company’s activity.

There are some special cases like duplication of equipment or human resources of the companies. For instance, some of the companies may have some equipment or human resources which already belong or are registered with other companies, which is illegal. With the database these kinds of illegal actions could be easily detected. If such case is detected, then the Ministry requires clarification on this issue from the applicant before issuance of license and makes a decision on issuance.

The database will help also for short and midterm planning of activities related to upgrading the national geodetic network, mapping, infrastructure and urban development, disaster monitoring and the development of a NSDI. The database, which is containing nationwide information of human recourse and surveying hardware and software, is very important for the governmental authorities.

2 Creating a Registration Database for Surveying and Land Management Companies

The license database was created by the Ministry using MS Access. It has ten linked tables consisting of company registration information, human resources, type and number of license, issue and expiration date of license, agreement number, date and all related information to the license and equipment information including serial number, accuracy, manufacturer, calibration, etc. The table names, structure and key columns are shown in figure 1.

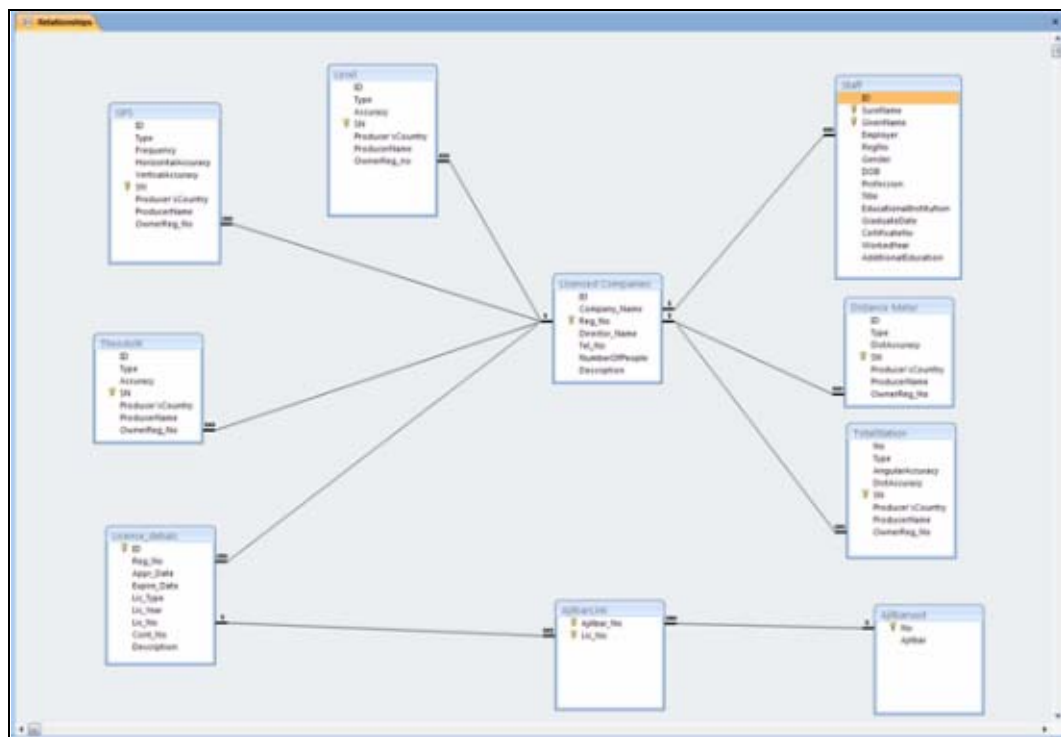


Figure 1: Registration database structure and its relationships

The database also has four look-ups: for gender, name of profession, academic title and license type. These tables simplify the data entering process.

The user interface for entering, updating, searching and deleting information has been developed in Visual Basic for Application. With this user interface it is possible to enter information of newly issued licenses and to search for existing licenses, e.g. for their extension or withdrawal or to update any of the information, see Figure 2.

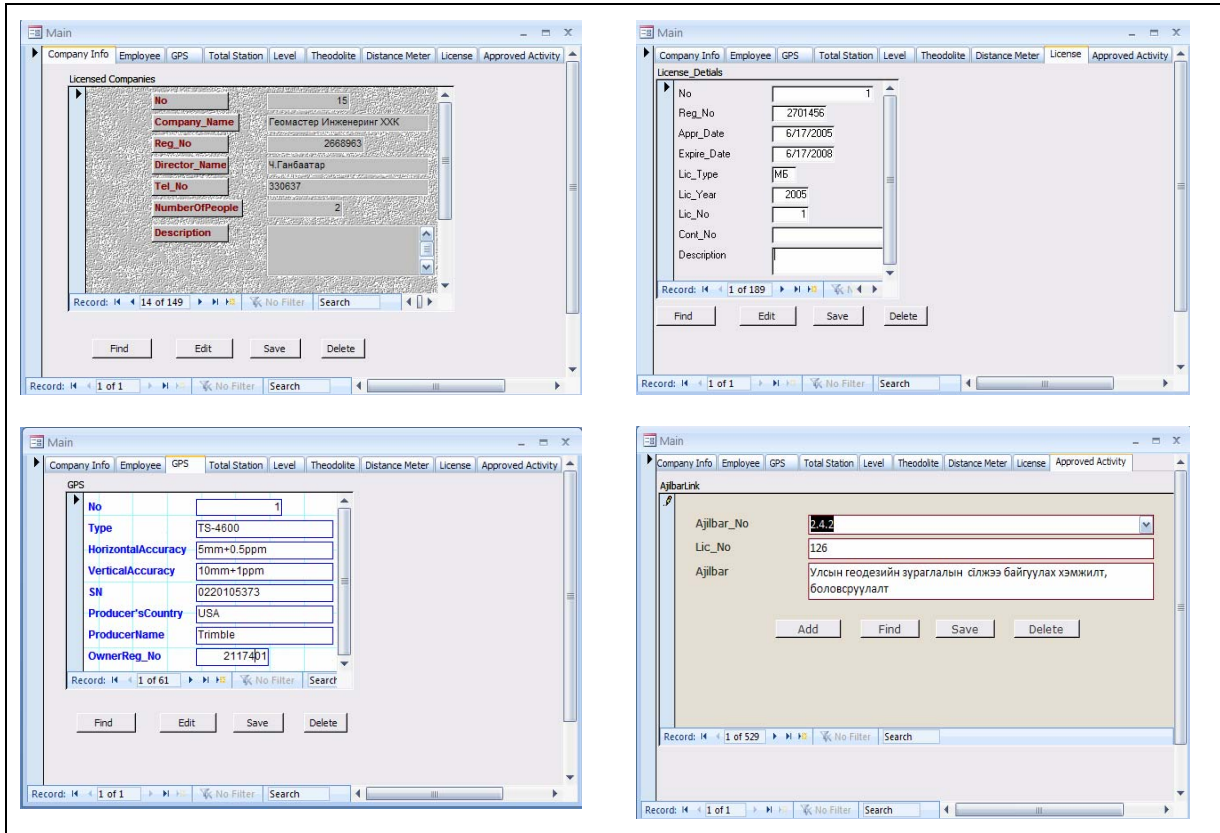


Figure 2: User interface

The main table is the table “Licensed Companies”, other tables are linked to it by the company registration number as a primary key. This table contains general information about the company such as name, registration number, director name, telephone number, and description. All other tables linked to “Licensed Companies” have one column containing the company registration number as a foreign key.

“License details” contains all licenses related information like license number, type, issue and expire date, contract number and description, including the history.

“Staff” section contains human resources information. Each row of this table contains personal information about one individual (company staff), that is first and last name, registration number, date of birth, gender, profession, title, name of graduated educational institution, graduation date, certificate number, additional training if any, number working years as of the date submission and employers’ name (company name that he/she is currently working in).

“Ajilbar” contains a list of activities that will be written on the license certificate. Only those activities, permitted by the Ministry depending on the capability of the company, will be written on the license certificate. A company only has the right to perform those activities written on the license certificate.

The other tables named by equipment types contain information of corresponding equipment type e.g. type, serial number, manufacturers name and country, accuracy and owner’s registration number referring to the foreign key.

The Ministry issues a certificate to the companies in order to permit their activities. For the certificate preparation Microsoft Word’s mail merge command linking “Query table” from the registration database is used, see Figure 3.

Licensed Co.	Company Name	Licensed Cor.	Director Name	Tel No.	Number	Licensed Comp.	Licen.	License_I.	License.	Expire Date	Lic_Type	Lic_Year	Lic_No.	Cont_No.
169	Жеинбан болд ХХК	2855615	С.Эрдэнэбаатар	688011	3	190	2855615	8/7/2008	8/6/2011	T3	2008	176	T103	
170	Сант-Ондор ХХК	2110008	Ч.Баярмаа	01-362-2-22-74	Хөвсгөл аймаг	191	2110008	8/7/2008	8/6/2011	T3	2008	177	T104	
171	Анурсүрэй ХХК	5230349	Г.Мөнх-Эрдэнэ	461504, 95882395	4	192	5230349	8/7/2008	8/6/2011	T3	2008	178	T105	
172	Тэйхэлэг-Уул ХХК	5107423	Т.Мөнхцолмон	99070219	3	193	5107423	8/7/2008	8/6/2011	T3	2008	179	T106	
173	Ньюгоризонт ХХК	5125324	М.Базарраднаа	344208, 99900108, 99	3	194	5125324	8/7/2008	8/6/2011	T3	2008	180	T107	
174	Голденхорс ХХК	3813402	Т.Баатар	99840425, 99287132	4	195	3813402	8/7/2008	8/6/2011	T3	2008	181	T108	
175	Бестсүрвэй ХХК	5243882	Ш.Очирбат	345491, 99680429	4	196	5243882	8/7/2008	8/6/2011	T3	2008	182	T109	
176	Эксплосурвэй ХХК	5244625	Б.Цэвэлмаа	99032369	4	197	5244625	8/7/2008	8/6/2011	T3	2008	183	T110	
178	Менхолоон орчлон ХХК	5199425	Р.Оюунбилэг	315059, 99119048	6	199	5199425	8/7/2008	8/6/2011	T3	2008	184	T111	
179	Ололт тур ХХК	2541556	П.Пүрэвжав		3	201	2541556	8/7/2008	8/6/2011	T3	2008	185	T112	
180	Завхан трейд ХХК	2104148	Д.Мөнхжаргал		3	203	2104148	8/7/2008	8/6/2011	T3	2008	186	T113	

Figure 3. Query table for mail merge in MS Word

3 Benefit of the database and summary

First of all the Ministry has the possibility to control and easily manage licenses using the database.

By having this database the Ministry is able to explore different kinds of information which could be very helpful for the Ministry’s policy making. With the database the Ministry has been obtained information on the current situation of human resources and the capacity of companies. The Ministry has defined needs of surveyors and pays attention to their numbers and qualifications. The results from of a first evaluation shows however, modernization of technology in the companies is acceptable for surveying and mapping industry. Capacity building of the employee needs to be improved such as quality of education for surveying, mapping and GIS as well as the lecturers’ professional skills and experience.

The database analyses show many problems of the surveying and mapping industry of Mongolia. Most of the specialists working in surveying and mapping industry were graduated from Mongolian universities. Specialists graduated from higher educational institutions of developed countries are very few. That is a problem as Mongolian universities in the field of surveying and mapping have not invested in new technologies lacking of financing.

The Ministry has decided to send students to universities of developed countries for post graduate, master and doctoral study in the field of geodesy, surveying, GIS and remote sensing. Also, the Ministry is focusing on collaboration with universities and governmental organizations for the improvement of educational facilities.

The Ministry has implemented a “Cadastral mapping and land registration project” funded by Asian Development Bank (ADB) loan since 2002. For planning and determining the scope of work that in the call for tender (bid out to survey companies) under this project frame work, the Ministry has used the registration database. For example, based on the capacity (i.e. the number of personals and surveying equipment) of surveying companies, the Ministry has determined the size, the scope of work and the timing of each work area in the separated calls for tender.

After implementation of the database the following information has already been registered:

- Total licensed company 149
- “special permission” 17
- “professional rights” 1
- Surveyor/specialists 307
- Dual-Frequency GPS receiver 52
- Single-Frequency GPS receiver 9
- Total Station 102
- Level 65
- Electronic distance meter 2
- Optic theodolite 19

Based on the results of the database analyses, the Ministry makes plans for geodesy, surveying, mapping and land administration activities, and estimates budget (cost) and volume of surveying and mapping works considering the execution time.

According to the agreement, companies have to inform the Ministry about changes in human resources and surveying equipment so that the database information is updated immediately.

There are some special cases like duplication of equipment or human resources of the companies. For instance, some of the companies may have some equipment or human resources which already belong or are registered with other companies, which is illegal. With the database these kinds of illegal actions could be easily detected.

If such case is detected, then the Ministry requires clarification on this issue from the applicant before issuance of license and makes a decision on issuance.

There are detected 6 illegal attempts for licensing. Four of them were duplication of human resources and three of them were duplication of surveying equipment. For the case of human resources duplication it was clarified either the surveyor works for the new company or already registered company. After clarification, licenses have been issued for three companies and has been refused for the fourth company has refused. In case of equipment duplication the licensing was refused.

It was an example of real benefit of the registration database.

References

Mongolian Legal Unified Information System., 2006. Law of Licensing.

<http://www.legalinfo.mn/insys/lawmain.php?vlawid=1314> (accessed 28 Apr.2009)

Thomas Connolly and Carolin Begg., 1998. Database Systems: A practical approach to design, implementation and management. Addison Wesley Longmann, London.

CURRENT STATUS AND CHALLENGES IN ESTABLISHING NSDI IN VIETNAM

Hang Tran Minh

Department of Survey and Mapping Vietnam, Ministry of Natural Resources and Environment
Hoang Quoc Viet Road, Hanoi, Vietnam
hangtm73@yahoo.com

KEYWORDS:

GIS, NSDI, Geoinformatics, Vietnam, Geographical information standard

ABSTRACT

Which characteristics of geoinformatics help people recognize its possibilities for application in the society and environment? The first part of the paper addresses this issue. The main part of the report briefly introduces the current status and challenges in establishing NSDI (National Spatial Data Infrastructure) in Vietnam. The current status including the construction of framework data, standards, distribution technology development and GIS education in Vietnam is presented. As defined, in Vietnam, framework data includes administrative boundaries, transportation, marine and water resources, geodetic control points, topography, cadastral, land use, facilities, satellite images and aerial photos. Because framework data is commonly used in extensive and varied fields, they must be built according to basic geographic data standards. The challenges in establishing a NSDI in Vietnam is addressed. A solution for the development of applied geoinformatics in Vietnam is proposed.

1 Literature review

1.1 Why Geoinformatics can be applied to society and environment

It can be said that 90% of information relating to location. GIS provides data retrieval, storage, integration of multi-data sources and data management as well as analysis capability, data modeling, and data visualization. Therefore, GIS can be applied in various socio-economic fields.

Many definitions have highlighted that geoinformatics is a single discipline, which combines computer science and geosciences with the ability to answer complex scientific questions. Thus, massively increased computer storage, processor capabilities and internet has lead to the support of more and more requirements from users in GIS. New effective GIS enhancement is geo-processing on server, with the data centrally managed. Server GIS facilitates effective communication and decision making. Geoinformatics support services for visualization are upgraded with 2D and 3D map services, image services. With all of its advantage, geoinformatics has been widely applied at research institutions as well as management departments in dealing with society and environment issues

1.2 Concept of NSDI

1.2.1 Definition of NSDI

SDI can be said as a fundamental that promotes the development of Geoinformatics applications. NSDI is SDI for one nation and it provides the core requirement for any Geoinformatics application which benefits for national society and environment.

NSDI composes of Framework Data, National Standards for geographic information, National Geographic Clearing House, GIS Education.

1.2.2 Components

- *Framework Data*: The most basic geographic information of any country needed by the public and widely used it for various purposes can be referred to as *Framework Data*. Three parts of framework data are:
 1. Framework of digital geographic dataset: Normally, the Framework Data content of the following information: cadastre, facilities, statistics, transportation, hydrography, ocean, administrative boundaries, topography, spatial images, and surveying control points
 2. Unique feature identifiers: These are numbers that make topographical features distinguished from each other and used as a reference when connected to external databases.
 3. Data models: Increase data use by describing how data items related and how those are structured.
- *Standards*: Standards establishing consensus on terminology make technology transfer easier and safer. They are an important stage in the advancement of new technologies and dissemination of innovation. International standards provide a reference framework or a common technological language between suppliers and their customers, increase business activities
- *Standards for digital geographic information*: Geographic information standard is a document agreement such as technical specifications, rules, guidelines, characteristic definitions, norms and criteria is necessary for establishing, distributing and utilizing the information on locations and attributives. There are several categories of International Standardization in GIS:
 - *ISO Standards*: ISO (International Organization for Standardization) is the world's largest developer and publisher of International Standards. ISO is a non-governmental organization that forms a bridge between the public and private sectors. ISO enables a consensus to be reached on solutions that meet both the requirements of business and the broader needs of society.

ISO/TC211 is an organization that is establishing a structured set of standards for digital geographic information. ISO/TC211 Standards are also known as ISO 19100 series. The Standards are being developed by Technical Committee 211 (TC 211)
 - *Standards developed by the Open Geospatial Consortium (OGC)*: OGC is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services. OpenGIS® Specifications support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT. The specifications empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications.
- *Geographic Information Clearinghouse*: A Clearinghouse in GIS is a repository structure, physical or virtual, that collects, stores, and disseminates information, metadata, and data. A clearinghouse provides widespread access to information, e.g., provides the spatial data owned by the central ministries, local governments and public institutions to the demander and provides the function of distributing the file-based data and the feature-based spatial data
- *Background*: No amicable information exchange among the institutions that implement the spatial data, data are repeatedly implemented. Implemented data is not commonly utilized.

2 Current status and challenges in establishing NSDI in Vietnam

2.1 Current status in establishing NSDI in Vietnam

2.1.1 Framework data construction

Content of Framework data: As defined, in Vietnam, framework data includes administrative boundaries, transportation, cadastral, land use, marine and water resources, geodetic control points, topography, facilities, satellite images and aerial photos. Following is information about Framework data construction according to basic geographic data standards in Vietnam:

- In progress: Construction of Framework data relating to map scale of 1/2000 and 1/5000 for developing regions

- Data source: Topographic maps in MicroStation format with scale of 1/2000 and 1/5000; topographic data update for the changing areas by Total Station. Additional measurement is needed for DTM generation.
- Data type: Geodatabase

- In progress: Construction of Framework data relating to map scale of 1/10000 for national territory

- Data source: Topographic maps in MicroStation format with scale of 1/10000; topographic data update for the changing areas by Total Station; with regions not yet having topographic maps of scale 1/10000, aerial photos are required to be taken. Additional measurement is needed for DTM generation
- Data type: Geodatabase

Related lesson learn for the implementation of Framework data in Vietnam

Before the time that geographic data standards are established in Vietnam, some projects of geographic information data creations were carried out by government institutions and local authorities, the data in MapInfo format and in ArcGIS format (.shp file); Land management system, called VLIS, is established in Vietnam in 2005, but it is a desktop-based system. The system is developed based on MapInfo. Some restricts have been founded are the problem in data update and sharing with other systems, different systems need different data set and different requirements of data quality.

From the experiences gained after the implementation of the above projects, there are some lessons learned as follows:

- Because the Framework Data are the information that provides the most basic framework, and is commonly used in extensive and varied fields, the Framework Data must be built according to strict standards and guidelines.
- Because the Framework Data are composed of several different items, it is difficult for one organization to implement completely. Therefore, related public institutions should implement and continue to maintain the Framework Data. In order to avoid overlap of framework data's application, a framework data integration and management institution, which synthetically manages all items of framework data, will be designated and managed.
- The most desirable situation would be to newly develop Framework Data according to current requirements in terms of quality. However, as it would involve a lot of time and expense, the Framework Data can be implemented through application of digital topographic map. That is, the procedure to connect a structured editing and attribute information after extracting the geographic information layer from the digital topographic map must be additional executed.

2.1.2 Establishment of National Standards for geographic information

The National Standards for geographic information in Vietnam have been established in 2008 by The Department of Survey and Mapping Vietnam (DOSM 2007) with 9 standards. As defined, DOSM has the role of a national surveying and mapping organization. The Department has the responsibility of establishing framework data and national geographic standards. The standards are adapted ISO/TC 211 standards and nine geo-standards have just been introduced in order to serve the framework data implementation.

- 1- Conceptual schema language: provides rules for the use of a conceptual schema language. The chosen conceptual schema language is the UML.
- 2- Feature catalogue: provides a standard framework for organizing and reporting the classification of real world phenomena in a set of geographic data. Feature catalogues defining the types of features, their operations, attributes, and relationships represented in geographic data are indispensable to turning the data into usable information. Such feature catalogues promote the dissemination, sharing, and use of geographic data through providing a better understanding of the content and meaning of the data.
- 3- Spatial referencing by coordinate: A coordinate reference system is a coordinate system which has a reference to the Earth. Vietnam use VN2000 coordinate system that based on UTM projection, WGS 84 datum.
- 4- Spatial schema: provides conceptual schemas for describing and manipulating the spatial characteristics of geographic features. Spatial characteristics are described by one or more spatial attributes whose value is given by a geometric object (GM_Object) or a topological object (TP_Object). Geometry provides the means for the quantitative description, by means of coordinates and mathematical functions, of the spatial characteristics of features, including dimension, position, size, shape, and orientation. Topology is commonly used to describe the connectivity of features.

- 5- Temporal schema: defines the standard concepts needed to describe the temporal characteristics of geographic information as they are abstracted from the real world. Temporal characteristics of geographic information include feature attributes, feature operations, feature relationships, and metadata elements that take a value in the temporal domain.
- 6- Spatial referencing by identifiers: Spatial reference systems using geographic identifiers are based on a relationship with a location defined by a geographic feature or features. This standard specifies ways to define and describe systems of spatial references using geographic identifiers.
- 7- Quality principles: provide principles for describing the quality for geographic data and concepts for handling quality information for geographic data.
- 8- Metadata: defines the schema required for describing geographic information and services. It provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographic data.
- 9- Encoding: The purpose of an encoding standard is to enable interoperability between heterogeneous geographic information systems. This International Standard specifies requirements for creating encoding rules based on UML schemas, informative XML based encoding rule for neutral interchange of geographic data.

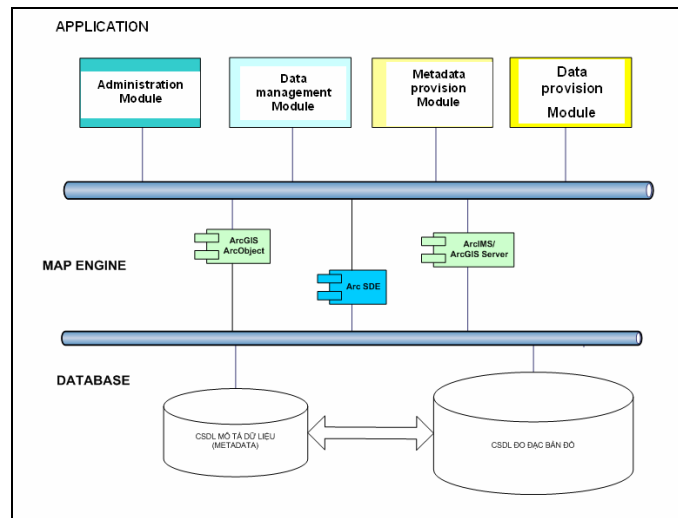


Figure 1: Architecture of management system for survey and mapping databases

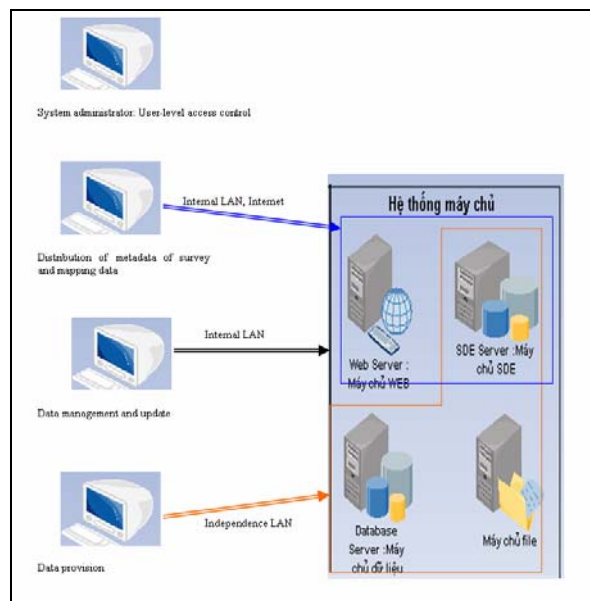


Figure 2: Model of management system of survey and mapping databases at DOSM

2.1.3 Construction of National Geographic Clearing House in Vietnam

Because in Vietnam, the framework data implementation and geo-standards setup are in its initial stages, the construction of National Geographic Clearing House is yet to be started due to the limited knowledge and budget as well as due to the non-existence of standards for its construction.

2.1.4 GIS Education

As Vietnamese scientists recognize the value of GIS and Geoinformatics for society, GIS education is in great demand at the natural sciences and technical universities (Ministry of Natural Resources and Environment, 2008).

2.1.5 Typical projects support to development in establishing NSDI in Vietnam

In 2007, a proposal for establishment of management system for survey and mapping databases, national geographical information databases base was submitted with following objectives:

- Creation of the GIS applications that based on ESRI technology
- Setup infrastructure of the system: computers, servers, other equipments
- Creation and unification of Survey and mapping databases
- Geographical information databases base: standardization and integration
- Improve human resources

In 2008 a proposal for geographical names standardization was submitted with the purpose of defining the unique use of specific geographical names which will be used in Framework data.

2.2 Brief SWOT analysis for GIS development trend in Vietnam

2.2.1 Strengths

- The leadership of Ministries, Institutes have paid attention to application of technology, and know about the necessity of applying GIS to improve the quality of their works.
- There is a certain amount of GIS applications in Vietnam, though as yet not bringing in much benefit, but they can be a premise for further researches and development of higher applications.
- Techniques for data acquisitions are improved very fast, making data retrieval in a short time with high degree of accuracy.
- National standards in geographic information have been finished for the first phase with nine standards which will be a base for the creation of framework data and data sharing.
- The problem in data integration and data sharing started to be considered.
- The GIS education has been added as a subject for students of geo-related fields at Natural Sciences Universities as well as Construction and Architecture Universities.

2.2.2 Weakness

- Lack of experts in both GIS and IT fields; Lack of equipments: LAN and WAN infrastructures are not yet fully constituted.
- Framework data in form of geodatabase is not yet finished in order to be provided for society.
- As yet there exists no policy for multi-field cooperation; Limited budget

2.2.3 Opportunities

In the era of globalization, experiences in strategies and technologies from developed countries could be learned.

2.2.4 Threats

- Changes in the use of human resources to support technological developments have faced difficulties, especially in transferring new technology to old technology specialists.
- The establishment of some systems requires not only skills in pure GIS but also knowledge in merging GIS with other technologies.
- In the situation that technologies in the world develop very fast, Vietnam might be in risk of lagging behind if does not have rapid leap as well as continuously self-motivated and creative efforts.
- Limited investment for research works.
- Not yet having efficient use of highly educated human resources: Currently, in Vietnam, there are a number of high-knowledge people who had graduated overseas but are unwilling to work in the country.

- A lot of money is needed for initiation of a GIS, sometimes the investment can hardly be accepted in the absence of experience in establishment of GI technology. Often it requires generation of economic benefits and also GIS application are not yet deemed to be a requirement by the society at large.

3 Proposed solution for the development of applied Geoinformatics in Vietnam

Policy mechanism such as close co-ordination between decision makers, educationalists, planners, managers, and IT people should be considered. From this co-ordination, the established GIS-related policies will improve the status of GIS applications. The pilot works will be useful to check the chosen solutions.

There is an urgent need in defining management mechanism that suit market economy.

The Infrastructure Environment should be improved which includes Tools for Development (Platform), Integrated Spatial DB, Standardization, and Participation of Stake Holders.

Geo-standards should be seen as important task in the development of applied Geoinformatics in Vietnam.

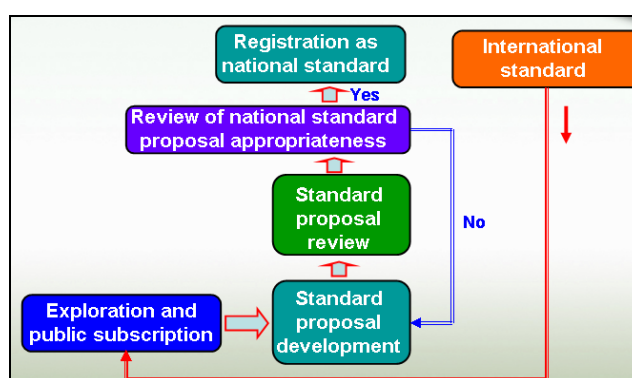


Figure 3: Proposed procedures of GIS Standard Development in Vietnam

4 Conclusion

With numerous applications in societal and environmental problems, geoinformatics is highly appreciated. Being far behind in knowledge, technology and budget in comparison with most developed countries, it is also a challenge for developing countries to efficiently apply geoinformatics to support development of the country. Vietnam also has to face this problem. This report is aimed to share the experiences of establishing a NSDI in Vietnam, which is a very important geoinformatics application in Vietnam. In the future, Vietnam has to have to make a great effort itself as well as with the support of developed and other GIS-successful developing countries to improve this work.

References

Department of Survey and Mapping Vietnam, 2007. Project Establishment of management system of survey, mapping database and national geographical information.

Ministry of Natural Resources and Environment, 2008. Instruction for use of standards for national geographical information.

Acknowledgment

I would like to use this occasion to express my thanks to the financial support from DAAD, with that I had the chance to attend MSc course in Photogrammetry and Geoinformatics at SUAS, and now again I can come back to Stuttgart to participate in the Second Summer School. I also would like to show my special gratitude to professors in the Faculty of Geomatics, Computer Science and Mathematics for the useful lectures and practices. My thanks also go to the staff of the University of Applied Sciences for coordinator and technical assistance during my study at SUAS. Thanks to the organizers of Second Summer School, their great effort makes possibility for course alumni and scientists having a chance to meet and share experiences in the field of applied Geoinformatics on the special occasion of the course 10th anniversary.

MONITORING AND MAPPING OF MINING AND EXPLORATION LICENSES FOR MONGOLIA

Jamsranjav Munkhbileg

Denison Mines Mongolia LLC, St-Olympia-8, Shuren Bldg, Ulaanbaatar-13, Mongolia
jamsranjav@denisonmines.com

KEYWORDS:

Thematic map, GIS database, exploration, mining, license, Mongolia, ArcGIS 9.3

ABSTRACT

One of the responsibilities of the company “Denison Mines Mongolia” is to process exploration and mining licenses data for Mongolia and report to “Denison Mines” company six times per year.

Data on exploration and mining licenses and on boundaries of state protected and special public needs areas which are restricted and prohibited by an authorized government entities are distributed every month by the Geological and Mining Cadastre Department of Mineral Resources and Petroleum Authority of Mongolia (MRPAM). Boundary data are stored in ESRI shape file format and other attributive data are stored in a MS Access database.

A GIS database is created with ArcGIS 9.3 using the above mentioned data. Thematic maps and statistic reports of licensed areas are produced and analyzed every two months for further use of the Denison Mines company's business purposes.

By the use of the database, the company is able to know which company, where, and what kind of licenses they get or they have to return. It is important for our company to monitor license information for the future work and for the developing business plans.

1 Introduction

1.1 Overview

Mining and exploration license monitoring is a preliminary task of a business company and corporation working in that field. For expanding their business, the companies have to know the trend of other companies' licenses situation in the same field of work.

Denison Mines Corporation is a diversified, growth-oriented, intermediate uranium producer with six active uranium mines in North America (five in the U.S. and one in Canada). In Mongolia, Denison owns a 70% interest and is the Managing Director in the Gurvan Saihan Joint Venture (GSJV).² Denison Mines Corporation needs mining and exploration license monitoring maps and reports in English language but the source data are in Mongolian. Therefore Denison Mines Mongolia LLC is involved. License data are obtained from the Geological and Mining Cadastre Department of the Geological and Mining Cadastre Department of Mineral Resources and Petroleum Authority of Mongolia MRPAM every two months. This institution is responsible for

- monitoring activities related to exploration and mining licenses,
- providing the public access to the processes of issuing and reissuing of licenses, license revocation, transfer, pledge and surrender of for the entire or a part of the licensed area;

¹<http://www.denisonmines.com/SiteResources/ViewContent.asp?DocID=3&vIID=&RevID=392&lang=1>

- receiving, registering and making decisions with respect to applications for licenses;
- maintaining the registry of licenses;
- maintaining the cartographic registry of licenses;
- issuing exploration and mining licenses;
- collecting service and license fees including official translations
- resolving boundary disputes between and among license holders;
- providing interested persons with access to the registry and the cartographic registry of licenses and to notify relevant government agencies as well as the public about any changes made in the registry

Study area

Mongolia is the nineteenth largest and the most sparsely populated independent country in the world, with a population of around 2.9 million people. It is also the world's second-largest landlocked country after Kazakhstan.³ Mongolia's vast territory has a great potential to have rich mineral deposits including gold, copper, coal, fluorspar, silver, and uranium. Mongolia produces gold, copper, coal, fluorspar, zinc, iron ore, tungsten, and the most of produced copper concentrate, molybdenum, coal and zinc are exported to China, fluorspar to Russia, the United States, Ukraine, and gold to Canada, the United States, United Kingdom, and China.



Figure 1: Major Operating Mines and Mineral Deposits in Mongolia

Companies and corporations involved in mining and exploration business are making substantial contributions to the Mongolian economy by paying over 20 types of taxes, fees and charges to the state and local budgets. For example in the figure 2 is shown for last year's fees which were paid to the state budget as exploration and operation fees.

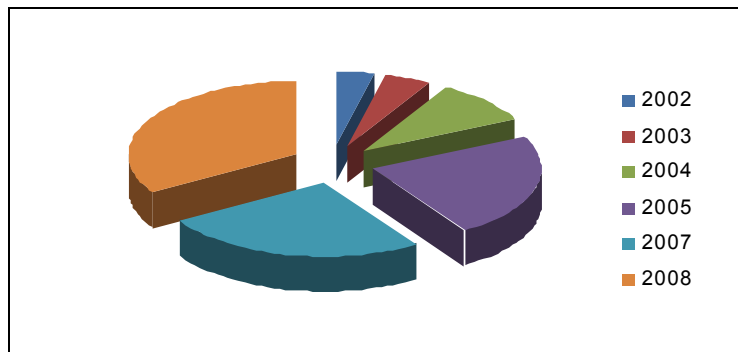


Figure 2: Exploration and operation fees for 2002-2008

^{**}<http://en.wikipedia.org/wiki/Mongolia>

As last four months of 2009, 12.4 billions Tg was accounted to the state budget revenue and it is 51% of the total state budget revenue.

2 License database

2.1 Data organization

The original sources of georeferenced data are existed in various formats, and at different map projections. The exploration and mining license data contain license number, holder name, type of licenses either exploration or mining, date of issuing licenses and valid period, coordinates of boundary points of the licensed areas and their size in hectares. They have been integrated in ArcGIS using the Asia North Lambert Conformal Conic projection. The integrated data currently is available in a local database. It consists of two datasets which are called base and title data. The base dataset consists of administrative boundaries of Mongolia and its provinces, main roads, railways as well as hydrology information. The title dataset contains application, mining and exploration license data, which are obtained from the Geological and Mining Cadastre Department of MRPAM. The data are collected in several months from 2005 and 2009 in the database. With the database it is possible to input data and to produce reports and maps to monitor movement of the various licenses and information about new license etc.

2.2 Analyses

The license data is analyzed and produced as thematic maps that show the most recent status of uranium licenses in Mongolia for the Denison Mines company use. An example of such a thematic map is shown in the Figure 3.

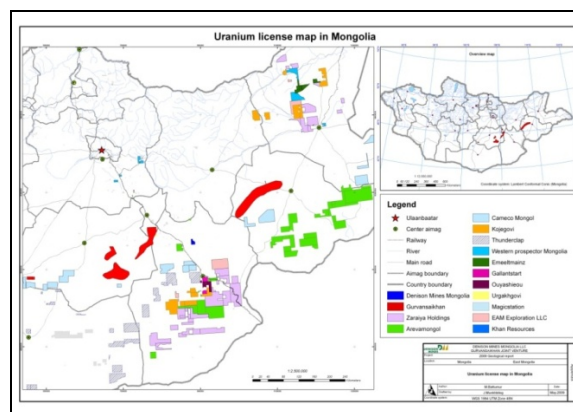


Figure 3: Uranium license map in Mongolia as of May 2009

Two examples of analyses results are shown in the Figure 4-5 and Table 1.

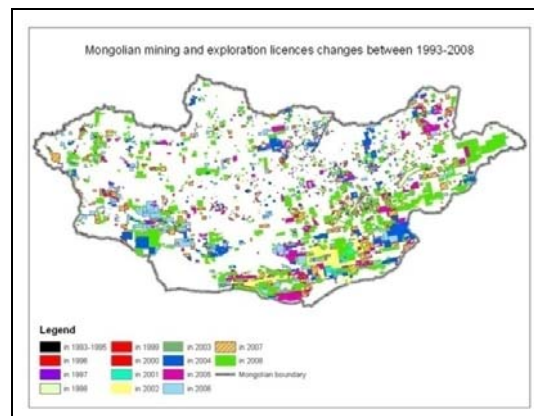


Figure 4: Map of Mongolian mining and exploration licenses for 1993-2008

Years	Area (km ²)
1993-1995	143.53
1996	160.4
1997	158.39
1998	6846.59
1999	108.36
2000	283.12
2001	7919.15
2002	36959.02
2003	11260.51
2004	58951.25
2005	52155.33
2006	63190.03
2007	60600.97
2008	145637.77

Table 1: The area of mining and exploration licenses for 1993-2008

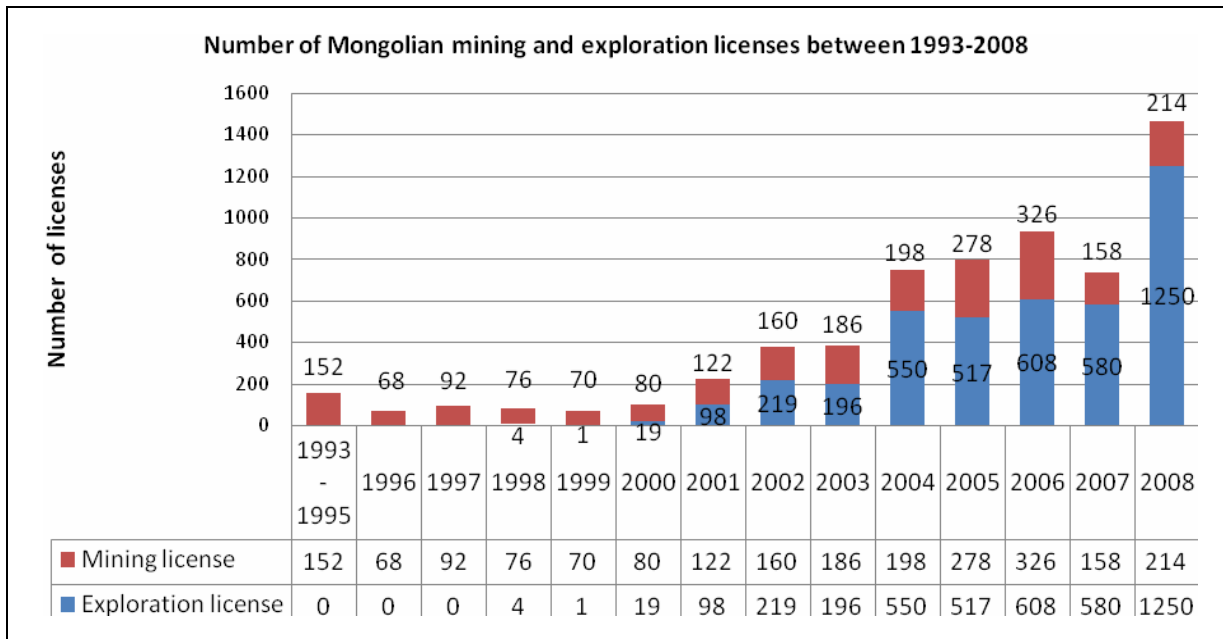


Figure 5: Comparisons of mining and exploration license numbers for 1993-2008

It is clear, from the graph that exploration licenses are growing faster than mining licenses starting from the year of 2000.

The exploration investment has played a main role for the economic growth, which is averaged over 7 percent per annum for the last 5-6 years. This is because local and foreign investors have been more interested in Mongolian mineral resources when Mongolia has started to transfer to the market economy.

As in May of 2009, the exploration and mining licenses cover 27% or 42.27 million hectares of the total land in Mongolia and from them 41.9 million hectares belong to the exploration licenses.

From the 5126 mining and exploration licenses that have been valid on May 4, 2009, 1102 (21.5%) are for mining and the remaining 4024 are for exploration.

3 Conclusion

Thematic maps and statistic reports do satisfy the basic needs in term of access, availability, dissemination, visualization and simple exploration of the available license data on the local database. Also, the obtained license data have the possibility to do different analyses by type of license, license revocation, transfer, number of licenses in administrative units, etc.

In the future GIS database has to be expanded and to be moved to web based technology. A web-based database will be useful for accessing of requested license information, viewing and downloading maps and reports by different staffs from anywhere, anytime with internet connection.

References

- Denison Mines Company., 2008 <http://www.denisonmines.com/SiteResources/ViewContent.asp?DocID=3&vIID=&RevID=392&lang=1> [accessed 03Apr. 2009]
- Mongolian Mineral Resources Authority ., 2008 . The minerals law of Mongolia . http://mram.gov.mn/en/-index.php?option=com_content&task=blogcategory&id=13&Itemid=34 [accessed 26 March 2009]
- Mongolian National Mining Association ., 2009 . About the sector . http://www.miningmongolia.mn/en/-index.php?option=com_content&task=view&id=20&Itemid=38 [accessed 12 Apr. 2009]
- The world bank ., 2006 . A review of Environmental and Social Impacts in the Mining Sector . <http://siteresources.worldbank.org/INTMONGOLIA/Resources/Mongolia-Mining.pdf> [accessed 7 Apr. 2009]
- Wikipedia ., 2009 . Mongolia . <http://en.wikipedia.org/wiki/Mongolia> [accessed 15.Apr. 2009]

NATIONWIDE SPATIAL BASE DATA ACQUISITION AND PROVISION IMPLEMENTATION PROCESS IN DEVELOPING COUNTRIES UNDER THE ASPECT OF DATA ACTUALITY AND QUALITY

Claudia Specht-Mohl

Consultancy, Project Management, Institutional Capacity Building, Research,
Kartoffelweg 13, D-70599 Stuttgart, Germany
claudia.specht-mohl@t-online.de

KEYWORDS:

National Spatial Base Data, Digital Mapping, Topographic Data, Cadastral Data, NSDI, Spatial Information, Data Actuality, Data Quality, Developing Countries

ABSTRACT

Actual and reliable Spatial Information is indispensable for planning and decision making processes in the context of sustainable development and poverty reduction in developing countries. The implementation process of National Spatial Data Infrastructure (NSDI) has been initiated in many countries. This very complex process is not only a technical but also a political and organisational challenge. All involved governmental agencies and organisations are traditionally used to acquire and maintain spatial data independently and often parallel.

Communication and interdisciplinary cooperation between agencies will play an important role and institutional restructuring will be necessary. Consequently the establishment of an NSDI in developing countries will be a long term process over years. On the other hand nationwide Spatial Base Data are urgently needed in state organisations, municipalities and others. These data consist of basic reference information, e.g. high resolution spatial imagery, large scale topographic and cadastral information as well. Herewith the relevant institutions can develop thematic spatial data sets for their own special fields.

Generally, the responsibility for the acquisition, provision and maintenance of Spatial Base Data are in the hand of Geodetic Authorities or other mapping agencies. This paper shows conditions and possible stepwise and iterative approaches in order to accelerate the acquirement and in-time dissemination of reliable Spatial Base Data.

DEVELOPMENT OF A GIS APPLICATION IN PURPOSE OF LAND VALUATION AND FEE COLLECTION IN MONGOLIA

EXTENDED ABSTRACT

Altantsetseg Purevsuren

GIS and Cadastral officer,
GTZ – “Land management and Fiscal cadastre” project in Mongolia
paltantsetseg@yahoo.com

KEYWORDS:

Geodatabase, land fee, land valuation, WebGIS

1 INTRODUCTION

According to the new constitution concept the Government of Mongolia has raised the issue of “Land Reform” as one of leading objectives and it is giving a great significance to land privatization, creation of a legal framework for effective land tenure as well as putting land into economic processes. Moreover, to achieve the objective it is important that the state ensures titles to land and real property, registers titles in the property register (legal cadastre), makes valuation of land and real property, imposes and collects taxes and fees based on correct assessment (fiscal cadastre) and maintains proper land management (land use cadastre) in order to increase economic benefits of the efficient use of land. In initial stages of the Governmental policy on Land Reform a basic Cadastral system, cadastral mapping and land registration, has been established in Mongolia.

Taxes and fees imposed on land and real property are one of the reliable incomes that comprises State and Local budgets. The amount of the tax and the fees to be paid depends on the value of land and real property. But assessment of the value requires much data about the property, which should be added to the basic data of the cadastral system. Not only the size and location of the real estate, soil quality, improvements and their construction costs needs to be maintained, but also its relationship to public utilities and infrastructure, future business perspectives and possible land use are prime factors which influence the value of the property.

Information and communication technology (ICT) have been developing rapidly. Accordingly, the importance of engaging ICT as a key tool for development in all social and economic sectors is getting much higher in worldwide. Especially, Geoinformation technology is broadly used in the fields such as Land Administration sector which deals with a lot of spatial data. Recognizing the advantage of using Geoinformation technology in its activities, Administration of Land Affairs, Geodesy and Cartography (ALAGaC) has realized that an establishment of computerized and transparent services could decrease bureaucracy in land sector and provide easy and fast services to the public. Therefore ALAGaC aims to develop such computerized systems which help them to do their work in an automated way.

With this presentation, an introduction to the development of a GIS application called LandManager, which facilitates land officers’ daily work in respect of land valuation and land fee collection, is given.

2 German Contribution towards the Development of a Fiscal cadastre in Mongolia

2.1 “Land management and Fiscal cadastre” project

“Land management and Fiscal cadastre in Mongolia” project has started its activities since 2005. This project is implemented in cooperation with ALAGaC and financed by German Federal Ministry for Economic Cooperation and Development (BMZ). For the past several years, the project has supported land management and valuation of real estate initiatives in Mongolia. One of the main objectives of the project is to establish and develop a proper valuation system assessing the property value according to the market prices which leads to a more

reliable and fair land fee and tax collection. In order to achieve this goal and also in accordance with the wishes of partner organization, ALAGaC, the project is aiming to develop “LandManager” application.

2.2 LandManager application

This application consists of the following components:

- Geodatabase
- WebGIS / WMS
- LandManager program itself

A geodatabase has been created according to a datamodel developed by the project in order to store basic cadastral data and additional information necessary for valuation and land fee collection. PostgreSQL with PostGIS extension, one of the most popular Open Source SQL database management systems, is used for implementing the database model, storing the data and acting as Datasets server.

Purpose of a WebGIS is to make some of the information stored in the geodatabase accessible through the network to the officers. It shows the same and the latest information to everyone and has some standard GIS tools: zooming, panning, measuring, identifying and printing and so on. In addition, there are several options for searching objects such as: parcels by parcel id, address, owner’s name etc. UMN MapServer, an open source map server, is used for publishing the maps on the browser. A web application development tool called pmapper is used for creating the web client application, which is compound of graphical user interfaces.

LandManager program itself is a GIS based application written in C# programming language. It has 4 main modules called Administration, Cadastre, Valuation and Landfee. Each module has different functions. For example: Administration module has functions to configure settings, to create and manage user accounts and to authenticate users while Cadastre module has functions to import new parcel information into the database and to generate new property ID in case of any cadastral updating.

More explanation is given in the presentation showing some examples which demonstrate the application performance and how the components work together.

3 Facing Obstacles

Each new activity or development faces some obstacles. As same with this, the project faces the following obstacles during its activities to develop the application:

- Legal framework for cadastral issues is incomplete
- Quality of existing cadastral data is unreliable in terms of content and topology
- Existing cadastral data does not cover the whole territory of the country
- Lack of enough support and understanding with the partner organization
- No data exchange between cadastre and land registry
- Cadastral updating is not done for all cadastral changes

GETTING RETURNS ON INVESTMENT ON DIGITAL GEOSPATIAL DATA

Hardy Lehmkuhler

Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
hardy.lehmkuehler@hft-stuttgart.de

KEYWORDS:

Geodata, SDI, Return on investment, ROI, OGC

ABSTRACT

This contribution addresses the economies of Digital Geospatial Data (here: Geodata) and the chances for their economic return on investment. Such points help us to explain and justify expenses for photogrammetry and Geoinformatics as investigation tools for questions in society and Environment. Furthermore, the price of geodata will influence chances of any future technologies and determine opportunities for professional careers.

Brought to digital formats Geodata can be distributed like any other digital data. The technical means are given by web technologies, e.g. data distribution or conversion, or the services palette of the Open Geospatial Consortium (OGC). Such services can be realized by institutions as Spatial Data Infrastructures (SDIs) that also comprise organizational aspects. In addition such infrastructures allow us to register and record the quantity as well as other properties of the transported data. Therefore it is possible to calculate a differentiated price and charge payment for it.

We can identify two situations when the price of Geodata is important for GIS professionals:

When we want to offer services that use our own or foreign Geodata data either free or non-free.

When we are responsible for a free-of charge data products and have to justify its costs.

Examples show countries/governments that provide free access to any geospatial data that is produced in their responsibility. Others charge a price determined from expenses. In contrast, potential users decide for products by evaluating their usability and estimating their economical benefit. In addition more and more data providers get competitors and even free data is available for certain purposes.

Besides providing pure data providers also want to use and uplift the quality of basic Geodata. When several serves of that kind are chained questions arise how the final price can be distributed among the unintended "partners".

SPATIAL-TEMPORAL MODELLING IN PROJECTS MONITORING AND EVALUATION

Laura Nibladze

Monitoring and Evaluation Unit, Millennium Challenge Georgia Fund (MCG),
Bambis Rigi str 7, 0105 Tbilisi, Georgia
Department of Statistics, Ministry of Economic Development of Georgia,
Pekini ave 4, 0115 Tbilisi, Georgia
l.nibladze@mcg.ge

KEY WORDS:

GIS, Spatial-Temporal Model, Time Series, Spatial Analysis, Project Performance Monitoring, Project Impact Evaluation, International Donor Organizations

ABSTRACT

The Monitoring and Evaluation (M&E) Unit of the Millennium Challenge Georgia Fund (MCG) in collaboration with the Georgia Department of Statistics (DS) are performing the monitoring and evaluation activities of Millennium Challenge Georgia (MCG) Program.

Over many years various projects in Georgia financed by international donor organizations have produced large GIS datasets. One example is the Cadastre and Land Register Project co-financed by KfW (KfW Bankengruppe is a promotional bank owned by German Government). The mentioned project has created the cadastre databases for 55 municipalities and has integrated the datasets produced by other cadastre projects into seamless environment, totally covering 65% of the territory of Georgia, excluding only the high mountain areas and separated territories.

GIS is one of the key technologies utilized by M&E Unit. For this reason, MCG have obtained the aforesaid geo-data from the ministries of Georgian government and have been adopted them for own purposes.

Alongside various powerful GIS functionalities that are used in the monitoring and evaluation processes such as Spatial Analysis, Data Visualization, etc., the Spatial-Temporal Model is in the creation process to visualize the M&E Indicators changing progress. The paper describes the concept of model from various sides – the scenario, the data sources, the system design approaches, etc. Besides, it discusses the challenges and benefits of its development and implementation.

1 Introduction

The purpose of this paper is to introduce the GIS works done in the Millennium Challenge Georgia Fund (MCG) from its program monitoring and evaluation processes point of view. Specifically, the paper describes the role of GIS and Spatial Analysis in these processes. And as an example more details about the MCG M&E Spatial-Temporal Model are given.

In chapter 2 the author gives the description of the MCG Program and Monitoring and Evaluation activities. The next chapter is completely dedicated to the MCG M&E Spatial-Temporal Model, covering the idea of scenario, the data sources, and the system design concept. The chapter 4 discusses the benefits and challenges of Spatial-Temporal Model development and implementation. Finally, the last chapter makes a resume of the whole paper.

Important note: For information confidentiality, the values from which the maps presented in this paper and in the presentation were produced are not real. The maps have only demonstrative purposes for delivering a better visual understanding of the topic discussed.

the MCG Program intervention goal. The indicators and their predicted values become a foundation for the development of MCG Monitoring and Evaluation Plan (PMEP) – the essential document of M&E activities in MCG (MCG 2009).

For the monitoring purposes the Millennium Monitoring Information System (MilMIS) was developed. For the evaluation activities, MCG in close collaboration with Georgia Department of Statistics (DS) is responsible for baseline and follow-up data gathering statistical surveys design for project activities. Besides, it employs the most rigorous analytical methodologies that will deliver the Program impact evaluation results to the end of MCG Compact year.

GIS is one of the key technologies that MCG M&E utilizes. For this reason, MCG has obtained the geo-data produced by projects financed by international donor organizations from the ministries of Georgian government and has been adopted them for its own purposes (see the details in the Data Sources section of next chapter below).

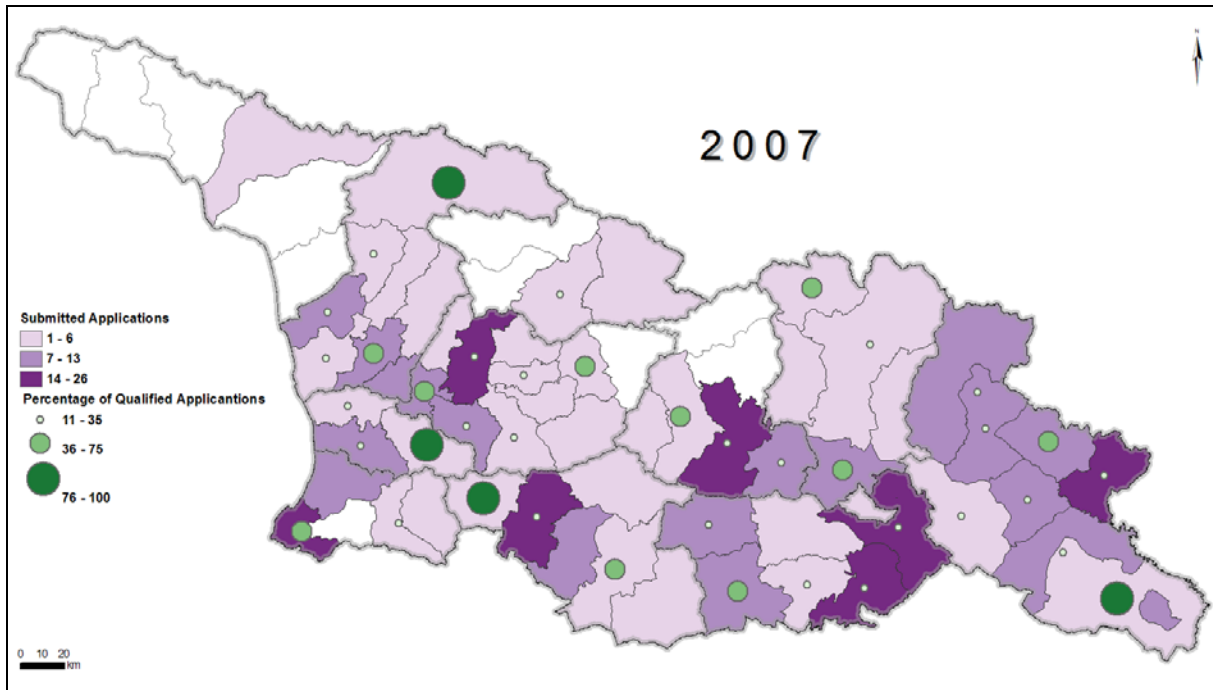


Figure 2: Example of the spatial analysis results of the Agribusiness Development Project outreach sessions

Examples of the GIS works in the MCG are named in the following list:

- MCG impact evaluation – Agribusiness Development Project and Samtskhe-Javakheti Road Rehabilitation Project (Figure 1);
- Creation of Common GIS Environment (more details in the subsection 3.4.2 of next chapter);
- Creation of geo-databases for all five MCG activities as well as MCG Program;
- Spatial analysis of the Agribusiness Development Project outreach sessions and their results for year 2006 and 2007 (Figure 2);
- Definition of standards for MCG and DS GIS activities (is in process);
- On-going mapping and data visualization in everyday MCG and M&E live;
- Merge of MilMIS and GIS – development of MCG M&E Spatial-Temporal Model (still in process).

Further, the paper will be focused on the last one.

2.1.1 M&E Indicators

The PMEP integral part is the M&E Indicators sheet representing the measurable values of MCG Program performance monitoring and its impact evaluation. The indicators are divided on four different hierarchical levels – Program Goal, Projects Objective, Activity Outcome, and Activity/Progress.

The highest level indicators are the Goal indicators, whereas the lowest are – the Activity/Progress ones. The M&E Indicators with total number of 77 represent with high degree of precision every stage of the MCG Program and its Projects progress. They cover all important stages of the MCG Program starting from overall program goal, depicting objectives of two projects, and giving outcomes and indicating the detailed

achievements of each activity. The indicators distribution according to the above-named levels is provided in the summary table below (see Table 1).

Name	Compact Goal	Projects Objective	Activity Outcome	Activity Progress
<i>MCG Program</i>	3			
<i>Infrastructure Project</i>		1		
SJRR Project			4	3
RID Project			3	13
Energy Project (all phases)			1	16
<i>Enterprise Project</i>		2		
ADA Project			4	11
GRDF Project			5	10

Table 1: Summary of MCG M&E Indicators and their distribution according to hierarchical levels

Each M&E Indicator has a baseline, i.e. initial value and the target value or by other words the value that is expected or planned to be achieved at the specific time periods. The difference between the value defined for current or every particular timeframe, i.e. month, quarter, year, end of the activity and the baseline value denotes the progress of indicator, whereas the difference between the same and target values signifies any backlog or delay (see Figure 3). Further details can be found in M&E Plan in (MCG 2009).

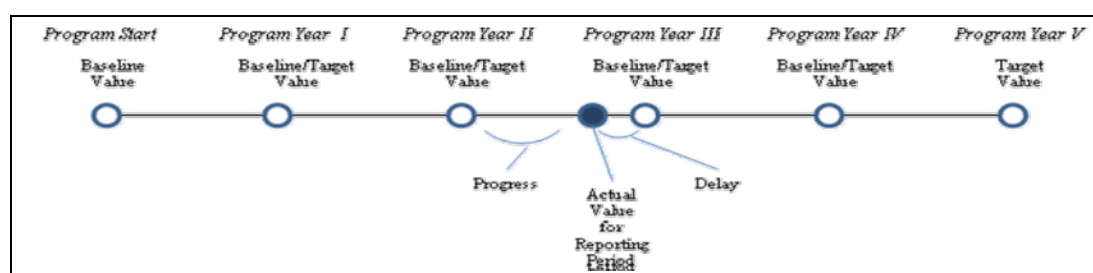


Figure 3: Simplified schema of M&E Indicator live time

In order to keep track of all M&E Indicator’s progress, as well as possible delays or backlogs, in MCG the Millennium Monitoring Information System (MilMIS) was developed (more details about MilMIS see in the section 3.3 below).

3 MCG M&E Spatial-Temporal Model

3.1 Spatial-Temporal Scenario for Modelling

The M&E Indicators are the values collected regularly over a certain period of time, having baseline and target values. Besides, many indicators represent cumulative values that either can be disaggregated on specific geographical areas, i.e. administrative units of Georgia or represent particular objects located on specific geographical and therefore can be depicted on the map.

From the GIS and mapping point of view, each indicator or very small groups of them should be worked out individually. In order to simplify the understanding of the methodology, an example of one particular group of indicators related to the household savings or income increase, i.e. direct benefits of families from MCG Program intervention will be taken.

Specifically, one of the Compact Goal level indicators is *Household Benefits Generated from Program Interventions* that represents the “Aggregate cumulative household savings derived from RID and S-J Road Rehabilitation and household net incomes derived from ADA and GRDF” (MCG Program and Monitoring Plan, Appendix II, see References). As clearly seen from the definition, the indicator is a cumulative value calculated

from the lower level indicators. Each Project contains the indicator related to the household savings and similarly each Activity contains one or more indicators that contain the value for upper level indicators. In the Baselines and Targets (MCG Program and Monitoring Plan, Appendix III, see References) for all indicators are identified the baselines and the targets that should be achieved at the end of each Compact year. Noteworthy, for this particular group of indicators the baseline value is defined as 0. This is related to the monetary improvement of financial conditions of ordinary citizens and their families that will be achieved as already told as a result of MCG Program intervention.

As already mentioned, the indicators have tendency to have different values over time allowing creation of time series and is considered to be a temporal aspect for the Spatial-Temporal Model.

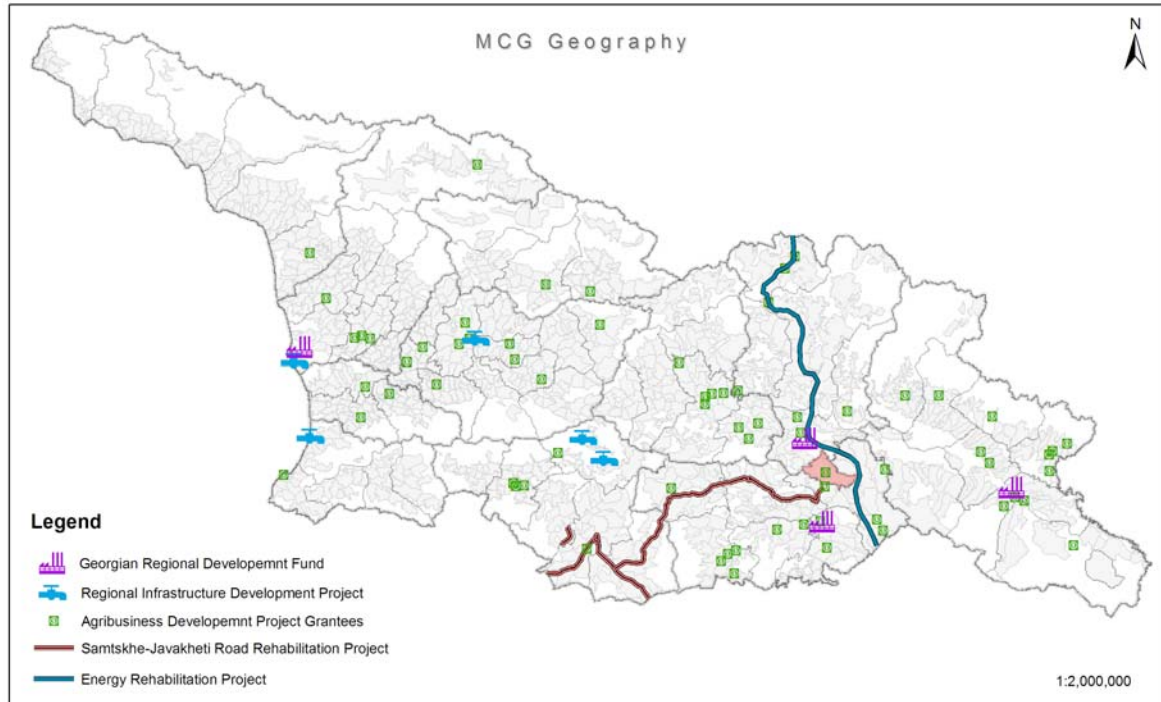


Figure 4: Schematic drawing representing the MCG Program’s geographical dispersion

3.1.1 MCG Program Geography

The Figure 4 above illustrates how the MCG Program activities are spread on the territory of Georgia. It is clearly seen that the MCG covers the whole country excluding the separated regions. This indicated that many M&E Indicators can be illustrated on the map. On the example of the Household Benefits indicators category, they can be related to the administrative units of Georgia; thus, can be visualized via choropleth maps. This assures the existence of spatial aspect for the Spatial-Temporal Model.

3.2 Data Sources

MCG is regularly acquiring data from various sources, there are described in following subsections.

3.2.1 Geographical Databases and Data Sets

As already mentioned, MCG has acquired the geo-data produced by international projects from the ministries of Georgian government and have been adopted them for own purposes. The description of the geo-data, which is now on MCG disposal, is given in the following.

Over many years various projects in Georgia financed by international donor organizations have produced large GIS datasets. For example the Cadastre and Land Register Project co-financed by KfW⁵ had a total budget of

⁵ KfW Bankengruppe is a promotional bank owned by German Government that is oriented on economic, social, and ecological development worldwide (KfW Bankengruppe 2009).

30,000,000 DEM6 plus 5,000,000 USD. The mentioned project has created the cadastre databases for 55 municipalities and has integrated into seamless environment the datasets produced by other cadastre projects, totally covering 65% of the territory of Georgia, excluding the high mountain areas and separated territories. Alongside the cadastre related information, the KfW project produced precise orthophotos covering the project area and the topographic GIS datasets. The complete set of these geo-databases was acquired from the National Agency of Public Registry.

In the frame of the same KfW project the SoilGIS geo-databases and various thematic geo-data sets such as precipitation, relief, hydrology, etc. were produced. These data were obtained from the Ministry of Agriculture. In the SoilGIS databases the following data are stored: the information about soil fertility in Georgia, the results of new complex field surveys and laboratory analysis, etc. Besides, in the mentioned databases is safeguarded the archive of the soil information gathered over twenty years in Georgia. Fortunately, the author was participating on this project and had developed all the databases and geo-databases, as well as several applications to them.

Ministry of Health has provided the geo-databases produced in the Primary Health Care project of World Bank (WB), containing among valuable information about the location of the Hospitals and other health care centres, conditions, potential, distances between the centres and towns or villages, etc.

Finally, the Ministry of Environment Protection and Natural Resources supplied MCG with the results of several projects. MCG has received the GIS suitable versions of the Topographical Map of Georgia in the scale 1:250000 and the Administrative Map of Georgia in the scale 1:500000.

3.2.2 Millennium Monitoring Information System (MilMIS)

The Millennium Monitoring Information System (MilMIS) was developed in MCG in order to collect the M&E Indicators from all involved sources on regular basis, to generate the reports at every predefined time – quarterly, monthly, and annually.

The goal of MilMIS is to assist MCG and its M&E Unit in the projects performance monitoring processes, to gather the actual values of the indicators at the specific period of time, to store the supplied data in the SQL database and to provide the weekly, monthly, quarterly, or annual reports, depending on the pre-defined conditions. The system interface considers several functionalities, such as data entering, data viewing, and exporting to other formats. The semi-automatic reporting system is an essential part of MilMIS.

3.2.3 Data from other Sources

Besides the above described major data sources, MCG M&E Unit receives regularly the data sets and databases in various formats from different sources:

- *Statistical Data:* Under MCG finances several contractors conduct statistical surveys, which are valuable sources of the information for the M&E Indicators:
 - Village Infrastructure Census and Integrated Household Survey are conducted by the Department of Statistics; in the Household Survey databases the historical data since 1996 are kept, which can be considered as a good source for time series and spatial-temporal modelling;
 - Additional surveys are conducted by other MCG contractor companies; these are:
 - Origin-Destination and Traffic Count Survey;
 - Settlements Infrastructure Survey;
 - ADA Beneficiary Survey;
- *Data from Road Department:* MCG is getting the data from the Road Department. These are GIS data sets and databases from HDM-4 – the software created for the economic calculations of road projects;
- *Data from MCG Activity Implementing Units:* The data sets and databases covering progress of five MCG Activities are supplied on regular basis by the Activity Implementing Units, which are the companies contracted by MCG.

⁶ German Marks

3.3 Tentative System Design of the Spatial-Temporal Model

The system design of the Spatial-Temporal Model is still in development. However, it will represent the series of interactive maps, each illustrating one or a small group of M&E Indicators (see Figure 3).

- ❶ – *MilMIS Database* is an enterprise database in the SQL Server format, where are gathered the M&E Indicators values at specific time; in addition, all historical values are stored;
- ❷ – *MCG Program Activities* data are the data that regularly come from the Activity Implementing Units via virtual private network (VPN) connection and are stored in the MilMIS database;
- ❸ – *Queries* are once defined standard queries allowing the linkage to the geodatabase, i.e. the database in the GIS readable format; the queries represent MilMIS database certain selection of the records participating in the maps creation;
- ❹ – *Geo-Located Data* are the coordinated symbolic location of the objects assigned to the M&E Indicators, these can be a road, pipeline, farm, enterprise, or region, municipality, settlements etc.;
- ❺ – *GIS Geodatabase* represents the database where the geo-located data are stored along with the additional descriptive information, so-called attributes; the descriptive information can be also linked from MilMIS database;
- ❻ – *Maps* are interactive maps divided on two major categories:
 - o Interactive mapping background in three different automatically switching modes, where the level of details changes according to the scale – cadastre map mode, when the scale is larger than 1:100,000; topographic map mode, when the scale is between 1:100, 000 and 1:600,000; and administrative map mode, when the scale is less than 1:600,000. The mapping background can be dynamically depicted on the screen, i.e. zooming in and out, panning, etc. (Figures 5 and 6).
 - o The series of overlay layers each illustrating one or a small group of M&E Indicators for a different time frame;

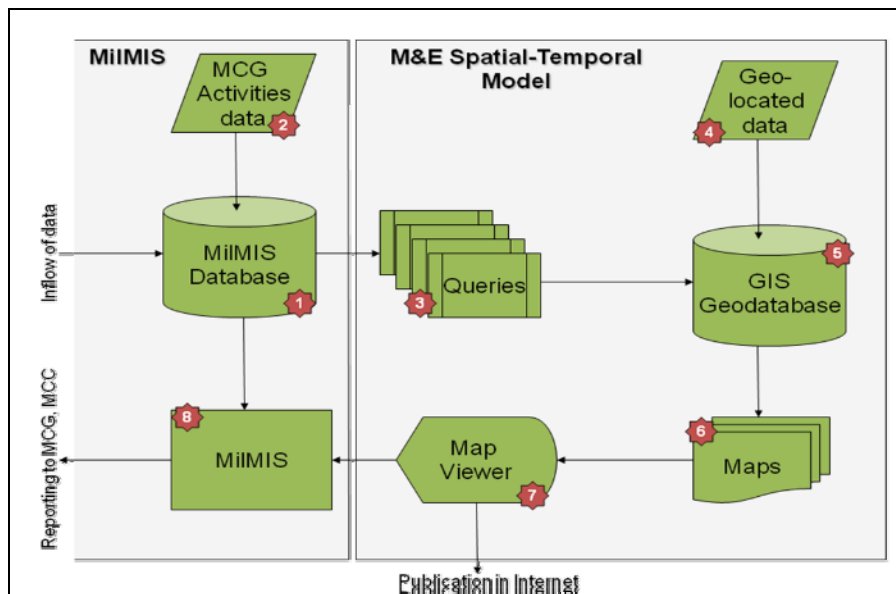


Figure 4: System Design of the MCG M&E Spatial-Temporal Model

- ❷ – *Map Viewer* is a stand-alone application intending to show in the interactive manner the maps; the interactive maps are dynamically embedded into the Map Viewer application and allow any user to interact with and to decide himself or herself what level of details to see; the Map Viewer will be designed such way being used both in the MilMIS environment for restricted access showing complete information and in the Internet browser environment for publishing showing the information reduced to selected indicators;
- ❸ – *MilMIS* is an interface of the Monitoring Information System (MilMIS), in which along with the other functionality the Map Viewer will be embedded allowing viewing the maps or using them in the reports production.

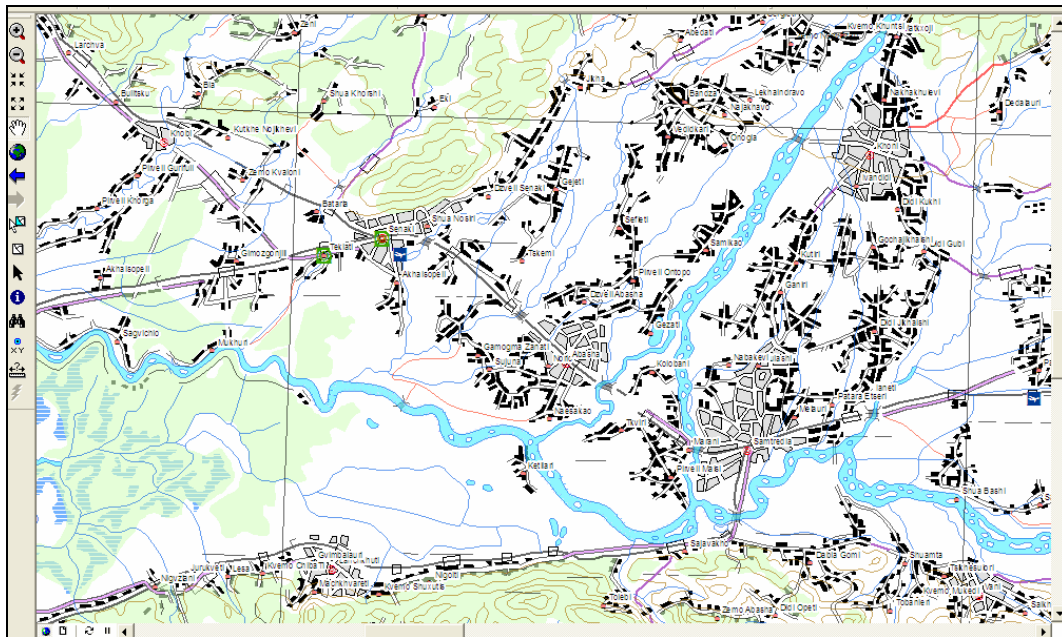


Figure 5: Sample showing the screen view in topographic map mode with two Agribusiness Development Project grantees (green rectangles)

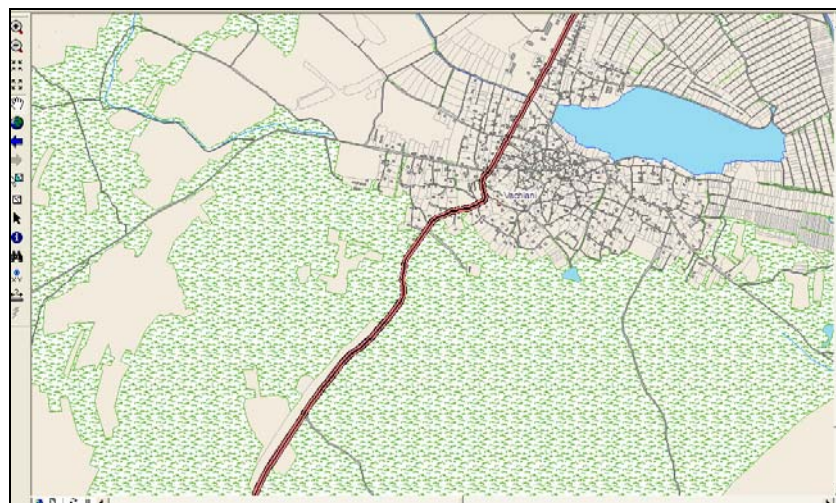


Figure 6: Sample showing the screen view in cadastre map mode with the fragment of Samtskhe-Javakheti Road

4 Benefits and Challenges

The following benefits and advantages can be named for the described MCG M&E Spatial-Temporal Model:

- Excellent source of information for the MCG Program management and Government of Georgia;
- The maps will significantly improve the perception of valuable information;
- The use of an alternative communication way in the crucial information delivery to readers assures that this information will be more understandable;
- Utilizing diversified methods of the same information delivery assures that the information will be much better comprehensible;
- Provide any person with different background, education, social status, traditions with the source of most intuitively, naturally perceptive way of communicating the information;
- Reduce uncertainty and doubts in the validity of the supplied information;
- Make publicly available in the Internet the MCG Program progress monitoring information;
- The successful implementation of the proposed development can be a case study for further implementation of such kind of systems in the monitoring processes of other projects.

The challenges met are mostly technically related:

- Lack of standards for GIS and IT, which is common problem in Georgia;
- High dispersion of the data sets and databases formats that requires individual handling and specific considerations in the system design and administration

5 Conclusion

Overall, the described MCG M&E Spatial-Temporal Model will be a very effective tool; it is an innovative and universal approach in the projects monitoring and evaluation, and can be implemented in different projects.

References

- KfW Bankengruppe, 2009. http://www.kfw.de/EN_Home/KfW_Bankengruppe/index.jsp [accessed May 10, 2009]
- Millennium Challenge Georgia Fund (MCG), 2009. <http://www.mcg.ge/> [accessed May 10, 2009]
- Millennium Challenge Georgia Fund (MCG), 2008. MCG Program Monitoring and Evaluation Plan. <http://www.mcg.ge/?l=1&i=317>, http://www.mcg.ge/data/file_db/Monitoring/Approved_PMEP-Eng-09-05-08_6fPRfV-w.EO.pdf [accessed May 10, 2009]
- Ministry of Foreign Affairs of Georgia, 2009. War Timeline. http://www.mfa.gov.ge/index.php?lang_id=ENG&sec_id=556 [accessed May 10, 2009]
- Ministry of Labour, Health and Social Affairs of Georgia, 2009. <http://moh.gov.ge/> [Accessed May 10, 2009]
- Ministry of Environmental Protection and Natural Resources (MOE), 2009. Maps. <http://www.garemo.itdc.ge/-index.php?site-id=9> [Accessed May 10, 2009]
- National Agency of Public Registry (NAPR), 2009. <http://www.napr.gov.ge/?lng=eng> [Accessed May 10, 2009]
- Road Department of Georgia, 2009. http://www.georoad.ge/index.php?section=1&lang_id=ENG [Accessed May 10, 2009]
- Shatirishvili M., 2007. Spatial Analysis Applications in Georgia. Edited by 56th International Statistical Institute, Lisbon, Portugal.
- Shatirishvili M. & Nibladze L. 2008. GIS and Spatial Analysis Usage for MCG Monitoring and Management. Unpublished MCG Internal Presentation. Tbilisi, Georgia
- Shatirishvili M. & Nibladze L. 2008. GIS and Spatial Analysis Usage for MCG Program Evaluation. Unpublished MCG Internal Presentation. Tbilisi, Georgia.
- Statistics Georgia (Official site of the Georgia Department of Statistics), 2009. <http://www.statistics.ge/index.php?plang=1> [accessed May 10, 2009]
- World Bank (WB), 2009. Georgia: Primary Health Care Development Project. <http://go.worldbank.org/IS65VN7EF0> [Accessed May 10, 2009]

Acknowledgements

The author would like to give her deep gratitude to the MCG and M&E staff that is always ready to assist and represent a very good example of a well-organized team. Specifically, she expresses appreciation to Mamuka Shatirishvili, M&E Director. Without his constant support and open minded attitude this work will never be done. Many ideas discussed on the pages of current paper came from the discussions between him and the author.

And finally, the author thanks SUAS professors and AGSE Administration Committee for the provided financial support from DAAD funding that allowed attending the AGSE 2009 Summer School and Conference and making this publication happen.

IMPLEMENTATION OF E-CADASTRE IN MALAYSIA

Latib Mohd Rozi

Department of Survey and Mapping, Malaysia
mohdrozi@jupem.gov.my

KEY WORDS:

GIS, Spatial-Temporal Model, Time Series, Spatial Analysis, Project Performance Monitoring, Project Impact Evaluation, International Donor Organizations

ABSTRACT

The Malaysian government's vision of becoming a developed nation by 2020 encompasses the realization of an efficient public delivery system at various levels. Among the national emphasis are land related matters which include cadastral survey. Towards this end, in its push towards a fully digital Malaysia by the year 2015, the Government has approved what is now known as the eCadastral project, to be implemented by the Department of Survey and Mapping Malaysia (DSMM). This is by far the largest Information Technology project approved under the 9th Malaysian Development Plan, which span over a five year period from 2006 till 2010.

Since 1995 DSMM has embarked on a modernization program that saw the dramatic computerization of both its office and field processes of its cadastral survey division. The Digital Cadastral Database (DCDB), which is the crown jewel of the department, was created by capturing the survey accurate information of all land parcels. Under the eCadastral project, a comprehensive nationwide readjustment of the meshwork of parcels would be carried out based on a new geocentric datum. A dense network of global positioning system (GPS) RTK permanent stations has been established to provide on-the-fly precise geocentric positioning. Upon the successful implementation of eCadastral, DSMM has envisaged a significant reduction of time taken in any cadastral survey process from the existing average of 2 years to within 2 months.

The current system of cadastral survey is unable to capitalize on the advent of satellite based technology. A complete revamp of the system is required before any improvement to the delivery system could be achieved. The new environment will allow various cadastral survey processes such as planning, design layout submission, field data capturing, completed job submission, quality control, and approval to be carried out remotely via the mobile telecommunication network. Global positioning system will provide real time positioning at centimeter resolution homogenously to the entire country and coordinates will replace relative measurements as the ultimate prove of boundary mark position. Additional features such as building footprint and space images will be incorporated into the new database in a move towards a multi-purpose cadastral. This new database will also be the launching pad to enable final title to be issued within a day.

1 Introduction

Since 1995 DSMM has embarked on a modernization program that saw the dramatic computerization of both the office and field processes. Initial changes occur in the office, where manual plan drafting was replaced with a computerized drafting system to enhance and expedite output of certified plans for the issuance of land title. Subsequently, the field equipments were upgraded from electronic distance measurement to total stations assisted by host of peripheral such as handheld GPS, and tablet PC. Hardcopy plans, field tracings and star almanac were converted to digital information stored in the tablet PC to ease information retrieval, assist computation and quality verification.

Currently, DSMM manages the cadastral workflow in a totally digital environment. Applications for surveys are lodged into the computerized system which will monitor files movement, assign jobs, verify jobs, and get the jobs approved by the state director of survey. Digital files are transferred through handshaking protocol between headquarters and district offices before the jobs are assigned to the field officers. However, the field procedures are still rigidly regulated to comply with accuracy set for older equipments which includes chains and theodolites. Translating such regulations into the computerized application modules limits the functionalities of

computerized system. Current infrastructure requires the field officers to commute between field site and the district office when the need arises to extract addition information, download and upload jobs.

Early computerized office system was developed based on automating the manual procedures. The core module was developed to comply with the existing land law which requires hardcopy plans to be generated, approved and deposited with the state DSMM. Customized graphical editing tools were developed to assist the drawing of certified plans emphasizing aesthetic presentation. The approved plans are scanned and stored into an image database. Changes to the approved plan will require manual editing of the hardcopy plan and rescanned into the image database. As the demand for vector data increases, the department initiated the keyboard entry of bearings and distances portrayed in certified plans to form a complete cadastral network (known as DCDB). Discrepancies or gaps exist between the graphical display and the value of bearings and distances stored within the database as attributes. The gaps are snapped close to ensure topological integrity. Spatial analysis is limited due to the different that exit between the certified plans values and those extracted from the graphical display. Subsequently, pilot projects were conducted to correct this peculiar situation. The studies recommended that DSMM carry out a readjustment of the cadastral network based on a more accurate datum. The proposed model comprises of the introduction of a new datum, readjustment of the cadastral network, using coordinate based procedures and introduction of least square adjustment methodology for cadastral survey. The model is known as the Coordinated Cadastral Systems (CCS) and is to be implemented through the eCadastrre project.

2 eCADASTRE

The primary objective of eCadastrre is to expedite the delivery system for land title survey. This would entail the creation of a survey accurate database at the national level suitable for geographical information systems (GIS) users. Various issues related to the generation of a survey accurate database need to be addressed. Since 1996, those issues were addressed through pilot projects conducted to optimize the usage of coordinate based systems such as GIS and GPS. The CCS model outline in figure 1 was finally adopted by the Department.

The implementation of CCS is a major part of the eCadastrre project which includes field and office reengineering to reduce processes and increase the use of digital technology. The three main components in eCadastrre may be divided into three sub-systems namely CCS, virtual survey system, and cadastral data integrity system.

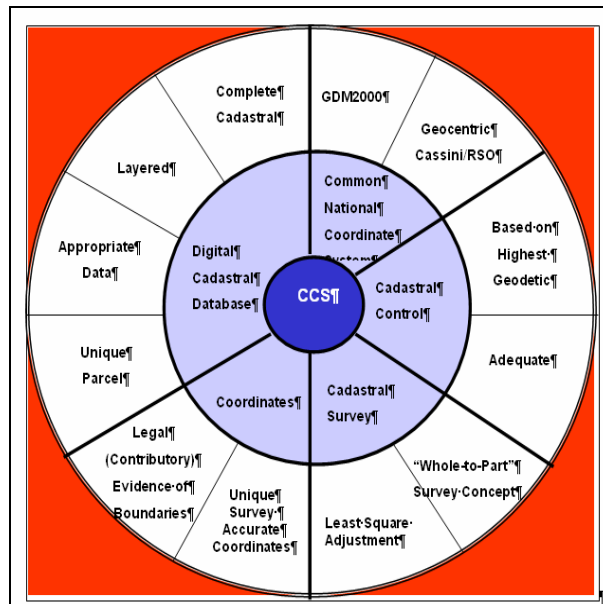


Figure 1: CCS model of Malaysia

2.1 Coordinated Cadastral Systems (CCS)

Since 1996, DSMM has work closely with the engineering and geo-information science faculty of University Technology Malaysia on the development of coordinated cadastral system for Peninsular Malaysia. Among the research conducted were the use of least square adjustment for cadastral survey, use of GPS for transfer of

control for cadastral survey in isolated area, application of geocentric datum for cadastral and mapping to ease integration of both datasets, possible use of rectified skew orthomophic (RSO) in cadastral survey, issues related to legal traceability, standards and specification on use of GPS, the institutional and legal aspect of using coordinated system and the cost-benefit of CCS. Among the main products of the pilot projects is the prototype database re-coordination system and design of the cadastral control infrastructure (CCI) to constraint the propagation of error in the cadastral network. Subsequently, the prototype modules were tested in a pilot project carried out in the state of Malacca. Improvements were made to the modules and workflow modified to suit production roll out.

The main objective of CCS, formulated from the pilot projects, is to develop a homogeneous cadastral database based on the geocentric datum with a spatial accuracy of better than 5 centimeter in urban area and better than 10 centimeter in semi-urban and rural areas. The present accuracy of the DCDB is a few meters level and is not homogeneous. This is partly due to the inherent inaccuracy found in the underlying datum and unconstrained propagation of error within the network. Subsequently, in the year 2003 the department decided to adopt the geocentric datum GDM2000 which is supported by permanent GPS tracking stations and real time kinematics stations. However, the Cassini projection is maintained but is now based on the new GDM2000 parameters. At the national level, the process requires the readjustment of the cadastral network based on coordinates obtained from GPS observation.

In order to achieve the above objective there is a need to establish a dense Cadastral Control Infrastructure (CCI) grid of 0.5km spacing in urban area and 2.5km spacing in semi-urban and rural areas. The underlying technologies needed for the establishment of CCI includes GPS positioning based on GDM2000 geodetic datum, and least squares adjustment. Once the dense CCI has been established the readjustment of the cadastral network will be carried out and this adjusted national digital cadastral database (NDCDB) will then form the base layer for all future title surveys. The readjustment uses least square methodology will distribute the residues homogeneously in the large cadastral network. Consequently, cadastral survey practices will be revamped to accommodate the use of least square adjustment.

The study group had also drafted new survey procedures to serve as a guideline for all future surveys. The new procedures will inevitably be much simpler and quicker to reduce field cost and to further reduce mobility cost; field surveyors will be encouraged to submit their work online. Validation of work under CCS environment will be much faster and simpler. The control infrastructure is currently supported by an advance RTK-GPS network which can provide real time correction to field observations.

2.2 Virtual Survey System (VSS)

This sub-system will equip the field surveyor with state-of-the-art technology in ICT, total station, GIS and GPS. The surveyor will be able to interact with the system to extract information that will assist him in the field operation and most of the work will be automated to reduce tedious computation. The virtual survey system will re-engineer the field processes and permit real time digital submission of completed surveys to servers located at the state DSMM for verification. The most obvious change will be to replace the current field survey system with the use of coordinates based system such as GPS and GIS. Figure 2 shows the various components in the eCadastre environment.

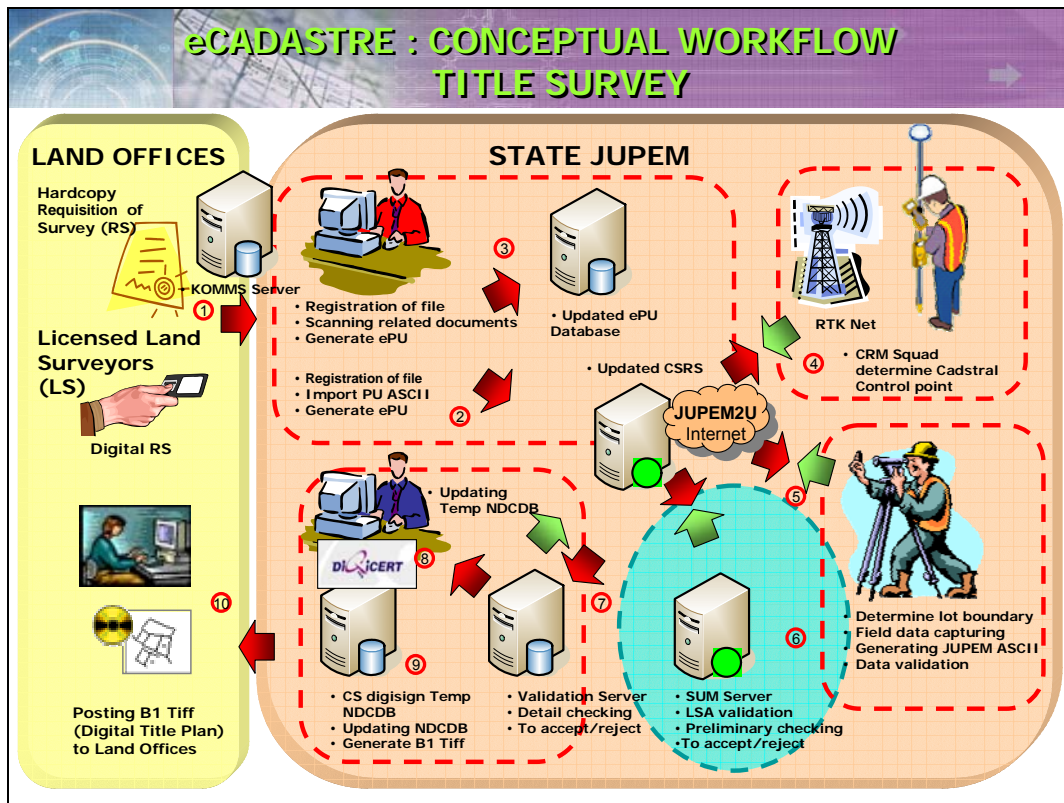


Figure 2: eCadastre Conceptual Workflow

All requests for title survey either from the land office or the private licensed land surveyors will be lodged with the Department prior to field survey. The spatial location of the land parcels will be verified against the NDCDB to ensure that there is no encroachment. Initially the Department’s cadastral control mark group (CRM) will facilitate the field survey teams by establishing GPS control marks surrounding the perimeter of the new request for survey. All information related to the GPS control can be accessed by the CRM group, the Department and private field surveyors via mobile internet. The field surveyor may start the survey based on controls obtained from existing marks stored in NDCDB, CRM layer or through GPS RTK-Network services provided by DSMM. Once the survey is completed, it may be submitted to the VSS servers located at the state DSMM for quality verification. The surveyor may choose to work in real time environment or online through the web depending on the communication bandwidth available. Rules will be coded to control workflow and decision making and subsequently minimize human intervention. The field surveyor will be informed on the acceptability of the job in near real time. This will allow the surveyor in the field to rectify the survey if required. The most significant change will be to allow surveyor the flexibility to use best practices in a totally digital environment. The final adjusted coordinates will then be posted into the NDCDB. Finally, a digital copy of the title plans will be generated based on the coordinates stored within the NDCDB and be kept in a separate database for security purposes. The main emphasis is the concept of coordinates which is the fundamental element employed in modern technology such as global positioning system (GPS) and geographical information systems (GIS).

2.3 The Cadastral Data Integrity System

The Cadastral Data Integrity System (CDIS) comprises of all the office applications which include pre-survey verification, field survey data computation and verification, digital title plans generation and approval. This sub-system will be developed to ensure high integrity of the data and to render them GIS-ready. Various checks will be put in place to assist users when making decision on the validity of data before posting it to the database. The raster title plans which are generated based on NDCDB will be delivered on-line to the Land Office.

Subsequently, datasets from other land-related agencies will be incorporated to complete the requirement of a complete cadastral database especially the qualified title (QT) layer. Graphical user interface will be provided to assist users in data capturing, editing, and manipulation. Additional servers will be added to increase processing speed and storage space. The present communication network will be upgraded to cater for the high volume of data throughput between servers and users, including the daily field operation. Much of the applications will be designed based on a fully integrated system and web-enabled.

Among the new requirements will be the need to capture 3D data to cater for strata, stratum, and the marine environment. These databases will be coordinates based which are tied to GDM2000 to better serve all future cadastral surveys. The system will be integrated with other land related systems such as the land office and the Licensed Land Surveyors Board through handshaking process. Ultimately, the various databases will support the implementation of utility mapping.

3 Conclusion

Once e-Cadastral is implemented the time required for cadastral survey will be significantly shorten, thus allowing qualified titles, which are issued in advance of survey to cope with the fast pace of development in the country, to be phased out. The current National Land Code already permits the issuance of final title without having to first issue qualified title. The image of DSMM will be greatly enhanced with the expedient issuance of titles and for being the sole custodian of the complete cadastral database for the country, which is much sought after by many government departments and agencies.

It is envisaged that eCadastral will be fully integrated with eLand to form a complete Land Information System for Malaysia capable of completing all surveys and title delivery within a week. Land Information Malaysia will serve as the first fully digital system that will help thrust Malaysia into the digital era. This system will greatly benefit the citizen who will receive their final land title within a short span of time and also to generate greater confidence in the land market.

THE POTENTIAL OF USING THE EARTH GRAVITATIONAL POTENTIAL MODEL EGM2008 FOR GEO-INFORMATICS APPLICATIONS IN SRI LANKA

P. G. V. Abeyratne

Department of Surveying & Geodesy, Sabaragamuwa University of Sri Lanka,
PO Box 02, 70140, Belihuloya, Sri Lanka -vipula@sab.ac.lk

KEYWORDS:

Earth Gravitational Model, GPS-levelling, Height anomaly, Geo-informatics, DTM, Airborne Laser scanning.

ABSTRACT

The GPS positioning is widely used for Geo-informatics related applications especially in GIS. Besides that it is being used in Airborne Laser Scanning, Remote Sensing and Photogrammetric tasks where 3D coordinates are essential. In most of applications the orthometric heights are preferred than the ellipsoidal heights directly given by the GPS receiver. Orthometric heights can be derived accurately from GPS heights by using a well refined (regional) geoid model at the accuracy of centimeter level. At present the Earth Gravitational Models (EGMs) have been used for various applications in Geodesy. EGM2008 is a combined high resolution EGM (Degree 2160) derived with satellite and terrestrial gravity, elevation and altimetric data by the National Geospatial-Intelligence Agency (NGA) of the USA which has the minimum wavelength of ~10 km at the equator. This is a remarkable step compare to its predecessor EGM96 (Degree 360) whose minimum was ~110 km at the equator. The new model can be used to get more accurate solutions basically in determining orthometric heights from GPS measurements.

This paper addresses the potential of using EGM2008 for applications in geo-informatics in Sri Lanka where showing the standard deviation of ± 0.184 m in the height anomaly over 204 benchmarks throughout the island while having a -1.760m bias between the GPS-levelling and the EGM2008. This technique would be one of the alternatives which could be applied to derive heights directly from GPS measurements for geo-informatics applications for the countries where well prepared geoid models are not available.

GEOGRAPHICAL NAMES FOR CARTOGRAPHIC PURPOSES IN MOROCCO

Faquiri Meryem

meryemfaquiri@hotmail.com

KEYWORDS

Morocco, Geographical Names, Cartography

ABSTRACT

Geographical Names, toponyms or place names provide the most useful geographical reference system in the world, Therefore it is important to indicate those names accurately and correctly on the maps.

Consistency and accuracy are essential in referring to a place to prevent confusion in everyday business and recreation

Land registry, survey and cartographic offices are especially good sources of geographics names for that most cartographers and organisms deal with the difficulties to obtain correct, accurate and consistent data, needed for a map.

Each authority and nation on behalf of The United Nations Group of Experts on Geographical Names(UNGEGN) have to develop procedures and establish mechanisms for standardization in response to national requirements and particular request; and is responsible to provide accurate sophisticated toponymic products as practical information for as wide a user community as possible, through all appropriate media and set theory and methodology of the Electronic Names Database.

Information about the geographical names and features are stored and maintained in this database..

Internet based Applications, Open Source Solutions

IRRIGATION INFRASTRUCTURE INFORMATION MANAGEMENT SYSTEM (IIIMS)

H. Gadain^a and G V. Sanya^b

^a Food Agriculture Organization Somalia Water and Land Information Management (FAO SWALIM), Kenya

^b National Environment Management Authority (NEMA), Kenya

KEYWORDS:

Irrigation infrastructure, IIIMS, Somalia

ABSTRACT

Currently, the geoinformation systems available for management of irrigation infrastructure in Somalia are devoted to similar tasks but with complexities such that only the Geographic Information Systems (GIS) professionals can utilize them effectively. The increasing demand for irrigation data, both spatial and nonspatial by the United Nations (UN) agencies, their partners, non-governmental organizations (NGOs) and other stakeholders is growing. Clearly, the challenge is the need to have a system that will provide accurate information for the medium and large scale irrigation schemes but which will not be too complex. The system will provide information on the current and planned irrigation projects, project names and funding details of the intervening agencies, water supply and control infrastructure location and specification of areas covered by infrastructure and an estimate of farmers served. The infrastructural information will provide crucial information for planning and management of agricultural projects and more so for agencies and organizations working on or rehabilitating these irrigation infrastructures.

1 Introduction

This document provides specifications for an Irrigation Infrastructure Information Management System (IIIMS) which Somalia Water and Land Information Management (SWALIM) is proposing to develop as part of SWALIM-III activities. A complete system specification is presented here with an aim to provide complete information upon which a system developer could develop the system.

Information sharing in a country that saw most of its information lost or not updated due to war is paramount to any development plans geared to resuscitate the economy or sustainable development. For quite a period of time different information have been gathered on irrigation infrastructure in Somalia by different agencies and some of the problems have been the slow manner in which this information is disseminated, use of techniques that require special training on the use of software's handling the data and aging of data after they leave the GIS labs and the handicap of some software in handling business processes of GIS data that support interoperability and compatibility of data.

In this respect the validity and accuracy of these data may be questionable.

However, with a strong GIS enterprise these data that over a period of time have seemed locked, may be opened up to a wider audience in a faster effective manner, taking advantage of the business processes and utilization of cheaper light clients.

This document describes how SWALIM intends to coordinate the process of data acquisition of such information for easy integration into the overall system and provides valuable irrigation infrastructure information that links various related information that initially existed as independent pieces, to the main stakeholders.

The IIIMS will provide users of irrigation data with the platform to discover what is available, query the system for specific datasets, statistical geo-processing, and also facilitate download and transfer of data and information to typical desktop data processing and presentation applications. Standardized irrigation information that is easily accessed by all will improve planning and development within the irrigation sector. In addition, a system that allows data collection that eliminates problems of data duplication and redundancies. This can be achieved by integrating open source relational databases into the system.

The subsequent parts of this document will discuss on what the current situation is, problems and possible solutions that can be adopted to resolve the difficulties faced by agencies and NGOs in infrastructural data sharing and acquisition.

2 Background

Following the collapse of the formal administration in Somalia in 1991 and the subsequent civil war, operation and maintenance of irrigation infrastructure ceased and subsequently the infrastructure deteriorated rapidly. For example, most of the operating and movable gears were either vandalized or left in a state of disrepair, sedimentation complicated gate operation and, erosion endangered the life of the barrages through creation of large whirl water pools downstream. A number of donors have moved to restore these infrastructure and funded rehabilitation of the irrigation infrastructure in southern Somalia with the European Community being the major donor supporting the UN and NGO's rehabilitation efforts.

There are many actors and players in the agricultural sector in southern Somalia. The donor community organized their interventions on the basis of emergency needs. It became almost difficult to adopt a common system for storing information and reporting on rehabilitation efforts by donors and, understand the status of irrigation infrastructure status in Somalia. Currently it is extremely difficult to organize proper planning action and identify priority interventions through data analysis and identification of priorities to be applied on the intervention has been based only on local knowledge and historical memory of experienced experts on Somalia and, short livelihood interventions due to the lack of reliable and homogenous infrastructure information covering the whole area of intervention.

SWALIM under Phase – II carried out extensive spatial analysis work and identified the major barrages, their primary and secondary irrigation canals, and irrigation schemes they feed. The canals were digitized from existing topographic maps, originating from the 1970's and reflecting the existence of the irrigation schemes at that time. These maps were overlaid by another set of data on canals that was derived mainly from LANDSAT satellite images reflecting their situation at the beginning of the new century (year 2000). Thirty two irrigation schemes were identified from feasibility studies and reports, their boundaries were delineated and, their associated infrastructure attributes were generated and linked to the database. This has resulted in a comprehensive spatial database for the irrigation infrastructure along the riverine areas which is currently stored and managed by SWALIM.

3 IIIMS Objective

Foremost, the purpose of the IIIMS will be to provide NGOs and donors involved in irrigation infrastructure rehabilitation with a tool and the necessary information in order to update and manage their irrigation information for proper intervention, reporting and monitoring. There are many other factors that are of interest in developing the IIIMS, below are a few:

- Make the irrigation infrastructure database accessible to all partners;
- Help improve donor decision relating to irrigation interventions and investments and;
- Provide a picture of the irrigation infrastructure situation in Somalia; and if possible the area irrigated over time, i.e. identify irrigated field at a seasonal time scale.

Information will be both spatial and tabular, and information management will encompass field data collection by partners, processing and storage by SWALIM, access and use by all. Although the IIIMS may not play a direct role in field data collection, it will provide updated information that will support efficient field data collection and design of the field data collection forms. Through the involvement and contribution of different partners, the IIIMS will provide the information for the different regions of Shabelle and Juba but also overall statistics for the specific valleys and whole southern Somalia. Given the different nature of irrigation in northern Somalia, specific task modules could also be developed in the future.

4 Development Principles

When developing the IIIMS, SWALIM will adhere to the following principles:

- Focus on what the end user needs. User needs have been briefly assessed and includes simplicity in system design and use, possibility for generating hard copy and soft outputs (maps and tables) that can

be transferred to typical desktop computing environment and freedom from proprietary technology so that the system can be used without expensive and rigid licensing arrangements and future software maintenance fees. However, for agencies to be able to access the system they need to register and use a software key. Further user needs evaluation will be carried out by a small team consisting of SWALIM and partners.

- Maximize on existing field data collection process by partners. SWALIM will not collect information in the field and the IIIMS will depend on partners for update. SWALIM will involve and work with all partners to avoid data collection duplication.
- Emphasize common information management standards. The IIIMS will develop and promote common data collection, processing, storage, metadata standards among all data collectors/information managers to ensure that information is standardized and easily shared across a wide spectrum of irrigation information users.
- Create a system that will address the current need, i.e., medium to large irrigation schemes infrastructure information management, but design the system so that it will adapt to new / future needs, i.e. modular approach.
- Develop a system that supports interoperability with other data formats, e.g. FAO AQUASTAT system.

5 Methodology and Technical Approach

The IIIMS will store spatial and tabular information. Furthermore, at the end the tool will have some spatial tools available for user interaction with maps and their attributes and performing basic data capture, processing and analysis in order to answer various user questions and needs. A better tool will be that which is compatible with the open GIS standards to allow the user to integrate various geospatial data formats, cascade and overlay various spatial and non spatial information, and utilize the information for planning and development of new information. The software will take advantage of the existing information and data structures in SWALIM and any other organization that may intend to utilize it. An example will be ability to consume web services from SWALIM Geo-server.

Development of the software will be geared towards simplicity, extensibility and adaptability to current and future technologies. It will be advantageous to develop an application with a familiar interface to the user and that which is able to take advantage of the existing available open source technologies in the market by taking advantage of the various IT standards that are light for the computer with possibilities of minimal installations of additional wares.

The general approach to the development of the IIIMS is:

1. Structuring and analyses of the database developed in SWALIM Phase-II to form the database sub-system for the IIIMS,
2. Integration of the database for user interaction through graphical user interfaces (GUI) and,
3. Spatial analysis and geo-processing tools.

The methodology of achieving the objectives can be summarized in the diagram below

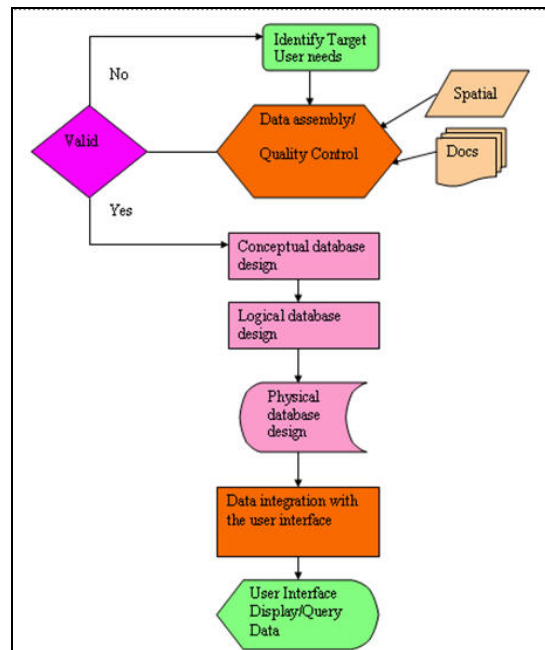


Figure 4: Main steps in the design of the database

After identifying the user needs data the data is checked and the consecutive process will be to design a schema for the database and separately design an interface that will eventually be integrated together.

5.1 Development of the Database Sub-System

The database sub-system of the IIIMS will be based on the information intersecting / lying within the Southern Area of Interest (AOI) identified as the area important for irrigation (as shown in Figure 5 below) and analyzed in SWALIM Phase-II as shown in Figure-1 and available from SWALIM database. The different layers will have a conceptual overview as shown in Figure-2. Detailed description of these data is available from reports and maps produced by SWALIM land and water themes and include:

1. Biophysical data: terrain or contour line and spot heights data including other derived properties (slope, aspect, flow direction, etc.), land cover, soils, hydrographic data (streams network, basins boundaries), land forms, land suitability, etc.
2. Administrative data: country, region and, district boundaries, roads, regional and district capitals, etc.
3. Irrigation infrastructure and their associated attributes: barrages, primarily canals, secondary canals, boundaries of irrigation schemes, irrigation pumps, location of off takes, etc.
4. Hydrological and meteorological data: location, historical record (rainfall, temperature, wind, evaporation, etc.), long term means, nearest flow hydrographs, available water for irrigation, etc.
5. Crop data: types of crops, length of growing period, crop water requirement, data necessary for temporal analysis (NDVI), etc.
6. Socioeconomic data: settlements, population, livelihood zones, livestock (if available), income, markets, etc.
7. Digital documents: feasibility studies, project document, progress reports on on-going rehabilitation projects, designs, maps, photographs, etc. that can be searched by keywords and by scheme name.

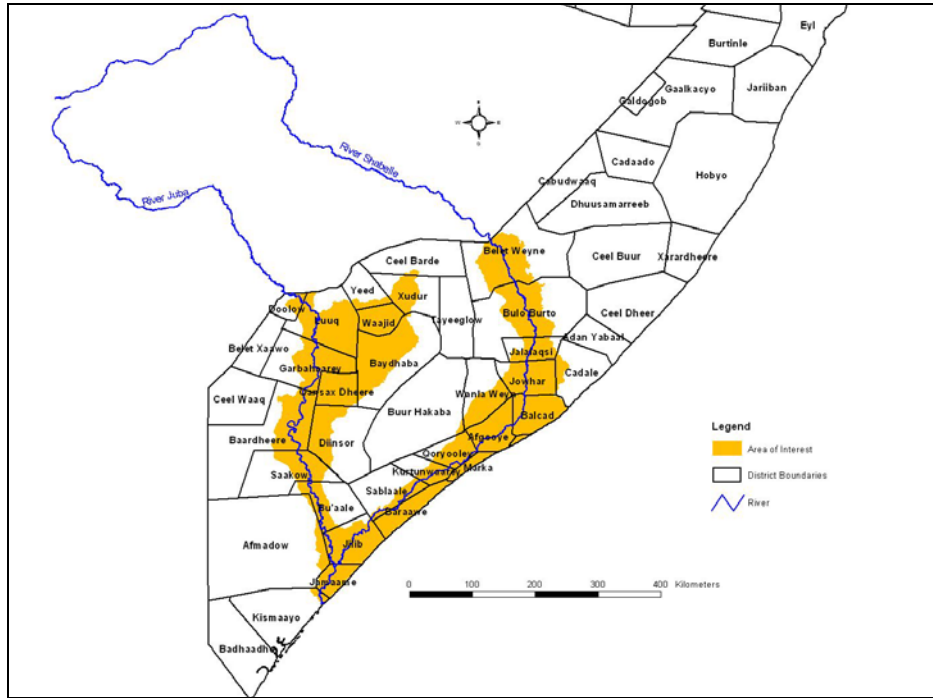


Figure 5: An overview of the area of interest

The area of interest is the inter-riverine area of Southern Somalia. These rivers originate from the Ethiopian highlands and run southwards through the bottom southern part of Somali. The figure depicts the area of interest under which most of the irrigation infrastructure exists in Somalia and therefore defines the extent to which data used to build the IIIMS will be limited.

Most of the data listed above does exist in a spatial flat file format as shape files. The data will have to be transformed into a relational database existing in mysql or postgres_post GIS spatial database. Data edit and update capabilities will be provided in the interface. The level of detail/accuracy of the database sub-system will be related to the different levels of information introduced in the database in different areas. There will also be data analysis tools for geo-processing and geographic data management. Data analysis tools will include geo-processing querying, catchment analysis, modelling, i.e., assessment of water balances requirements and scheduling allocations and hydraulic Modelling – future.

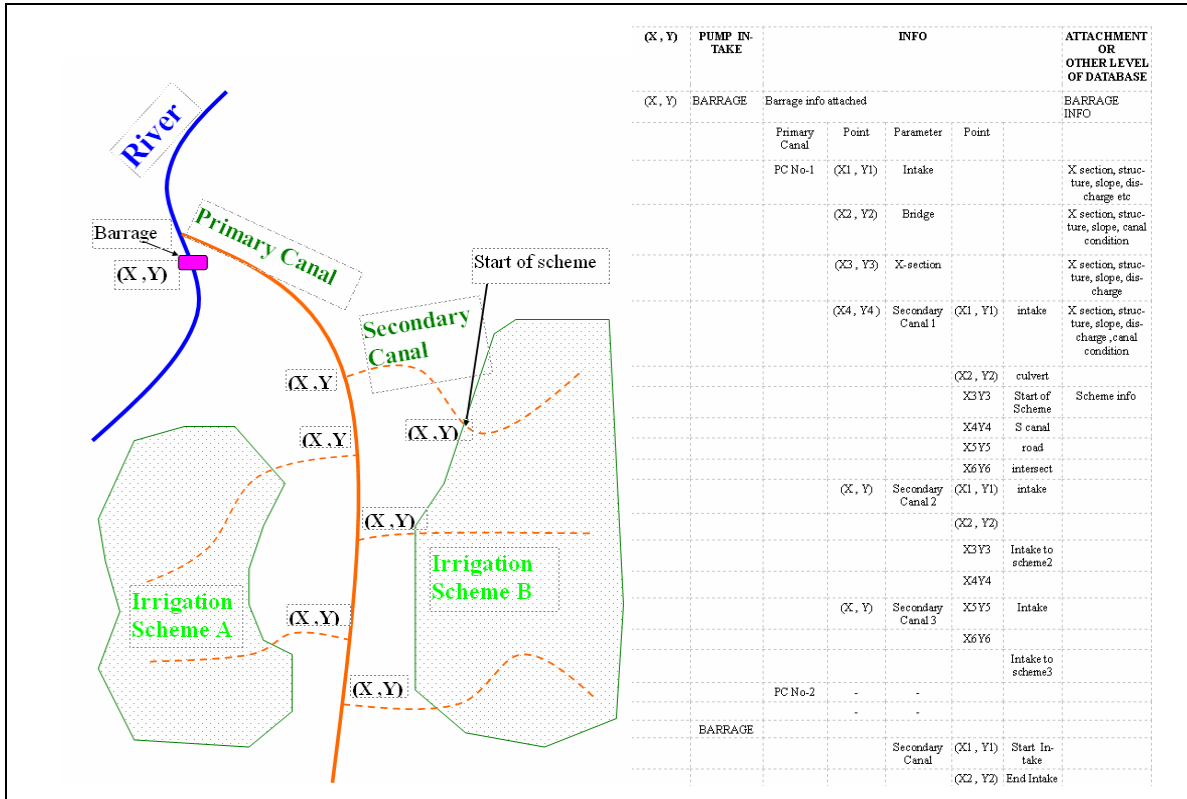


Figure 6: Sketch network of the Irrigation Infrastructure

The irrigation infrastructure in the lower Juba Shabelle Rivers consists of barrages that act as barriers on the river raising the water level for the canal to take off water at some distances up the stream. The initial off take canal becomes a primary canal which has subsequent sub canals it distributes to. These sub canals are referred to as the secondary canals which may or may not distribute to other sub canals. The lowest level of the sub canals off takes water from the secondary canals and are referred to as tertiary canals which supply water to the schemes for irrigation.

The diagram in Figure 6 is a representation of the entities in quadrilateral blocks and are related to each other and connected with lines that have names representing the associations with some values on both ends defining the cardinality between them.

5.2 Interface Development

There are quite a number of commercial software available in the market, but SWALIM is intending to use open source technologies parallel to commercial softwares for development of the IIIMS. Three different options have been thought of and are in the process of development and testing to find out which will be the best way forward:

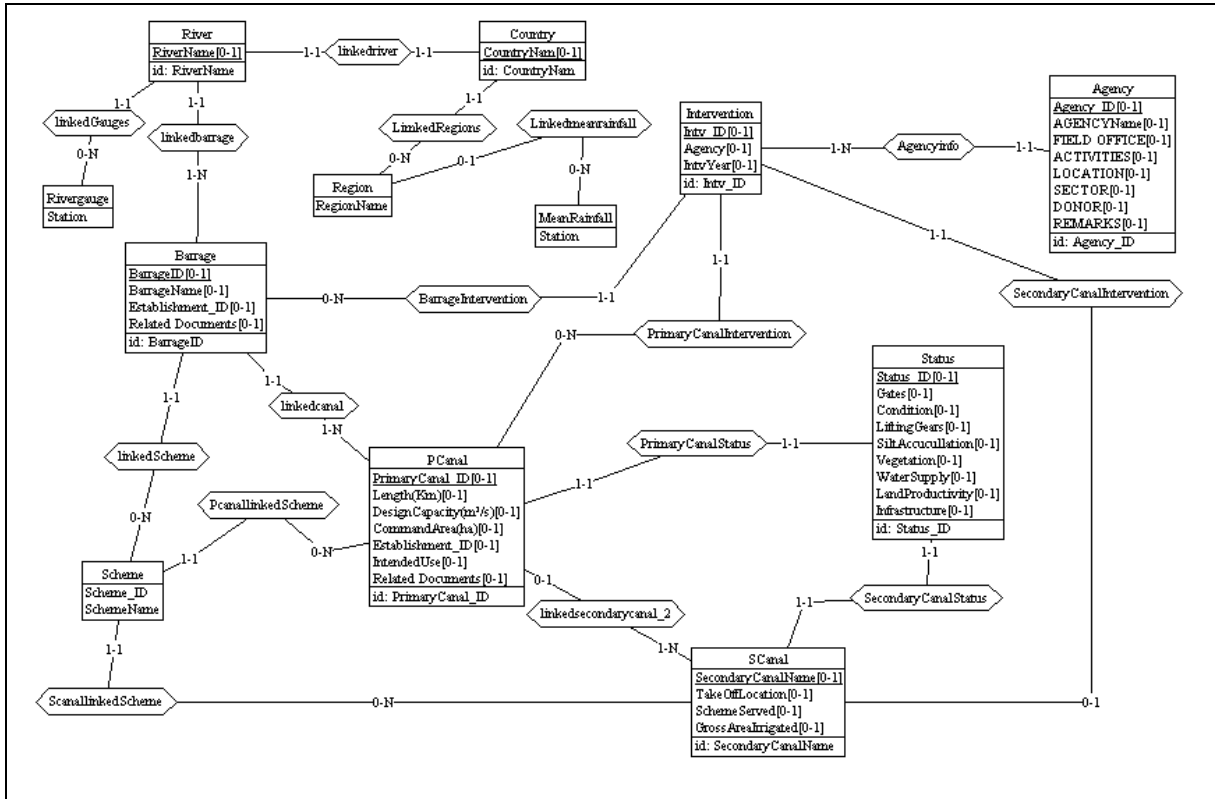


Figure 7: Database conceptual design and linkages

5.2.1 Open Sources Web-Based Spatial Viewer

The viewer will be public domain and similar to FAO and/or SWALIM Geo-network spatial data service provider for offering public web services for users and, is expected to be used by specific stakeholders in the irrigation sector for thematic level generation of information. The idea here is to develop an application that disseminates spatial information through web based technologies. This approach will be geared to simplify the user's task by offering an interface that can be accessed without need of installing additional applications on their computers. The spatial information will be streamed from a server that will be running services developed from the database sub-system hosted by SWALIM. The information will be displayed on the users' screens using a standard web browser at his/her convenience. The user will have the advantage of interacting with dynamic maps and more so be able to participate in offering or sending data via the web interface. However, users will be restricted from updating the data directly on the database but they will have a provision to work with the database administrator whose task will be to maintain the database. However, options for printing maps and drawing features for the purpose of making reports will be available.

There are a range of open source programming languages to be used for implementation using this approach, and it includes ajax, php, html and mysql.

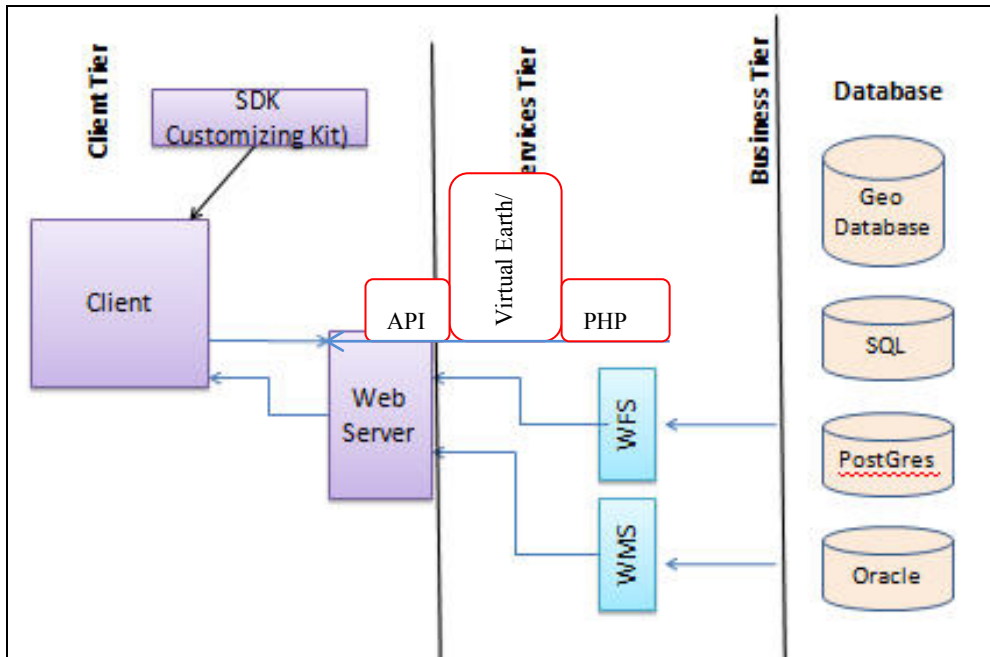


Figure 8: Web service architecture

The GIS data with the irrigation infrastructure will be hosted in the server as a relational database. Different business services will run calling for data to be consumed as web applications to the users interface.

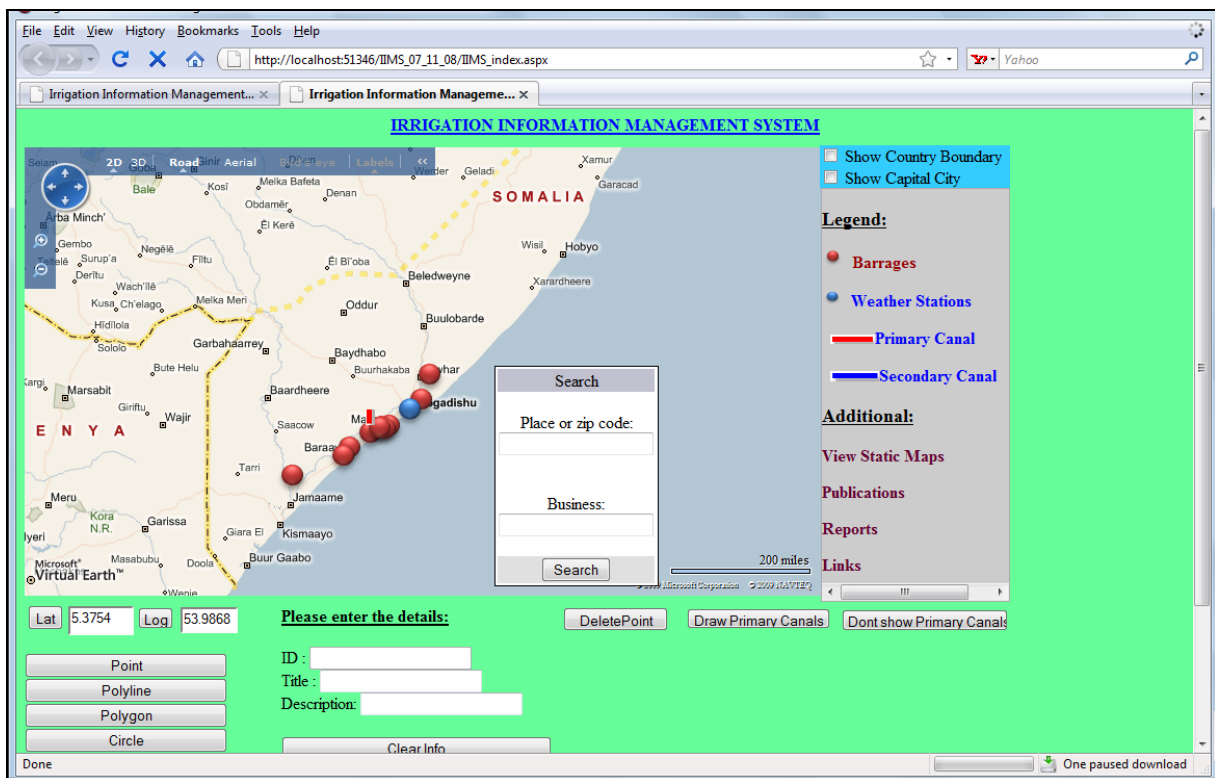


Figure 9: Virtual Earth client interface of the IIIMS

The above interface is a prototype of the intended interface when it is done. The interface is still under development.

5.2.2 ESRI web-based approach

This approach is similar to the earlier open source web approach but it has an advantage over the previous open source one because the process of building web applications will be faster and a little easier. The reason to this is that Environmental Systems Research Institute (ESRI) applications have additional objects existing in the database that makes it easier to access data existing in other Relational Database Systems RDBMS without much coding or configuration. This approach may seem very appropriate, very applicable because it has lots of benefits that may accrue to the office and to the user at the end. The user will still have the option to interact with maps and query for information using a standard web browser. It carries all the benefits that open source web applications have except that it is not free. In addition, the users do not need to have licensed ESRI products installed in their computers for them to use this approach, SWALIM will host the service and the user has to point their web browser to access the database. Options for query, digitizing features and customizing maps and, printing will be available; however, the database will remain untouched if modified.

5.2.3 Standalone Software

This will be a standalone software build with mapwindow objects. On the user interface is a viewer with a Microsoft access database. It differs from the Somalia Water Sources Information Management System (SWIMS) developed by SWALIM for point water sources management in that; this will handle spatial data and will be able to render them on the screen for visualization of both the geometry and attributes. The user interface will comprise the following key components:

1. The database: Currently the data exists in an access format. However, the data format will be converted to an RDBMS before the initial release. The intended RDBMS to be used is MYSQL or Microsoft SQL express format.
2. Viewer: Simple viewer which will be part of the graphical user interface (GUI) and to offer user graphical interaction / visualize the database.
3. Document finder: this will offer the capability to search for documents and any other info that the user may be looking for in the digital documents database described above.

The software organization currently consists of a root directory to host the application executables, IIIMS data directory to host the structured database where the interface will pick up data for rendering on the graphical user interface (GUI) and a map window project directory to store predefined project files and the software. The user can create different projects for different applications.

The user will have the capability to add features to the viewer to display various irrigation infrastructure data and query for information under the layer. The layers info will be supported by the database section which will offer the user with interlinked related information about a particular irrigation infrastructure, the location, and its status of operation, the interventions and the agencies responsible for them, etc.

More so, other related materials like pdf files or pictures related to a particular feature will be linked to them. In addition, other social economic information like population densities and administrative boundaries will be displayed as layers to act as additional information for the user. The advantage of this interface is that the user has the advantage of viewing relational database information and can update it as well.

This application will have spatial data functionality summarized as below:

- Mapping and visualization: Display spatial data, Data selection, Identifying features, Querying / finding features, Managing data presentation,, Managing table of content, Producing and Printing maps and reports / statistics, Exporting maps and reports / statistics
- Data editing and compilation: Creating and editing geometrical features, Editing and adding feature attributes, Creating new features and adding their attribute information

The present status of the stand alone interface is impressive since most of the functionalities mentioned above have been achieved and a relational database can be viewed. The drawbacks still lies in creation of reports, printing and editing of the geometry. The other pending task is implementing a connectivity and direct link between the shape files and the access database.

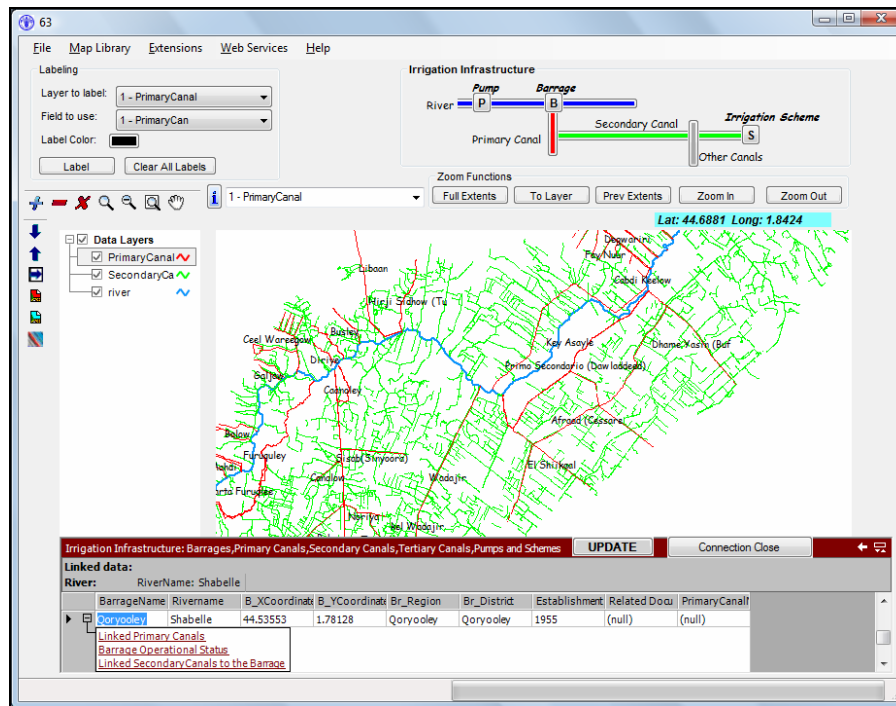


Figure 10: Somalia irrigation infrastructure information management system

The above interface is a prototype of the intended standalone Somalia irrigation infrastructure information management system built on mapwindow objects. The interface is still under development.

6 Future Work

The paper focused on the possible means of achieving an irrigation infrastructure information management system, which may provide various stakeholders and intervening agencies with information that may help in building up and rehabilitating the irrigation infrastructure in southern Somalia.

The challenge is to adopt what may seem as the best method in building the IIIMS. What is of particular interest is having a system that is simple and user friendly, interoperable, cheap to build and maintain yet comprehensive in disseminating the relevant irrigation infrastructure information.

The future focus will be devoted not only to the usability of the application but its integration with other related applications like FAO AQUASAT and the Somalia Water Information Management System (SWIMS). AQUASAT is FAO's global information system on water and agriculture developed by the Land and Water Division. A constant and close working relation with all the key players in this field will enable us to develop a usable application.

References

- FAO. (2009). FAO's Information System on Water and Agriculture. Retrieved April 21, 2009, from Aquasat: <http://www.fao.org/nr/water/aquasat/main/index.stm>
- Gadain, H. (2008). Irrigation Infrastructure Information Management System (IIIMS). Nairobi: SWALIM.
- Mbara C.J, G. H. (2007). Status of Medium to Large Irrigation Schemes in Southern Somalia. Nairobi: SWALIM.
- MERIMS. (2008). Middle East Regional Irrigation Management information. Retrieved 2008, from MERIMS: <http://www.merimis.org>
- Njeru, L.. (2007). Systems specification of an IIIMS. Nairobi: SWALIM.
- Sagart. (2004). culturalorientation.net. Retrieved April 27, 2009, from Somali Bantu-Their History and Culture.

SUAS MAPSERVER - AN OPEN SOURCE FRAMEWORK FOR EXTENDED WEB MAP AND COMMUNITY SERVICES

H. Li^a and F.-J. Behr^b

^a M-Way Solutions GmbH, Leitzstr. 45, D-70469 Stuttgart, Germany
leeglanz@gmail.com

^b Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
franz-josef.behr@hft-stuttgart.de

KEYWORDS:

Internet/Web, Mapping, Services, SVG, Interoperability, Spatial Infrastructures, Standards, Map Server

ABSTRACT

The Web Map Server Implementation Specification (WMS), originally developed and published by the Open Geospatial Consortium, was finally adopted by ISO as an international standard. According to this standard maps are presented either in “picture” formats or “graphic element” formats.

In this paper a framework named SUAS for supporting extended Web Map and map community Services will be presented. Geo-data is converted to Well Known Text format (WKT) and stored in a database management system, retrieved by the WMS server upon user request and transferred through the Internet. Finally it is visualized in Web browsers or using special map clients. Besides supporting the WMS standard operations, additional formats and extensions have been included in this framework.

SUAS is also one community platform to allow users to have the ability to create and share their own Atlas, which is the collection of geo-data and represents a map server. The development proves that open, XML-based standards in combination with modern programming languages and integrated development environments allow rapid implementation of recommendations and standards in geo-informatics.

1 INTRODUCTION

1.1 General Background

With large number of spatial data resources available, the Web Map Server (WMS) Implementation Specification, originally developed and published by the Open Geospatial Consortium (OGC 2002a, OGC 2006a) was finally adopted by ISO as an international standard titled “IS 19128:2005 Geographic information - Web map server interface”. It is a basic specification enabling users to transparently access data of interest from one or several map servers.

This standard is indeed a remarkable technical and commercial breakthrough in Internet mapping. Software conforming to this specification “*is able to automatically overlay map images obtained from multiple dissimilar map servers, regardless of map scale, projection, earth coordinate system or digital format*” (OGC 2004). Its success is based on the usage of a standard web protocol (HTTP), a standardized markup language (XML) and ordinary Web browsers. Request URLs may be bookmarked, pasted into HTML documents, and so forth, a benefit for the dissemination of WMS. This approach is also supported by the SUAS MapServer described here.

The service itself consists of three different operations with a corresponding set of parameters. As often defined for such services the first operation – the GetCapabilities request – provides general meta information to the user about available data, projection, and format, the so called service metadata. A client has to parse the XML capabilities document to retrieve the necessary information for the next step, the GetMap request.

Through this operation the map itself is obtained and can be visualized by the client software, sometimes combined with maps obtained from other servers. Such requests can be restricted to specific layers, size, extent and desired spatial reference system.

These two operations belong to the basic Web Map Service which can be extended to a queryable WMS by supporting a third operation, the GetFeatureInfo request which provides additional attributive information about geographical features in the map.

While textual output for service metadata, error messages (exception reports), or responses to GetFeatureInfo requests are usually formatted as Extensible Markup Language (XML), maps are presented either in picture formats or graphic element formats.

The pictorial (visual) representation using raster formats is most often implemented due to two reasons: The specification originally denotes a map as a visual representation of geo-data, not the data itself (OGC 2002a). Secondly, standardized raster formats such as Graphics Interchange Format (GIF), Portable Network Graphics (PNG), or Joint Photographic Experts Group (JPEG) can be displayed by common Web browsers, additional formats such as Tagged Image File Format (TIFF) can be visualized by additional software invoked by the Web browser.

For the representation in graphic element formats the specification mentions Scalable Vector Graphics (SVG, <http://www.w3.org/Graphics/SVG/>) or Web Computer Graphics Metafile (WebCGM, <http://www.w3.org/TR/REC-WebCGM/>). These formats constitute a scale-independent description of graphical elements, so that scale and size of the display may be modified while preserving the relative arrangement of the graphic elements, as ISO 19128 describes.

In this paper a framework for supporting Web Map Services with partial focus on SVG will be described. Geo-data is converted to WKT, stored in a ordinary relational database management system (DBMS), is retrieved and transferred – optionally compressed – through the Internet, and is finally visualized in Web browsers on desktop computers or mobile devices, natively or using plug-ins extending the browser's functionality.

1.2 Related Work

A few approaches for open geospatial services are described in literature and Internet resources:

- A widely used web mapping application is *MapServer*, formerly called UMN MapServer due to the development by the University of Minnesota (UMN, see <http://mapserver.gis.umn.edu/>). This application framework is now maintained by developers around the world as part of the Open Source Geospatial (OSGeo) Foundation. MapServer supports several OGC standards, including WMS and Web Feature Service (WFS). Because it runs as an executable program, the installation however requires specific settings and rights on server side which is not always given.
- *Deegree*, developed by lat/lon GmbH (<http://lat-lon.de/>) and the GIS Research Group of the Department of Geography of University of Bonn, is a Java Framework offering “the ... building blocks for Spatial Data Infrastructures” (<http://www.deegree.org>) by supporting a wide range of standards from OGC and ISO/TC 211 (like WMS, WFS, Web Coverage Service and Catalogue Service Web-Profile). However Java Servlet and Java Server Pages technologies are not provided by many Internet service providers; therefore SUAS is built on PHP and MySQL which are widely supported. Additionally experiences show that setup of Degree is not as easy as one could expect (Schweizer 2005, Pareeth 2008).
- *MapGuide Open Source*, sold until November 2005 as Autodesk MapGuide, is a web-based platform to develop and deploy web mapping applications and geospatial web services. Autodesk submitted this product to the OSGeo Foundation in March 2006 under the LGPL license (<http://mapguide.osgeo.org/>).
- Williams (2005a) and Neumann (2006) use PostGIS (<http://www.postgis.org/>) to store geometries in WKT format. A server-side scripting language (PHP) extracts data from the database and creates SVG geometry fragments on the fly supporting a service similar to WMS's GetMap request.
- GeoServer, written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards (<http://geoserver.org/>).

Besides these open source solutions several commercial internet mapping software packages exist like ArcGIS Server, GeoMedia Web Map, or MapXtreme; these approaches are not scope of this paper.

1.3 Web Map Server Related Specification

There exist several versions of WMS implementations on the market. While WMS 1.1.1 is implemented by more than 240 products (OGC 2009), the recent version, WMS 1.3, is supported only by 72 products. This demonstrates the use, popularity and stability of the version 1.1.1 specification. Also the SUAS framework described here is currently based on WMS 1.1.1 specification.

Styled Layer Descriptor (SLD, OG 2002) specification is designed to permit a wide variety of implementations of WMS which support user-defined symbolization. SUAS supports the SLD specification and can produce maps with user-defined symbolization of features instead of named Layers and Styles.

With the WMS operations DescribeLayer, GetLegendGraphic and GetStyles, a client can retrieve further information about features and styles from a server.

2 The Wms Server Implementation

2.1 Database Structure

The database – in this framework currently MySQL is used – consists mainly of three tables as described in table 1. The FeatureClass table stores meta-information about single layers. A *layer*, in this context, is a collection of features belonging to the same feature class. The features themselves are stored in the FeatureGeometry table. All the metadata for the collection of FeatureClasses of multiple layers, which will be used for GetCapabilities request, are stored in Atlas table.

The attribute *layertype* describes where and in what format the features of this layer can be found. The attribute *description* contains short textual information about the layer. The bounding box for the features is stored in the attributes *xmin*, *ymin*, *xmax*, *ymax* defining the lower left resp. the upper right corner. The spatial reference system is contained in the *srs* attribute usually specified according to the EPSG Geodetic Parameters dataset (<http://www.epsg.org/>). *Stid* field points to the id of a style definition for this collection, where style properties for a feature class can be supplied optionally. Raster layer have no attributes and are not *queryable* when using GetFeatureInfo request, *queryable* field should be set to true. The field *elevation* is used for building 3D models.

The FeatureGeometry table partially consists of similar attributes, but is related to single features. The type of geometry (region, polyline...) is stored in the attribute *geomtype*, the geometry itself in Well Know Binary format (WKB) in the attribute *geom*. *xlink* can be used to embed the SVG geometry into a hyperlink according to W3C's XLink recommendation (<http://www.w3.org/XML/Linking>). The *attributes* field contains the feature's attribute / value pairs in XML format for ease of parsing on client-side.

The relevant administrative metadata according to OGC's WMS Capabilities DTD (OGC 2002a) have to be specified and are stored for further use as fields in table *Atlas*. The *status* field indicates if the atlas is public or private. If commercial mapping application programming interfaces (API) like Google Map API are used, the *key* field is used to store the API key. All configurations are saved in XML format in field *variable*.

FeatureClass	FeatureGeometry	Atlas
fcid	id	aid
aid	aid	uid
stid	recid	key
layer	layer	variable
description	geomtype	status
geomtype	srs	name
layertype	xmin	title
srs	ymin	abstract
xmin, ymin,	xmax	layertitle
xmax, ymax	ymax	keyword
queryable	geom	person
visible	xlink	organization
priority	attributes	position
elevation	
recnum		accessconstraints
size		type

Table 2: Essential tables and attributes of the SUAS MapServer database

Additional metadata for the GetCapabilities response are derived from the FeatureClass table. For a GetCapabilities request the server generates a XML metadata document, which includes information about layers, coordinate systems, and bounding box values for each layer. Additionally the image formats supported (see section 2.3) are listed in the format elements of the metadata. The extended capabilities and operations are also defined by instances derived of `_ExtendedCapabilities` or `_ExtendedOperations` elements. All extension names have been selected with care to avoid conflicting with other names mentioned in the standard.

2.2 Data loading

The WMS framework offers several methods to load spatial data into the spatial database. The first input method uses CSV formatted files (comma separated values) with information about layer name, extents, geometry, reference system and attributes of spatial features. Due to their simple but comprehensive structure, CSV files can be generated quite easily by many GI systems.

The second method uses SVG formatted files containing feature information within SVG elements. All geographic information such as element ID, layer name, shape type and shape style, can be picked up and stored into the database.

Additionally some widely used formats such as MapInfo Data Interchange Format (MID/MIF), ESRI's Shape, E00 format, and GML are supported for bulk-loading of geo-data. Consequently SUAS supports explicitly commonly used formats of commercial GI systems.

Working with Google Map API, SUAS offers users also JavaScript based web GIS tools (cf. Fig. 1) to edit and import geometry data manually. Three types of geometries were supported: Point, Linestring and Polygon. Geometries will be saved into one layer under reference system EPSG:4326(WGS84).

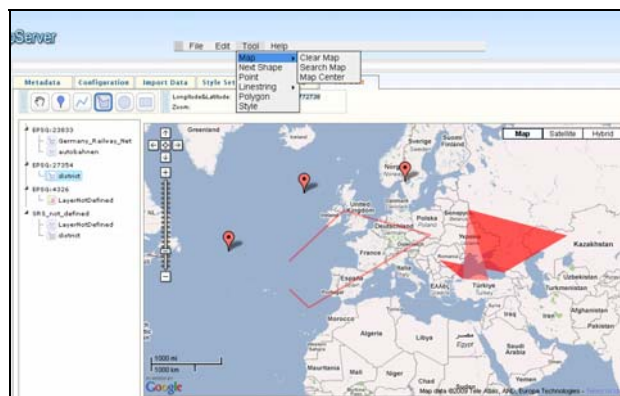


Figure 1: Web GIS tools to edit and import data with Google Map

2.3 Server Side Rendering

The server's rendering component supports PNG, GIF, JPEG and WBMP raster image format using the built-in library GD of PHP5, but also extends the WMS specification by providing SWF and PDF output.

For Shockwave Flash Format (SWF) an additional library named Ming is used. Ming is open-source and allows creating Flash movies, including almost all of Flash's features, like shapes, gradients, bitmaps etc (<http://de.php.net/ming>).

Because PHP5 does not include a built-in module for generating Portable Document Format (PDF), currently a library named PDFlib is used (<http://www.pdfli.com/>). Because the whole framework should rely upon open source it is aimed to replace it by PDFlib Lite which can be used for free for open source projects (<http://www.pdfli.com/purchase/license-lite.html>), FPDF (<http://php.scripsi.de/browse/package/421.html>) or PDF-PHP (<http://www.ros.co.nz/pdf/>).

The output formats SVG, GML, KML, and X3D are XML grammars; hence server responses are generated upon request. For this task the Expat Library is used, the underlying XML parser for the Mozilla project, Perl's XML::Parser, and other open-source XML Parsers.

Virtual Reality Modelling Language (VRML) has its own data structure. A corresponding PHP class has been written to create the 3D model from the WKT geometries. VRML data in complete structure will be outputted line by line.

For these additional output formats some restrictions exist. For PNG, PDF, SWF, GIF, JPEG and WBMP format, Bezier curves and elliptical arc are not supported. For SVG and SVGT all types of geometry can be used.

2.4 Extended Operations

Two special operations extend the capability of map rendering: *GetMap25D* and *GetMap3D* (cf. Fig. 2). A 2.5D map has the strongpoint of 2D and 3D. It can have smaller file size than a raster image, but still has the 3D intuitionistic sense. Map in form of 2.5D has been widely used in mobile navigation system. These two operations follow part of the specification of Web 3D Service (W3DS, Quadt and Kolbe 2005), which is a portrayal service for 3D geodata. SUAS can extrude 2D geodata and coordinate system to 3D geodata and coordinate system with given elevation data, and produce a 3D scene graphs in X3D, VRML, KML, and GML format. Because it is “fake” 3D data, these two requests were named differently from the *GetScene* request in the Web 3D Service specification (W3DS), to avoid conflicting names.

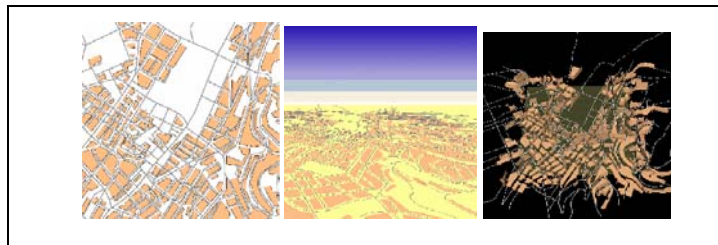


Figure 2: From left to right: 2D map from *GetMap* request, 2.5D map from *GetMap25D* request and 3D map from *GetMap3D* request.

As described above the *GetFeatureInfo* request enables the client to query attributes of features visible in the map. Traditionally features are selected by layer name and pixel based coordinate values. Using SVG however as map output format, real-world coordinates can be used in the map displayed on client-side. By evaluation of ECMAScript events like *onclick*, these coordinates can be determined and integrated in an extended *GetFeatureInfo* request. In the same way a unique identifier can be derived through navigating in the SVG Document Object Model (DOM), as described by Williams (2005a). Such an identifier can also be used by SUAS MapServer’s extended *GetFeatureInfo* operation for attribute retrieval.

3 Map Server plus Community Service

SUAS MapServer is more than a traditional map server, it offers the community society platform to allow user exchange, publish and share the geospatial data as well. Once a user has registered in community system, he or she gets the right to create *Atlas* under his or her account.

3.1 Atlas & Map Server

Atlas in SUAS MapServer represents a virtual, isolated map server defined by the user, which has its own metadata, configuration, feature geometry collection and feature class collection. In each atlas the user can upload geo-data and decide if it could be made publicly available or not. As described in Figure 3, if the status of the atlas was set to be public, everyone has the permission to connect; if the status is private, only the owner can explore the data, or those users who were granted with the permission by the owner.

Each atlas offers its own operations following the OGC specifications; the services are packaged inside atlas. From this point of view, an atlas can be regarded as an open map server.

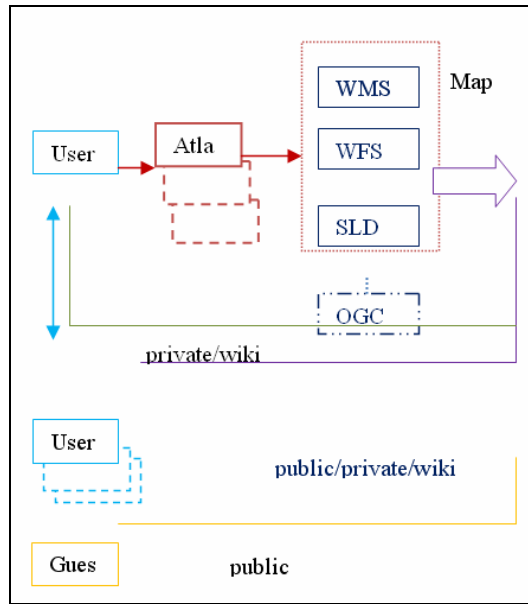


Figure 3: The relationship among user, atlas and Map Server

3.2 Community Approach

Besides the management of his or her own atlas and map, users have the capabilities to share their geo-data, send view request to the owner of private atlas; explore data from other users(cf. Fig. 4), as well integrate them into their own map requests, for example GetMap. With the help of web GIS tools in SUAS MapServer which offer the web interface to let the user explore, edit and save their geospatial data with feature attribute, it is possible for multiple users from different locations to contribute to the open map project in form of teamwork, which is called wiki map in SUAS.



Figure 4: Explore atlas list from users and check the map overview of one atlas

4 Server Installation and Configuration

SUAS MapServer is available for download from <http://suas.easywms.com/>. In addition the project is hosted by SourceForge.net and mirrored by <http://www.gis-news.de/wms>. It offers flexible and friendly user interfaces for the ease of installation, configuration and maintenance (cf. Figure 5). Users do not need special knowledge to install the server and operate the complex database setting. SUAS provides an automatic installation procedure programmed in PHP and checks the availability of all installation requirements (table 3).

<p>Apache HTTP server, version 2.0.x or 1.3.x</p> <p>MySQL 5.16 or newer as database management system</p> <p>PHP 5.05 or higher</p> <p>GD library: for raster image, PNG, JPEG, GIF and WBMP generation.</p> <p>MING library: for SWF image generation</p> <p>PDF library: for PDF image generating</p> <p>Expat library: for XML parsing using PHP</p> <p>phpMyAdmin: optional to manage the database</p>

Table 03: SUAS requirements

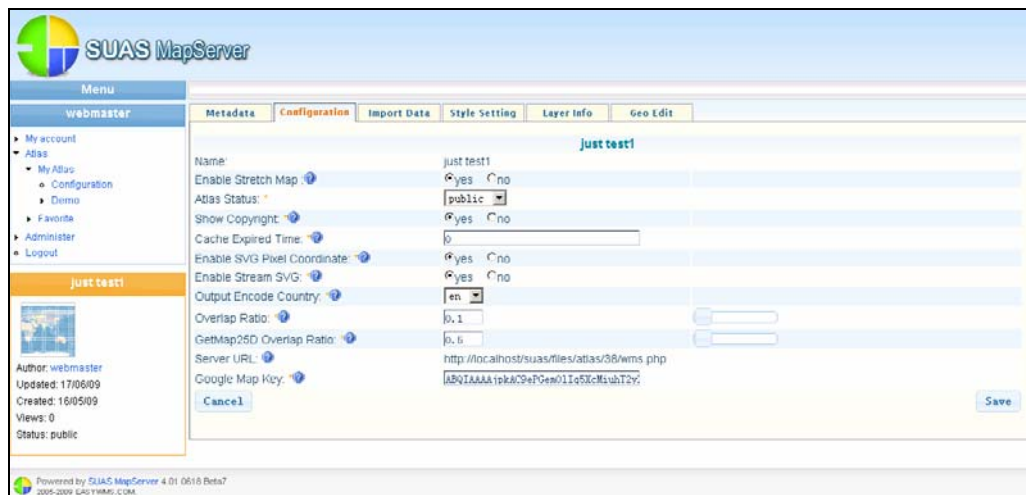


Figure 5: Interface of configuration for Atlas

5 CONCLUSIONS

An open source framework for a Web Map and Community Service environment has been implemented to upload geo-data into a database and support the WMS operations GetCapabilities, GetMap, and GetFeatureInfo as well as extended operations by providing service metadata, map data in 2D and 3D and attribute information for selected features. Multiple formats including raster formats, SVG, SWF and PDF format as well as X3D/VRML, GML, and KML format are supported.

Due to its architecture and the software components used it can be installed and used on almost any web server. Map output can be displayed in standard browsers, SVG enabled browsers.

However there are still some possible improvements:

- Some additional widely used formats such as AutoCAD's DXF or the GPS Exchange Format (GPX) should be supported for extension of file loading functionality.
- In addition to MySQL DBMS, SUAS should also support PostGIS, because it offers efficient spatial functions, such as buffering, overlaying and area selecting, which could improve the performance of SUAS.
- Further developments will support getting data from other WMS servers (while acting as a cascading WMS server) or creating map on the fly out of commonly used GIS data formats like Shape format.
- The WMS capabilities could be extended to handle efficiently tile requests as discussed by OGC 2007, a technology generally used by modern geo-browsers.

References

- Bulatov, V., Gardner, J. A., 2004. Making Graphics Accessible. *Proceedings SVGOpen 2004*, Tokyo, Japan, <http://www.svgconference.com/2004/papers/SVGOpen2004MakingGraphicsAccessible/> [accessed 15.07.2006]
- Campin, B., 2004. SVG Maps for People with Visual Impairment. *Proceedings SVGOpen 2003*, Vancouver, Canada, <http://www.svgopen.org/2003/papers/svgmappingforpeoplewithvisualimpairments/index.html> [accessed 15.07.2006]
- Garrett, J. J. (2005). *AJAX: A New Approach to Web Applications*. Technical report, Adaptive Path. <http://www.adaptivepath.com/publications/essays/archives/000385.php>. Accessed on 09.4.2008.
- Li Hui., Behr, F.-J., Schröder, D., 2006. Design and Implement a Cartographic Client Application for Mobile Devices using SVG Tiny and J2ME. in: *Geoinformatics 2006: GNSS and Integrated Geospatial Applications*, edited by Deren Li, Linyuan Xia, Proceedings of SPIE Vol. 6418 (SPIE, Bellingham, WA, 2006) Article 641810
- Kettemann, R., Zhu, W., 2005. Vektordaten der Liegenschaftskarte „on demand“ im eigenen GIS, *Ingenieurblatt Baden-Württemberg*, Heft 2 / 2005
- Open Geospatial Consortium Inc., 2002. *Styled Layer Descriptor Implementation Specification*. http://portal.opengeospatial.org/files/?artifact_id=22364 [accessed 27.04.2008]
- Open Geospatial Consortium Inc., 2002a. *OpenGIS® Web Map Server Implementation Specification - Version: 1.1.1*. http://portal.opengeospatial.org/files/?artifact_id=1081&version=1&format=pdf. [accessed 15.07.2006]
- Open Geospatial Consortium Inc., 2004. *The OpenGIS Web Map Server Cookbook*. http://portal.opengeospatial.org/files/?artifact_id=7769 [accessed 15.07.2006]
- Open Geospatial Consortium Inc., 2006a. *OpenGIS® Web Map Server Implementation Specification - Version: 1.3.0*. http://portal.opengeospatial.org/files/?artifact_id=14416. [accessed 15.07.2006]
- Open Geospatial Consortium Inc., 2009. *Number of Specification or Interface Implementations*. <http://www.opengeospatial.org/resource/products/stats> [accessed 05.05.2009]
- Open Geospatial Consortium Inc., 2007. OpenGIS® Tiled WMS Discussion Paper. http://portal.opengeospatial.org/files/?artifact_id=23206 [accessed 29.04.2008]
- Pareeth, S., 2008. *OGC Compliant Solution for Online Digitisation Using Open Source Tools*. Unpublished Master's Thesis, University of Applied Sciences Stuttgart
- Quadt, U., Kolbe, T., 2005: Web 3D Service. http://portal.myogc.org/files/?artifact_id=8869 [accessed 2009-05-15]
- Rowley, T., Morris, J., Watt, J., Fritze, A., 2005. Implementing SVG in a Web Browser: Past, Present, and Future of Mozilla SVG. *Proceedings SVGOpen 2005*, Enschede, Netherlands, <http://www.svgopen.org/2005/papers/MozillaSVG/index.html>, [accessed 15.04.2008]
- Schweizer, C., 2005. *Case study and realization of a web-based GIS Client-Server environment based on Open Source Products*. Unpublished Master's Thesis, University of Applied Sciences Stuttgart
- W3C, 2003. *Mobile SVG Profiles: SVG Tiny and SVG Basic*. <http://www.w3.org/TR/SVGMobile/> [accessed 20 Feb, 2006]

MASHUPS: THE SYNERGISTIC APPROACH FOR MELTING DATA AND SERVICES

Franz-Josef Behr

Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
franz-josef.behr@hft-stuttgart.de

KEYWORDS:

Mashups, Google Maps, Open source, OpenLayers

ABSTRACT

In recent years, an increasing emphasis on distributed Web services has emerged in many areas of information technology. Interest has been especially strong in Web GIS (Internet-based geospatial applications) since it is an integral element of the Web 2.0 movement.

One buzzword in this context is Mashup, a mixture of HTML, JavaScript, publicly available application programming interfaces (APIs), and data provided in different formats in order to provide new experiences and functionality in a new application.

In this presentation the relevance of mashups is shown, with special focus on geo-mashups. The basic technological principles and services are explained and commonly used formats are introduced. Relevant APIs and data sources for mapping purposes are presented, and an assessment is given. Key factors for successful concept and implementation are explained.

PUBLICATION OF ENERGY CONSUMPTION DATA OF SCHARNHAUSER PARK VIA WEB GIS

M. Z. H. Siddiquee^a, A. Strzalka^b and U. Eicker^c

^aGIS Expert, Engineering & Planning Consultants, 7/4 Lalmatia Dhaka, Bangladesh
zh027@yahoo.com

^bCentre of Applied Research of Sustainable Energy Technology – zafh.net, Schellingstraße 24, D-70174
Stuttgart, Germany

aneta.strzalka@hft-stuttgart.de,

^cursula.eicker@hft-stuttgart.de

KEYWORDS:

Energy Management, GIS-Implementation, Web GIS

ABSTRACT

Most of the human activities are taken place inside buildings especially in urban areas. These activities are mainly supported by different forms of energies such as electricity, heating which makes the energy management very important especially in urban areas. This paper has made an approach on the analysis of the buildings energy consumption by using geo-information systems (GIS). Energy consumption of the buildings can be visualized in different ways. Web GIS can address this issue very well over the Internet. This study was a part of a project namely POLYCITY, where the buildings are supplied with energy from biomass co-generation plant. The study area is located in Scharnhauser Park, very close to the city of Stuttgart, Germany. Buildings of the project area are provided with consumption data regarding heat and electricity, which forms the basis for analysis and display. GIS can perform the task of visualization in a number of ways; thematic map is one of the best. A web portal is developed for displaying maps and attributes, which enables the residents of the area to evaluate the status of their energy consumption. Dissemination of this information will lead to an increasing awareness among the residents of the project area in terms of energy consumption and supply. The result of this study would support the energy management system to monitor and evaluate the building energy consumption in a very efficient way having a positive impact on power saving in the residential areas.

1 Introduction

The Web GIS is comparatively a new but very fast growing sub-set of Geographic Information System. It is getting particular significance for spatial data handling over the web. In simple words this is for distributing and processing geographic information by the way of Internet and World Wide Web. It is getting increasing momentum and acceptability for different level of users such as geospatial data handler and producers as well as governmental and non-governmental agencies. It can provide GIS functionalities both on Intranet and Internet at the same time. As Internet GIS is platform independent it reduces the necessity of purchasing costly desktop GIS software.

Internet is a part and parcel in our everyday life. Useful information is available online regarding almost every sphere of life. Energy has played vital role in order to attain the advancement of technologies and civilization. Very few things are possible without the magic touch of energy. Buildings support greater portions of human activities. Thus the management of energy inside buildings is worth stating. Particularly in urban areas, it is very important. Geo-information can be the right choice for this type of energy management. The objective of this study deals with structuring a system where building energy consumption data such as electricity and heating and renewable energy supply are to be managed with the help of geo-information systems. The users can have access to the building energy consumption data over the Internet and hereby they can evaluate the status of their respective energy consumption and supply. This will increase the awareness about energy consumption along with the efficiency of energy use among the users.

2 Background

POLYCITY is an urban conversion project. It is focused on the large-scale urban development. In this project working places and living areas are integrated in such a way that it would result in a sustainable city quarters with minimum travel distance and low energy consumption. The sustainable city quarters mean that these would be the best for the people and environment both for now and the future. The project handles a number of aspects related to urban conversion such as new construction at the city edges of Barcelona in Spain; the conversion of an old city quarters with poly-generation energy and grid based energy supply at Torino in Italy; new building construction and renovating old ones on a large former military ground near Stuttgart with biomass heat and electricity supply.

The part of the POLYCITY project in Stuttgart and its name is Scharnhäuser Park (Figure 11). This is an urban conversion and development on an area of 150 hectares in the community of Ostfildern on the southern border of Stuttgart. Working places, residential areas and green park sections are integrated here to result a harmonious living and transportation environment with high comfort and low energy consumption. This one is also designed as an exemplary ecological community development where wood fired co-generation plants will deliver electricity and heat energy.



Figure 1: Residential area Scharnhäuser Park

The geo-information is one of the aspects of this project, which will be discussed in brief in the following sections.

3 Methodology

3.1 Available data

The energy consumption data of the buildings of Scharnhäuser Park reside in the archive of the municipal utility company Esslingen am Neckar GmbH. These data are comprised of annual heat and electricity consumption information for each building in form of Excel sheets. Then the collected data are stored in an Access database in tabular form. Additionally, the project POLYCITY is provided with a map of Scharnhäuser Park area from the city of Ostfildern. This map is a DXF-file, which contains all dimensions and object information for the study area, e.g. building construction, street name, etc.

3.2 GIS-Technology

The GIS-software used for this project is the program called GeoMedia Professional 6.0, which is powerful software for analyzing and managing spatial data. Additionally, further GeoMedia-Application, which is called GeoMedia WebMap Professional, is used for creating a Web application for publishing the project related data via Internet.

3.3 Workflow

Once the data about energy consumption of each building is stored in the Access database, it is joined with spatial data from the DXF map within the geo-information system for its visualization. The energy consumption data are visualized in a number of thematic maps, which show the numeric values in color intensities (Figure 2). This gives the visual impression about the whole area, e.g. buildings with the darker color indicate more energy consumption. GeoMedia WebMap Professional is used to create a WMS (Web Map Service), which is implemented in the POLYCITY-Website for the dissemination of spatial information.

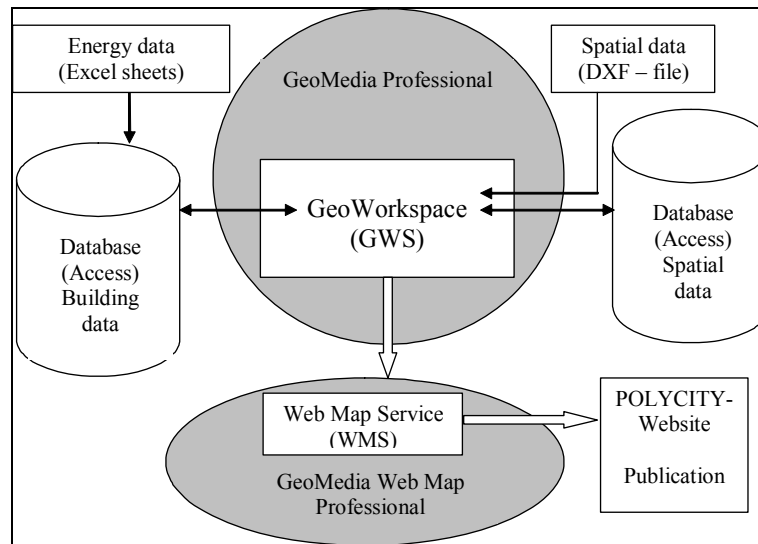


Figure 2: Flow diagram of methodology

4 Implementation

Implementation covers the working procedures in GeoMedia Professional for generating thematic maps, which enables the visualization and analysis of the energy consumption data and subsequently publishing the map with the help of GeoMedia WebMap. A concise description is provided in the following paragraphs.

The features with location data are in the GeoMedia warehouse and the most of the attribute data are stored in the Access database. The attribute data includes building information like building name, street name, house number and so on. The database also has information about electricity and heating energy consumption for each building. For visualization of these attributes data we had to establish a relationship between the database and the warehouse.

Once the connection is set up (joining by building ID) we can start processing data inside GeoMedia Professional. We are interested in energy consumption values per building. As we have already the data about heating per building we use the gross heating area to get the energy consumption data in desired unit of kWh/m²a.

A thematic map symbolizes geographic features according to non-graphic attribute data through the use of color and other user-defined display properties (Intergraph, 2005). It can give the visual impression of non-spatial attribute data over the maps. For making thematic maps customized ranges are used from 0 to 180 where the difference between two successive classes is 30 (Figure 3). The number refers to the unit of kWh/m²a. Disclosure of individual's energy consumption data on the internet may lead to the violation of the privacy policy, therefore the buildings are divided into different types and groups, and the energy consumption data are presented as an average for each of the category.



Figure 3: Thematic map for average annual heating energy consumption (2005)

The visualization and interpretation of the energy consumption data within the GeoMedia Workspace show significant differences between the values of the energy consumption of buildings within one building type. Changing the users behavior could help to achieve a significant reduction of the building energy consumption.

5 Publication via Web GIS

In order to publish the average energy consumption data of the buildings in Scharnhäuser Park using the GeoMedia WebMap Professional creates the Web Map Service (WMS). WMS is a specification that produces maps of spatially referenced data dynamically from geographic information [LI Hui, 2006].

```
<?xml version="1.0" encoding="UTF-8" ?>
<schema targetNamespace="http://www.opengis.net/gml" xmlns="http://www.w3.org/2001/XMLSchema" xmlns:gml="http://www.opengis.net/gml"
  xmlns:xlink="http://www.w3.org/1999/xlink" elementFormDefault="qualified" version="2.1.2">
  <annotation>
    <appinfo>feature.xsd v2.1.2 2002-07</appinfo>
    <documentation xml:lang="en">GML Feature schema. Copyright (c) 2002 OGC, All Rights Reserved.</documentation>
  </annotation>
  <!-- include constructs from the GML Geometry schema -->
  <include schemaLocation="geometry.xsd" />
  <!-- bring in the XLink namespace -->
  <import namespace="http://www.w3.org/1999/xlink" schemaLocation="xlinks.xsd" />
  <!--
  =====
  global declarations
  =====
  -->
  <element name="_Feature" type="gml:AbstractFeatureType" abstract="true" />
  <element name="_FeatureCollection" type="gml:AbstractFeatureCollectionType" abstract="true" substitutionGroup="gml:_Feature" />
  <element name="featureMember" type="gml:FeatureAssociationType" />
  <!-- some basic geometric properties of features -->
  <element name="_geometryProperty" type="gml:GeometryAssociationType" abstract="true" />
  <element name="geometryProperty" type="gml:GeometryAssociationType" />
  <element name="boundedBy" type="gml:BoundingShapeType" />
  <element name="pointProperty" type="gml:PointPropertyType" substitutionGroup="gml:_geometryProperty" />
  <element name="polygonProperty" type="gml:PolygonPropertyType" substitutionGroup="gml:_geometryProperty" />
  <element name="lineStringProperty" type="gml:LineStringPropertyType" substitutionGroup="gml:_geometryProperty" />
  <element name="multiPointProperty" type="gml:MultiPointPropertyType" substitutionGroup="gml:_geometryProperty" />
  <element name="multiLineStringProperty" type="gml:MultiLineStringPropertyType" substitutionGroup="gml:_geometryProperty" />
  <element name="multiPolygonProperty" type="gml:MultiPolygonPropertyType" substitutionGroup="gml:_geometryProperty" />
  <element name="multiGeometryProperty" type="gml:MultiGeometryPropertyType" substitutionGroup="gml:_geometryProperty" />
```

Figure 4: Declarations of the WMS

This WMS is then implemented into the Website of the project POLYCITY, what is shown in the following picture (Figure 5):

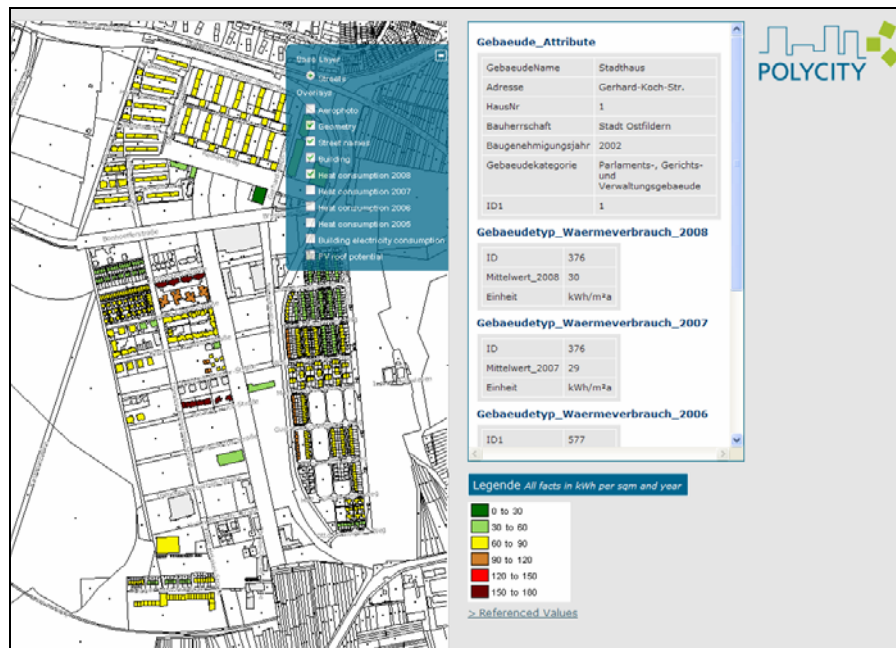


Figure 5: POLYCITY-Web GIS Application (Heating energy consumption 2008)

6 Conclusions

This paper makes an attempt to describe the visualization and publication of the energy consumption data of the buildings in Scharnhauser Park. This work is carried out within the project called POLYCITY funded by European Union. A web portal is designed having furnished with the maps and non-spatial attribute data regarding building energy consumption. This portal provides a certain level of interactivity for the users like viewing the attributes. The thematic maps show the annual average values of heating and electricity consumption for different building types. Other available specific information can also be provided through password protected system Analysis shows significant differences between the energy consumption of the individual buildings and the category to which the building belong to. The reduction of energy consumption could be achieved by changing the user's behavior, as the web portal would make an increasing awareness about the status of consumption.

The outcome of this paper will be integrated into the POLYCITY project to make the city of Ostfildern as energy efficient and sustainable for urban dwellers. Later this idea can be replicated for other cities in European countries. The result can also be interesting for urban planners, managers from utility supply companies, architects and engineers and so on.

References

- Intergraph (2005): *GeoMedia command Wizard*. Online Guide of GeoMedia Professional. Intergraph Corporation, USA.
- Hui, LI (2006): *Design and Implement a Cartographic Client Application For Mobile Devices using SVG Tiny and J2ME*, Master thesis, University of Applied Sciences Stuttgart, 2006.

OPENADDRESSES - FREE GEOCODED STREET ADDRESSES

Hans-Jörg Stark

School of Architecture, Civil Engineering and Geomatics, Institute of Geomatic Engineering University of Applied Sciences Northwestern Switzerland
Gründenstrasse 40, CH-4132 Muttenz, Switzerland.
hansjoerg.stark@fhnw.ch

KEY WORDS:

Open Geo-data, Addresses, Geocoding, Volunteered geography, Neo-geography, Crowdsourcing, Collaborative mapping

ABSTRACT

OpenAddresses is an Open Geo-data project. Its goal was originally to collect all addresses of buildings in Switzerland. Nowadays also other countries are involved. The process of data collection is organised as a collaborative process. Volunteers engage themselves in data collection using a GPS sensor or entering well-known addresses into a mapping mashup via the internet. The basic idea behind the project is that everybody has local spatial expertise. If this knowledge can be collected, organised and provided to the public, a global dataset of high value is achieved for free use. This information with a very fine spatial granularity can be used in many applications and help foster innovation and bring geographic information innovation into other business fields.

1 Introduction

Street addresses are of high value for micro-geographic applications in different domains. In the field of Health or Business Mapping, patients or customers need to be georeferenced as accurately as possible in order to run precise analyses and achieve the best results. Dr. John Snow's famous sample (figure 1) underlines the importance of fine spatial granularity for optimal analysis results.



Figure 1: Dr. Snow's famous map to fight cholera (source: <http://www.ph.ucla.edu/epi/snow/snowmap1.pdf>, accessed May 22 2009)

Another more current example is the determination of catchment areas for kindergarten locations. In Basel (Switzerland), these areas were determined by students of the University of Applied Sciences Northwestern Switzerland for the Basel City Rectorate. These catchment areas are determined based on the locations of all the addresses and kindergartens in Basel City. Without a reference dataset of geocoded addresses, this task would

not only have been very cumbersome but perhaps even. The result of the application can be seen in Figure 2 and Figure 3.



Figure 2: Geocoded addresses coloured according to their assigned kindergartens (source: www.map-your-world.ch, accessed May 22 2009)

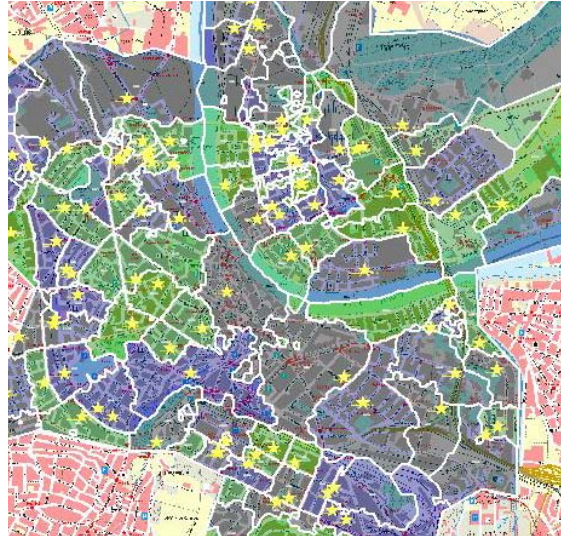


Figure 3: Kindergarten catchment areas after computation; yellow star symbols represent kindergarten locations. (source: www.map-your-world.ch, accessed May 22 2009)

1.1 Referencing Systems and Geocoding

Although the importance of geocoded addresses is apparent, such datasets are not easily accessible. While there are many free on-line geocoders available today - e.g. Google Maps, Yahoo! and Microsoft VirtualEarth, to mention just a few - most of them offer geocoding only through a linear referencing system. Geocoding is then done by interpolation and not by matching with the exact location. This linear referencing system is usually navigation data provided by one or both of the two world leaders (Navteq and Tele Atlas). In urban areas, geocoding based on navigation data might be sufficient for some or even most applications, especially when only navigation instructions are desired. But in rural areas or in scenarios such as the one described above, interpolation may not only be insufficient but may also be prone to error and thus lead to erroneous results.

Figure 4 and Figure 5 show the difference between the true location and the interpolated location. While with Figure 4, the true location of a specific street address was obtained with the on-line land surveying office geocoder, in Figure 5 (Map24 geocoder) only an estimated location was determined.



Figure 4: On-line Basel city lot plan (source: http://www.geo-bs.ch/stadtplan_parzellenplan_karte.cfm (accessed May 22 2009)



Figure 5: online portal "Map24" (source: <http://www.ch.map24.com> (accessed May 22 2009)

Mostly interpolated addresses are also placed on the linear referencing system (the street) itself, which makes it additionally hard to determine on which side of the road the specific building is located.

In most cases, portals like the one in Figure 5 are designed only to answer the question "where is...?" with regard to one address. As shown previously, this data is quite often not good enough for higher spatial analysis even though batch geocoding might be available.

1.2 Quality of online Geocoders

Recently, the geocoding engines of Google Maps and Microsoft Virtual Earth were examined by the author. 90'483 addresses from the Canton of Solothurn were used to test the geocoding accuracy. These addresses were provided by the Departement of Geoinformation in the Canton of Solothurn with the exact address locations given as co-ordinates. According to [2], who investigated the quality of the on-line geocoders, the spatial granularity at the building level is defined to 20m. This figure was taken as a threshold to assess the quality of the above-mentioned geocoders. The results are as follows:

- According to Google Maps, their engine geocodes 79'785 addresses (88.5%) down to the street level. Only 69'131 (76.7%) of these addresses have a distance lower or equal to 20m when compared to the reference data.
- With Microsoft Virtual Earth, the results are even slightly worse: according to their engine 77'392 addresses (85.8%) were geocoded as good match. However, only 36'770 (40.8%) of these addresses show a distance lower or equal to 20m when compared to the reference.

The need for an address dataset with exact locations is therefore obvious. However, when there is such a dataset, the conditions for access are usually quite restrictive, especially from a financial point of view.

2 OpenAddresses.ch

Today existing address datasets are only accessible at high costs. This means that for private or non-commercial use these datasets are not of interest. Hence the basic idea of OpenAddresses (OA) is to provide a free and complete dataset of geocoded addresses that can be used under a creative commons license (or other if the data is provided from an official cadastre).

The way to achieve this goal is to use the resource of collaborative mapping or volunteered geography (Aditya & Gadjah 2008, Fischer 2008, Goodchild 2008, Ramm & Stark 2008): Each person has a local expertise in the environment where they live. Apart from the very obvious local information from where they live or work, the person knows many more locations very well: where their favourite restaurants are located, where their best friends live, where they see their doctor, hairdresser, etc.

2.1 Collecting addresses

Thanks to the OpenAddresses map mashup, every person can enter their local spatial expertise into a centralised data repository where all addresses are stored with their corresponding co-ordinates. There is no data collected on individuals but only the address information mentioned before. Entering an address into the OpenAddresses database is very easy: after the map at the designated location is clicked on and the address-relevant information, such as street name, house number, postal code and city name, is entered, the address is saved directly into the database (cf. Figure 6).

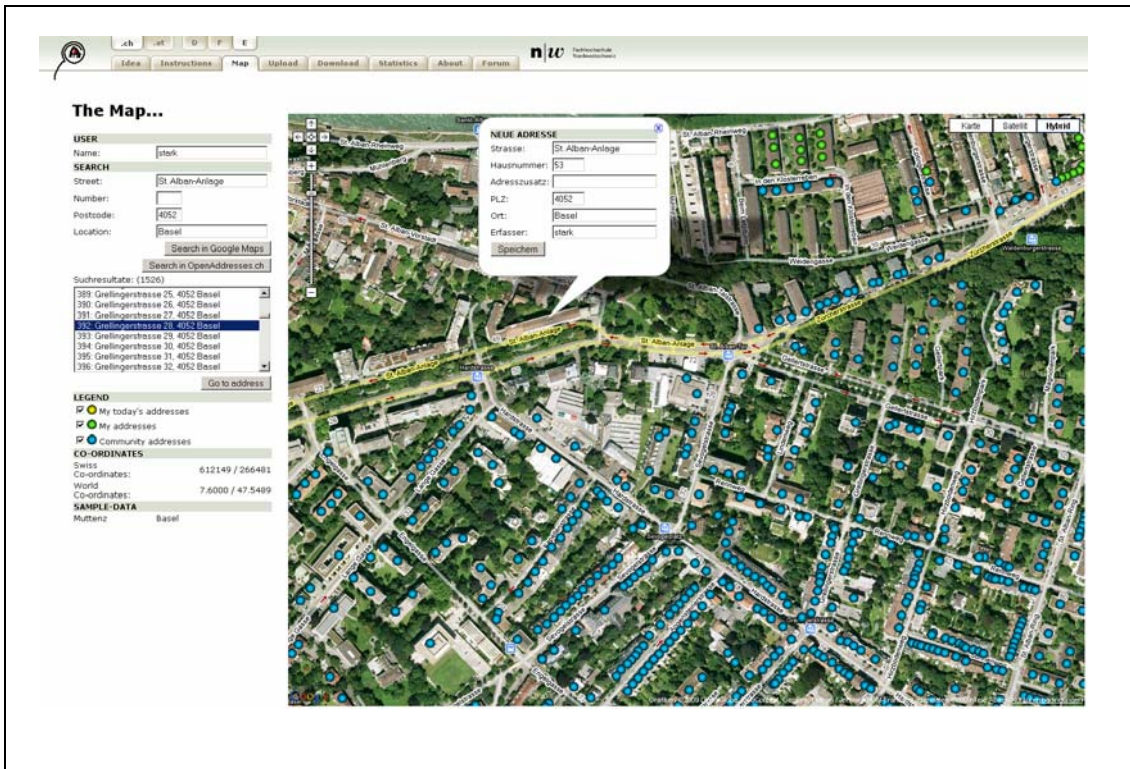


Figure 6: GUI to enter single addresses

People who like the idea of collecting addresses in a whole area can do so by either taking notes in the field or by using a GPS device. With the former, the OpenAddresses web page is at hand to enter all the addresses. With the latter, OpenAddresses provides an interface where the GPS tracks can be uploaded. The measured co-ordinates are placed on the web-map and need to be adjusted by the user. This is, on the one hand, because GPS measurements cannot be taken "on" the building outside and, on the other hand, because GPS measurements have accuracy only in a range of metres. This requires post-measuring adjustments to the locations.

A third option is to use address listings from a personal address book. If these addresses are in digitally structured format, they can also be uploaded to the OpenAddresses webpage. There the address information is processed and the addresses can be placed on the map manually. This option means it is possible to avoid the sometimes tedious work of entering the full address information.

2.2 Inside OpenAddresses

OpenAddresses is currently on the API of Google Maps. MySQL serves as the data repository. The whole functionality has been built using, on the client side, Javascript, CSS and HTML and, on the server side, Apache and PHP. OpenAddresses is a browser based application and is accessible via www.openaddresses.ch. A standard PC with a browser is sufficient to run OpenAddress and no additional software needs to be installed on the client. A fast internet connection is though highly recommended.

2.3 Functionality

The graphical user interface (GUI) of OpenAddresses is currently available in German-, French-, Italian- and English. It shows different tabs that either give information on the application and its use or that provide the interface for data collection as described above.

Apart from the functionality of data collection, also the download of the data is implemented. Currently only the whole dataset can be downloaded in XML format. A new version is being developed that will allow a user to select data based on different attributes and their values.

Existing addresses in the OpenAddresses database are shown as icons on the map. Thus a user can see whether address data which he is looking for is already available.

Simple statistical analysis gives an overview of both the activities of individual users and the number of addresses which have been collected for different locations.

Also search functionality gives the user the ability to check on existing addresses.

3 Experiences

Our experience to date has been positive. A total of roughly 440 users have joined the project. Since the beginning, around 143'000 addresses have been entered into the database. This is almost 10% of the total of Switzerland's street addresses.

The greatest challenge so far has been publicising the project. The project's success strongly depends on a great number of participants. As the task is simple and the system is very userfriendly many different kinds of people can participate. But informing people and motivating them to join in is difficult. Among the many projects that rely on volunteer participation, the immediate return of this one may not be as apparent as with others. But joining a mapping party nevertheless has great social value and reward.

To promote OpenAddresses, a new project "Map your World" (www.map-your-world.ch) has been initiated. Its goal is to invite middle school students to plan and work on a project in the field of volunteered geography. They will define the perimeter of their work themselves and collect geographic data in this area. This data will be entered into the OpenAddresses and OpenStreetMap projects. The equipment for the field work can be leased from the Institute of Geomatic Engineering of the University of Applied Sciences Northwestern Switzerland. This includes 16 sets of personal digital assistants (PDAs) in combination with GPS sensors. Also, the special software that runs on the PDAs and that helps with data collection is provided to the students. First experiences with this project have very positive. More detail can be found in Stark (2009).

References

- Aditya, T. & Gadjah M. (2008): Participatory Mapping. GIM International September, pp. 41-34.
- Ahlers, D., Boll, S., 2008: Retrieving address-based locations from the web. Proceeding of the 2nd international workshop on Geographic information retrieval.
- Fischer F. (2008): Collaborative Mapping – How Wikinomics is Manifest in the Geo-information Economy. GEO Informatics 11(2), pp. 28-31.
- Goodchild, M. (2008): Volunteered geographic Information. GEOconnexion International Magazine 7(10), pp. 46-47.
- Ramm, F. & Stark, H.-J. (2008): Crowdsourcing Geodata. Geomatik Schweiz. 106(7), pp. 315-319.
- Stark, H.-J. (2009): Map your World: Geodatenerfassung im Rahmen des Schulunterrichts. Geomatik Schweiz Edition 107(5), pp. 237-240.

XML-BASED AND OTHER GEORELATED ENCODINGS: OVERVIEW OF MAIN EXISTING GEOCODING FORMATS

Detlev Wagner ^a, Rita Zlotnikova ^b and Franz-Josef Behr ^c

University of Applied Sciences Stuttgart

^a detlev.wagner@gmx.de

^b dodonich@yahoo.co.uk

^c franz-josef.behr@hft-stuttgart.de

KEYWORDS:

Geotagging, GeoRSS, XML, GML, KML, WKT, GeoJSON, Formats

ABSTRACT

The importance of geotagging has significantly increased in the last years. Nowadays it is necessary to be able to georeference not only maps, airborne images or remotely sensed data, but also private pictures, news feed related locations etc.

The growing demand for geographic data resulted in different data formats and encoding standards which allow transfer, distribution and (for some of them) also representation of geographic features and georelated events on the web.

This paper describes and evaluates the main geotagging formats available today. These are XML-based standards, like GeoRSS, GML, KML and non-XML formats like GeoJSON and WKT.

They are evaluated with respect to their complexity, availability of predefined geometries, extensibility and integration of spatial reference systems and the definition of the latter.

In addition, an overview of major applications using those formats and providing interfaces or parsers is provided.

1 Introduction

About 25% of all commercial online searches were local searches according to a survey in the United States in 2004 (Karger, 2008). Search engines were not really able to handle georelated search requests that time. They were just gathering city or street names from the text content of the web pages. The proposition of geo tags was to "provide machine-readable information about country, region and exact latitude/longitude coordinates" (ibid.).

Simple applications of georeferencing soon became very popular, e.g. geotagging images with services like Flickr. Soon more complex applications were developed, mostly based on Google Maps, and so-called map mashups could be generated very efficiently (Ferrate, 2008). Today, there are a lot more providers offering similar services and interfaces around, some of them also from the open source community (Open Layers). We can even find ready-to-use Web-GIS which are running in a modern web browser and offer basic GIS functionality free of charge and accessible to everyone. Also geographic data is no longer bound to special applications but widely distributed in the internet instead.

The growing need to access geographic data resulted in adopting existing standards or in creation of new ones. The implementation of different data formats or encoding standards now allow transfer, distribution and (for some of them) also representation of geographic features and events on the web.

A list of all formats currently available for encoding geometry would be quite long and hence impossible to discuss within the scope of this paper. We focus on the most important and established ones like GML, KML or WKT besides more recent promising approaches like GeoRSS and GeoJSON. Some of those formats are based on XML and will be discussed first, before we are describing other important ones. The focus is on clarifying about the suitability of each format, its advantages and drawbacks.

2 XML-based standards

XML (Extensible Markup Language) is a simple, very flexible text based format which is in use for storage and exchange of a wide variety of data on the Web and elsewhere. (W3C World Wide Web Consortium, 2009) The main aims of XML are to store structured data, exchange data between the programs and also to serve as a base for creating more specialized languages.

In this chapter the selection of related XML-based standards will be shortly presented and commented.

2.1 GeoRSS

GeoRSS is a very new encoding, which has appeared only few years ago. It takes its roots from RSS (Really Simple Syndication) standard, which is used to publish frequently updated pages, e.g. news headlines, blogs entries and other feeds. (GeoRSS, 2007)

Normally the RSS feed structure contains a channel (feed), which has a title, link and a description; and the channel includes items (events), each one of whose has also a title, a short description and the link to a web page that contains the whole article.

The GeoRSS format has RSS structure, and additionally it is extended by the coordinates of the event. So the feeds can be geographically tagged and mapped.

GeoRSS differs from RSS by always having several namespaces based on XML schema files. This is in order to differentiate one document's elements from another document's elements and to identify a certain point of content from the Internet (Carey& Blatnik, 2002).

There are three encodings of GeoRSS, two primaries are GeoRSS Simple and GeoRSS GML and the third one is W3C Geo, which is older and already deprecated (GeoRSS, 2009).

Due to its simplicity, GeoRSS Simple is more in use nowadays than GeoRSS GML. For instance the earthquakes' geotagging is done with GeoRSS Simple:

```
<entry>
  <id>urn:earthquake-usgs-gov:nc:40237628</id>
  <title>M 2.6, Northern California</title>
  <updated>2009-06-04T12:49:49Z</updated>
  <link rel="alternate" type="text/html"
href="/eqcenter/recenteqsww/Quakes/nc40237628.php"/>
  <link rel="related" type="application/cap+xml"
href="/eqcenter/catalogs/cap/nc40237628"/>
  <summary type="html"><![CDATA[<img
src=http://earthquake.usgs.gov/images/globes/40_-120.jpg alt="38.191&#176;N
121.878&#176;W" align="left" hspace="20" /><p>Thursday, June 4, 2009 12:49:49
UTC<br>Thursday, June 4, 2009 05:49:49 AM at
epicenter</p><p><strong>Depth</strong>: 20.80 km (12.92 mi)</p>]]></summary>
  <georss:point>38.1910 -121.8778</georss:point>
  <georss:elev>-20800</georss:elev>
  <category label="Age" term="Past hour"/>
</entry>
```

GeoRSS example. Source: <http://earthquake.usgs.gov/eqcenter/catalogs/1day-M2.5.xml>

Although the structures of GeoRSS Simple and GeoRSS GML are very similar, there are significant differences in their abilities to describe geometries and to handle different coordinate systems. With GeoRSS GML it is possible to describe more complex geometries and assign any coordinate system, as soon as for GeoRSS Simple the coordinate system is fixed: geometries always have latitude/longitude pairs, and the elevation is taken from the WGS84 ellipsoid.

2.2 KML

The main use of KML (Keyhole Markup Language) format is in expressing geographic annotation and visualization on existing or future web-based online and mobile maps (2D) and earth browsers (3D) (OGC Open geospatial Consortium, Inc., 2009b).

KML was created by Keyhole, Inc., but the use of it increased significantly since late 2004 when the company was purchased by Google. It started to be used in Google Earth Browser (originally “Earth Viewer” by Keyhole Inc.) and gained its popularity.

KML is relative compact. This makes it easy to use and to learn.

The list of applications which are using KML is quite long. The main applications (from the most popular to less) are: Google Maps, Google Earth, Flickr, Google Mobile, WikiMapia, Google Sketchup, Live Search Maps, FME (Feature Manipulation Engine), OpenLayers, Geomedia, tripo, ArcGIS Explorer, Manifold System (according to Google Trends⁷).

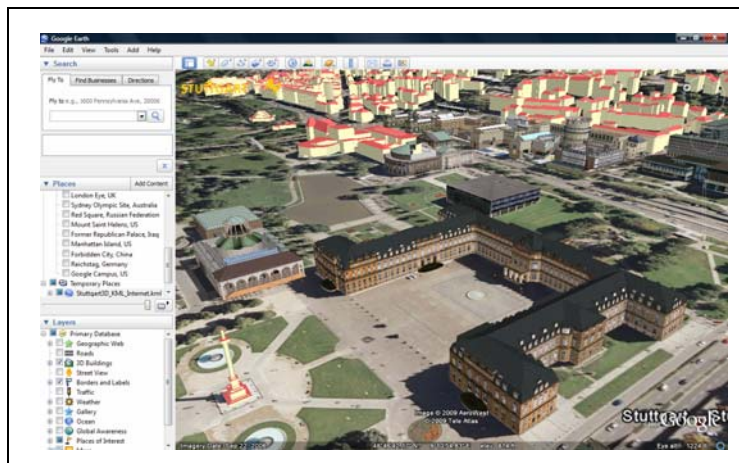


Figure 1: KML Example of 3D model of Stuttgart. Source: <http://www.stuttgart.de/3d>

KML is a very powerful language, but it does have some limitations, for instance the coordinate reference system for

KML is restricted to WGS84 and the altitude is defined by EGM96 Geoid Vertical Datum.

Another thing is that most of the KML viewers are 2D viewers without rendering of 3D models or providing a representation of the altitude. Other aspects of the standard (e.g. animation) are often not supported.

```
<kml xmlns="http://www.opengis.net/kml/2.2">
  <Document>
    <name>Bad Boll</name>
    <description>Bad Boll Image location</description>
    <Style id="gpsiesStyle">...</Style>
    <Folder>
      <Placemark>
        <name>Bad Boll</name>
        <styleUrl>#flag</styleUrl>
        <Point>
          <coordinates>9.601106643,48.63808437,411.00000</coordinates>
        </Point>
      </Placemark>
    </Folder>
  </Document>
</kml>
```

⁷<http://www.google.com/trends?q=Google+Maps%2C+Google+Earth%2C+Flickr%2C+Google+Mobile%2C+WikiMapia>

<http://www.google.com/trends?q=Google+Sketchup%2C+Live+Search+Maps%2C+FME%2C+OpenLayers%2C+Geomedia&ctab=0&geo=all&date=all&sort=0>

KML Encoding Example

Finally, as mentioned above, the KML's aim is to express annotation. It can be suitable for representing objects on already existing map, but is not rich enough to be able to define a complete map. In this case more powerful standard such as GML must be chosen.

2.3 GML

From the here presented XML-based formats GML is the most complex and most powerful. GML is a Markup Language which is used for the modeling, transport and storage of geographic information (Lake et al., 2004).

In contrast to KML, which describes object visualization and annotation, GML encodes geographic content by describing application objects and their properties. GML was not initially intended to have presentation information. It also differs from KML, which has only one static schema, by using application-specific schemas instead.

GML was developed between 1998 and 2003 and has been adopted as a specification by the OGC. The actual version of GML is 3.2.1. 2007. (OGC, 2007)

GML supports almost all the types of geometries, coordinate reference systems, also time, dynamic features, map coverage, units of measure and presentation styling rules.

Unlike KML or GeoRSS, GML does not default to a coordinate system when none is provided. Instead, the desired coordinate system must be specified explicitly (with a Coordinate Reference System (CRS) or Spatial Reference System (SRS)). The elements whose coordinates are interpreted with respect to such a CRS (Lake et al., 2004).

The richness of GML reflects its weakness as well, resulting in very big files. It can make it hard to impossible for the data transfer through the networks. The application-specific schema is another problem, which doesn't allow GML being directly portable between different applications (like KML for example).

A GML encoding example (Source: www.mpsupershape.com) is shown below.

```
<?xml version="1.0" encoding="utf-8"?>
<mpss:Mappoint xmlns:gml="http://www.opengis.net/gml" xmlns:mpss="http://www.mpsupershape.com/mpss
mpss.xsd">
<mpss:Shape gml:id="MPSS_1">
  <mpss:lineColor>65535</mpss:lineColor>
  <mpss:fillColor>16777164</mpss:fillColor>
  <gml:extentOf>
    <gml:Polygon>
      <gml:outerBoundaryIs>
        <gml:LinearRing>
          <gml:coordinates> 42.8398103825748,-86.1625626403838 56.8856766633689,-
90.1826373953372 41.0674982797354,-107.38607657142 39.026186093688,-87.8018286265433
33.4095101617277,-80.684738215059 39.9211347196251,-82.66426730901
</gml:coordinates>
        </gml:LinearRing>
      </gml:outerBoundaryIs>
    </gml:Polygon>
  </gml:extentOf>
</mpss:Shape>
</mpss:Mappoint>
```

3 Other Important Formats

3.1 WKT

WKT (Well Known Text) is a format for encoding simple features according to the specification of OGC (Open Geospatial Consortium, 2006, pp.62-64). It is widely used and supported for storing geometry data in data base systems. It offers a light-weight solution to encode features like Point, LineString, Polygon, MultiPoint, MultiLineString, MultiPolygon and GeometryCollections. In the latest

specification, version 1.1 (OGC, 2006), more complex geometries were added, like `Polygon`, `TIN` and `3D Points`. A simple `Polygon` shows the structure of the encoding:

```
'POLYGON ((0 0 0, 0 0 1, 0 1 1, 0 1 0, 0 0 0)) '
```

Coordinate reference systems can be defined in WKT. This is necessary because no default reference system is implemented, as well as in GML and GeoRSS GML.

The WKT standard is supported by most major applications and widely used with spatially enabled DBMS, due to its compactness and standardization.

3.2 GeoJSON

GeoJSON is rather new format that emerged in 2006 for the first time. The specification reached version 1 on June 16, 2008. The format was spreading quickly and is supported by more than 20 projects already with FME being the most important application (GeoJSON, 2009a).

“GeoJSON is a format for encoding a variety of geographic data structures“ (GeoJSON, 2009b). The base of it is JSON (JavaScript Object notation). The basis of it is an object and the data is given as key-value pairs. Another object can also be the value for a key, so nested structures are possible. Collections of values are represented by arrays; they can be nested as well.

As WKT, it is a light-weight format that focuses on a restricted set of geometries, very similar to the OGC simple features. These are `Point`, `LineString`, `Polygon`, `MultiPoint`, `MultiLineString`, `MultiPolygon` and `GeometryCollection`.

In addition, it is possible to combine geometries to a more complex so-called `Feature`, e.g. for describing a building. Also some other attributes can be included as key-value pairs (e.g. ID or properties). These `Features` can in turn be grouped in a `FeatureCollection`.

This definition of a `Feature` must not be confused with the feature definition by OGC!

For example a simple `Polygon` can be described like this:

```
{ "type": "Polygon", "coordinates": [ [ [100.0, 0.0], [101.0, 0.0], [101.0, 1.0], [100.0, 1.0], [100.0, 0.0] ] ] }
```

Any coordinate reference system can be assigned to each individual geometry; the OGC nomenclature is preferred to the EPSG numbers. The default coordinate system is latitude/longitude based on WGS84.

3.3 HTML Meta Tags

A whole HTML document can be geocoded using the GeoURL standard (Daviel, 2006). Position data is provided in the header section of the document inside special meta tags having a value for the name attribute starting with `geo`. A simple example:

```
<html>
<head>
  <title>My Document</title>
  <meta name="geo.position" content=" 48.64; 9.60" />
  <meta name="geo.placename" content="Bad Boll,Germany" />
  <meta name="geo.region" content="DE-BW" />
</head>
<body>
.....
</body>
</html>
```

Coordinates are given as latitude/longitude pair, separated by a semicolon, based on the datum WGS84. As a third value the elevation can be given, but this is quite unusual. The `geo.region` tag is optional. Only points can be geotagged.

Another widely used tag is the ICBM tag, which is the same as the `geo.position` tag but with a comma as coordinate separator, but it is not part of the standard:

```
<meta name="ICBM" content="48.169822, 11.601171" />
```

3.4 Geotagging in Wikipedia

The Wikipedia project offers a very easy-to-use solution for geotagging articles and other media. A simple string can be placed when creating the content and will be evaluated on the server side to display a link in the upper right corner of the article.



Figure 2: Point Feature Bad Boll as link in Wikipedia

A click on the globe opens an interactive map centered to the coordinates. A click on the coordinate string displays a list with other wiki media related to that position. This can be supported by geolocalization and mapping services like geonames.org (Hahn & Behr, 2006). The default coordinate reference system is latitude/longitude based on WGS84.

4 Conclusions

The main geocoding standards available today have been presented and their most important properties have been pointed out.

GML, provides almost limitless capability to define geographic objects. As GML format has almost unlimited abilities in defining geographic objects, it might be hard to quickly get familiar with this standard (specification of GML 3.2.1 includes more than 500 pages!); in addition it can be extended according to the user's needs. The size of files can become large, especially when extensive XML-style tags surround the actual data. This can make the transfer and access through the Internet difficult. Also this format is not intended for visualization.

KML, on the other hand, can be very useful to represent geographical features in 3D. The downside of this format is, however, that it can not support descriptions of complex features, a task easily handled in GML. KML is supported by commercial mapping APIs such as Google Maps, Virtual Earth and also from open source mapping APIs such as OpenLayers.

GeoRSS, in turn is the simplest of the three XML-based formats. It is not difficult to learn, can be quickly implemented, and files can be easily transferred through the Internet. Yet, GeoRSS is more restricted than the other standards. In contrast to GML, it cannot display most forms of information of geographic objects. As with KML, commercial and open source mapping APIs have support for GeoRSS, primarily as an import data format. It is used by most of the web-mapping applications, e.g., OpenLayers, Yahoo! Maps, Google Maps, Virtual Earth and others.

In general, XML-based formats differ mostly in capability and complexity, a common tradeoff when choosing such a markup languages.

Simple formats, like HTML meta tags for position or the geo tag from Wikipedia, are very easy to implement and use, but they can only handle simple positions, i.e. points. This might be sufficient for a lot of applications, like geotagging images, so it is a straight forward way for implementation.

More possibilities are offered by WKT and GeoJSON, both following the simple feature model of OGC more or less. Even coordinate system handling is implemented and easy to use. Both are 'lean' formats without a big overhead of tags around the data. Compared to fully-fledged GML, they are very well suited to decrease network load. Both are supported by a lot of applications. Especially WKT is very easily readable by human beings; GeoJSON in turn does not need a special parser, because JavaScript is parsed by any modern web browser directly.

Together with GeoRSS the latter two formats are a well suited middle way, offering almost every type of geometry that is commonly required. They also can be implemented very quickly without a long training period or previous experience.

To conclude, each of these formats has its own advantages and drawbacks, and the best is to get familiar with their capabilities and figure out which one is most appropriate for a specific task.

In the future we expect the georelated encoding to be more wide spread, implemented as well in other formats which are not georelated today.

References

- Anonymous, 2008. Das Geometriedatenmodell von GeoJSON. <http://geospatialweb.wordpress.com/tag/geojson/> [accessed 13.05.2009]
- Behr, F.-J., 2005. XML-basierte Kodierung von Geodaten mittels der Geography Markup Language. http://gis-management.de/papers/Behr_GML_3_Artikel.pdf [accessed 25.05.2009]
- Butler, Howard et al. 2008, The GeoJSON Format Specification. <http://geojson.org/geojson-spec.html> [accessed 13.05.2009]
- Carey K., Blatnik S., 2002. XML. Content and Data, Pearson Education Inc.
- Crockford D., 2006, Introducing JSON <http://json.org/> [accessed 13.05.2009]
- Daviel, A. 2006, Geo Tag Elements. <http://geotags.com/geo/geotags2.html> [accessed 13.05.2009]
- <http://geotags.com/geobot/add-tags.html> [accessed 13.05.2009]
- Ferrate A., 2008, 3 Top Data Formats for Map Mashups: KML, GeoRSS and GeoJSON <http://blog.programmableweb.com/2008/08/27/3-top-data-formats-for-map-mashups-kml-georss-and-geojson/> [accessed 13.05.2009]
- GeoJSON, 2009a, The GeoJSON Format Specification. <http://geojson.org/geojson-spec.html> [accessed 13.05.2009]
- GeoJSON, 2009b, Users. <http://wiki.geojson.org/Users> [accessed 13.05.2009]
- GeoRSS, 2007. GeoRSS: Geographically Encoded Objects for RSS feeds. <http://georss.org/> [accessed 25.05.2009]
- GeoRSS, 2009. Encodings. <http://georss.org/Encodings> [accessed 25.05.2009]
- Karger H., 2008, HTML Geo-Tag Generator. <http://www.geo-tag.de/generator/en.html> [accessed 28.05.2009]
- Lake R., Burggraf D. S., Trninic, Rae L., 2004. GML, Geography Mark-Up Language: Foundation for Geo-Web. Wiley.
- Lewis A., Purvis M., Sambells J., Turner C., 2007. Beginning Google Maps Applications with Rails and Ajax: From Novice to Professional. Apress, pp. 4-5
- Hahn M., Behr F.-J., 2006: From Concept to Realisation of an ISPRS related LBS Competition. ISPRS Commission IV Symposium, WG 4.6, Goa, India, http://www.gis-news.de/papers/Paper_Hahn_Behr_Wg46_2006.pdf
- Marchal, B., 2000. Applied XML Solutions. Sams, pp. 112-113
- Marsden R., 2009: Technical Overview GeoJSON. <http://www.geowebguru.com/articles/97-technical-overview-geojson> [accessed 13.05.2009]
- OGC Open Geospatial Consortium, Inc, 2006, OpenGIS Implementation Specification for Geographic information - Simple feature access - Part 1: Common architecture. http://portal.opengeospatial.org/files/?artifact_id=18241 [accessed 13.05.2009]
- OGC Open Geospatial Consortium, Inc., 2007. Geography Markup Language, http://portal.opengeospatial.org/files/?artifact_id=20509 [accessed 28.05.2009]
- OGC Open Geospatial Consortium, Inc., 2009. OGC KML, <http://www.opengeospatial.org/standards/kml/> [accessed 28.05.2009]
- W3C World Wide Web Consortium, Inc., 2009. Extensible Markup Language (XML), <http://www.w3.org/XML> [accessed 28.05.2009]

OPEN SOURCE GIS IN CADASTRAL GEOSPATIAL DATA BANK DEVELOPMENT OF COASTAL ZONE, BORDER ZONE, SMALL ISLAND AND SPECIFIC REGION (WP3WT) IN INDONESIA

Asep Yusup Saptari

Department Of Geodesi – Winaya Mukti University
Research and Social Service Institute of Winaya Mukti University
aysaptari@yahoo.com

KEYWORDS:

Indonesia, Open Source, e-government

ABSTRACT

The Indonesia Land Office has implemented a coordination policy in land consolidation for coastal zone, small island, border zone and specific region. The Land Office directorate of coastal zone, small island, border zone and specific region (WP3WT) is concerned with land information system management development, including arranging a municipal/country land database package, preparing attribute and spatial application system for land registration, development of land ownership database which is linked with e-governance and e-payment, cadastral mapping in case of land ownership investigation and registration empowered by satellite imaging technology and information technology to support land reform policy implementation through GIS. This situation has lead to the characteristic GIS development to provide a main chart of coastal, small island, border area and specific region database which will support development and the future integrity of database, provide interface for executive summary, availability of web GIS application offering many information connections and public communication.

1 Introduction

Indonesia Land Office has an exclusive characteristic in e-government development especially in relation with Land Information System. It started with LOC (Land Office Computerization) development which applied Smallworld and Oracle database to manage the information system. The Directorate of Border Island, Small Island and Specific Region as one of the institutions in the National Land Office environment has a very specialized data and analyses system to answer the demands of spatial information. On the other side the application to be implemented must adhere to LOC structure data (Smallworld and Oracle 10g). It is to guarantee that the system can be integrated in National Land Information System.

The developed information system is an intranet-based one that operates in local environment, but is applicable to be integrated with LOC system, since till now LOC spatial information system itself is under development and fine tuning for perfectness. This situation has relation to as built LOC's facilities accommodate developed query.

2 Aim and Purposes

The aim of GIS in Cadastral Geospatial Data Bank Development of coastal zone, small island, border zone and specific region development are:

- Arrangement of land database frame work that can be used as foundation for developing and maintaining land database integrity in the future.
- Build an interface / application as the base of decision making in organization and arranging of land authority, land utilization, land ownership, land beneficiary in Directorate of Border Island, Small Island and Specific Region (WP3WT).
- The availability of web-based application which is online for public.
- As the foundation of e-governance in Land Office environment.
- Database of Directorate WP3WT

This database is a back office database of WP3WT application. The database is constructed by what we called “plus integration”, plus mean besides integration the system should accommodate some existing database:

- Internal data unit
- External data (might be available)
- Build an Enterprise Application Integration (EAI) whereas selected EAI is a database enterprise which yields integrated WP3WT data system.

Database enterprise architecture can be illustrated as follows:

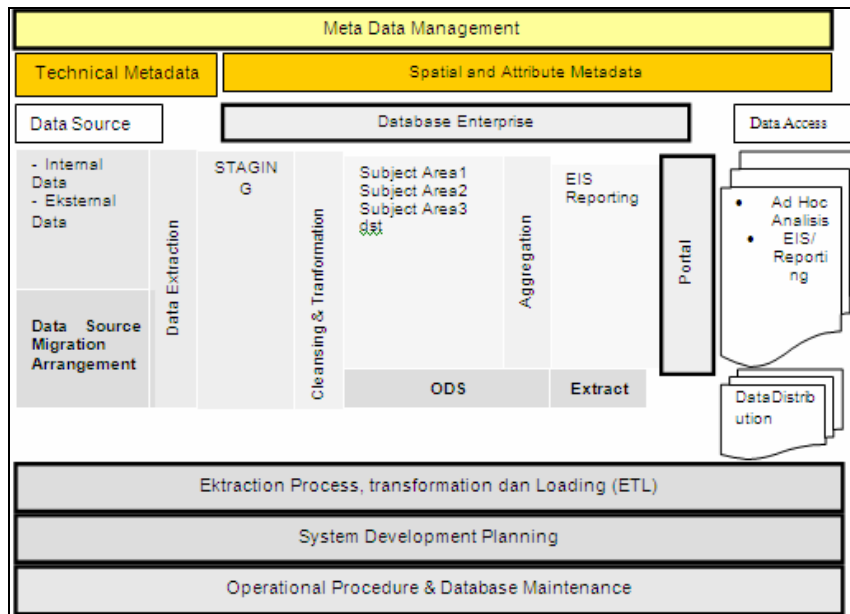


Figure 1: WP3WT Database Enterprise Architecture

The Data Sources are covering all data in WP3WT Land Office environment both internal and external.

The initial process is metadata management to collect information about the data itself, both for spatial and attributes information, so that the user can understand data terminology and information processes easily. The data collected from several sources is stored in a temporary warehouse in staging process. Staging maintains the data :

- In a certain database
- Non-indexing saving to accelerate transformation process
- Only developer can access the data
- Post-staging data can be transformed into database

Metadata contains information or definition as required by user about meaning, quality, ownership and the timelines. At the end information source and definition will be unique and easily understood by the user.

In database enterprise environment, coastal zone, small island, border zone and specific region, processed and integrated data will be applied for reporting and analyses. This application contains atomic data and summary or both, as per the user demand. Enterprise Data Warehouse (EDW) will treat data storage historically and is stored in a centralised server. Based on the EDW rule, data is organised in ODS (Operation Data Store) as data warehouse to store data transaction which is arranged to maintain the EDWs needed. Transaction data can be various follow the data operational change to intercept real time summary with good performance and scalability.

Extraction processes, transform and loading (ETL) has a function to gather data and to select data for consecutive processing into database as business requirement. Technically metadata also can be used to help ETS control processes. For every single process, change in data source, bussines process, target can be identified by how big the effect is on the database.

3 Analyses

User requirement analyses is performed to identify user needs, auxiliary information including restriction and level of data / information depth determination. User requirement was gathered through some investigation involving end user.

System Design Analyses comprises the conceptual and logical design of the system. In this step we formulate Entity Relational Database (ERD), Database connectivity applying GUI, Database integrity and logical query to develop application and database system,

Database Design: Shortly the developed database has these abilities:

- Back Office application to manage and process spatial and attribute data in the form of information technology digital map in suitable formats.
- Accessible for further development like web-based application as public information media.
- Provide attribute and spatial database.

For the above reasons, system development must concern data security aspect, easiness for end user and administrator, design, architecture, implementation has to accomodate general structure for interoperability purpose and further development.

Analyses function and spatial modelling development will be very useful in making decisions faster and more accurate. In the line of it, the process should meet the specific needs of the land office in coastal zone, small island, border zone and specific region environment. So it can be understood according to GIS application development directed to build functions as web-based database management system with spatial and attribute information integrity. The information system built is to identify data and information, the investigations by the management unit. This will remain so, until GIS functions can accommodate displaying the requirements, reporting, etc of source data and information that are required by the government and the public. To fill up the data and information requirements, there is a need for the existing data and information properties.

4 Attribute and Spatial Database

Attribute data are the data that are connected and pertains to a certain spatial data. The data includes related information, with the aim of system development. From the GIS components, application programs can be built. This makes use of application programs directed to main application in LOC environment.

Attribute database arrangement is based on existing layer and table as follows:

Table Name	Spatial Data Availability	Attribute Data Availability	Auxiliary
Master_Lokasi	A	A	Master
Land Utilization	A	A	Primary
Land Beneficial	A	A	Primary
Land Ownership	A	A	Primary
Land Authority	A	A	Primary
Social Economic	NA	A	Primary
Social Culture	NA	A	Primary
Administration	A	A	Primary
Survey note	NA	A	Primary
Image	A	NA	Primary
Text Administration	A	NA	Primary
Text Object Geographic	A	NA	Primary
Teks_Fasum_Fasos	A	NA	Primary
Reference Point	A	A	Secondary
Shore type	A	A	Secondary
Coral reef type	A	A	Secondary
Sea grass type	A	A	Secondary
Ground water intrusion type	A	A	Secondary

Sea water penetration type	A	A	Secondary
Agri land area	A	A	Secondary
People density	A	A	Secondary
Settlement area	A	A	Secondary
Shore buffering	A	A	Secondary
River buffering	A	A	Secondary
Land elevation	A	A	Secondary
Height Above MSL	A	A	Secondary
Depth from lowest tide	A	A	Secondary
Soil acidic	A	A	Secondary
Effective soil depth	A	A	Secondary
Soil texture	A	A	Secondary
Border factor	A	A	Secondary
Erosion type	A	A	Secondary
Soil evaporation	A	A	Secondary
Climate	A	A	Secondary
Sedimentation type	A	A	Secondary
Abrasion type	A	A	Secondary
Reclamation type	A	A	Secondary
Hazard potential	A	A	Secondary
Land ownership number	A	A	Secondary
National Spatial Planning	A	A	Primary
Province Spatial Planning	A	A	Secondary
City Spatial Planning	A	A	Secondary

Physical Modelling: Physical model contains table design, relation and description of land data tables in Directorate of coastal, small island, border area and specific region of land office.

Table 1: Attribute database arrangement is

The spatial data for WP3WT system are organized based on the principle of ISO / DIS 19135 (Procedures for registration of geographic information items, Draft of International Standard ISO / DIS 19135 2004). The geographical information system items registration have some value as following:

- Support internationally wide use of registered GIS items by providing that the initial items adhere to ISO standard or publication targeting to potential users.
- As reference for standarisation system in integration items of dataset collection.
- Adaptable to language and culture change in case of item names seamless using language, culture, application area and various profession to generate coherence perception of items.

Table description symbolisation is described as following:

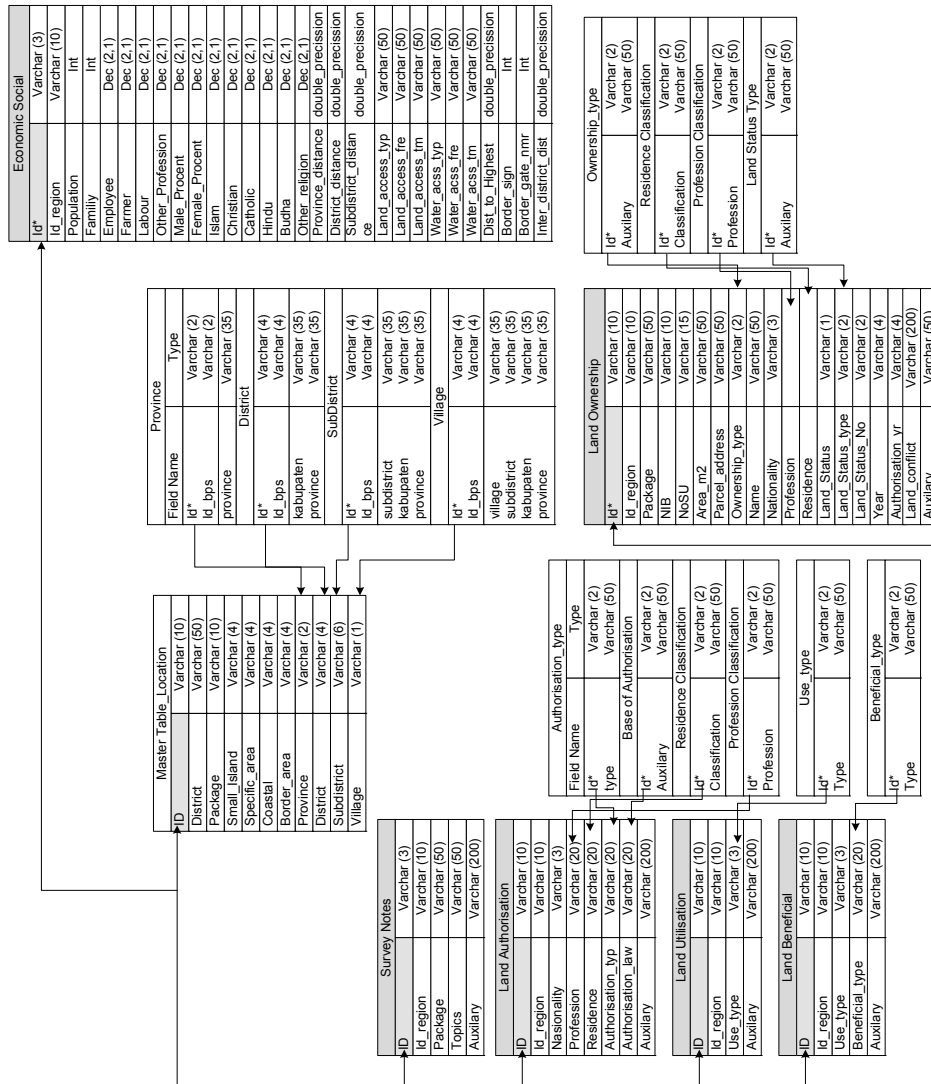


Figure 2. Table Relationship

5 WP3WT Spatial Data Organisation

5.1 Spatial Items Identification

All spatial data items connected with WP3WT are grouped into two main groups, primary and secondary data. Primary data grouping is characterized by; direct field acquisition or measurement, classified as main spatial data of WP3WT, data acquired internally in Land Office (WP3WT) environment. Secondary data grouping characterized by; Indirect field acquisition or measurement, classified as supporting spatial data of WP3WT, data acquired externally of Land Office (WP3WT) environment.

5.1.1 Spatial Items Definition

The spatial data of WP3WT is arranged as spatial data identity of WP3WT in land office environment. According to spatial data format organization, spatial data is divided into two large groups :

- Hardcopy format spatial data.
- Digital format spatial data which consists of two formats; vector and raster.

Both the spatial identity formats viz.,hardcopy and digital have similarity regarding description / spatial data name and spatial object data visualisation (texture, colour, symbol etc) and the differences of spatial data identity only exists for digital spatial data comprising unique spatial data ID and spatial data properties identities which optionally clarified spatial data identity and more efficient organisation. The raster / image which will be

integrated to system application should be post rectification image with the rectification data saved in the image header in TIFF format.

5.2 WP3WT Physical Data Modelling

5.2.1 Spatial Data Name / Description

Spatial data description is the theme's name of spatial data which will be considered for use in the analyses by WP3WT directorate, layer name description is acquired from several discussions and interviews with users in the directorate of WP3WT environment.

5.2.2 Spatial Object Data Visualisation

According to UN Publication 'Manual On GIS For Planners and Decision Makers' digital format spatial data visualisation is classified into three categories: Symbol / Point, Line/Polyline, Boundary/Polygon/Region.

Each of these categories of spatial data contains specific feature properties complying to feature shape category. The description of applied properties to the WP3WT Application are as follows:

Properties of Boundary/polygon/region consists of: Region colour, Pattern of region colour, Region line weight, Line colour. Line/Polyline consists of: Line weight, Line colour. Symbol/Point properties consist of: Point pattern, Point colour

Secondary spatial data (base map, cadastral map, etc) was collected from several sources, the spatial data list was treated only as a base on the theme of spatial items, properties comply to existing secondary data. This rule is also valid for the updating of secondary data.

5.2.3 Spatial Data File Storage Management

According to data grouping (primary and secondary), spatial data is stored into folder by folder hierarchy as :

1. Primary, contains survey data of coastal, small island, border area and specific region (WP3WT)
2. Secondary, contains secondary data or existing data that spreads out into several institutions.
3. Satellite Image, contains raster / satellite image named base on administration hierarchy ; Province, District, Subdistrict and Villages



Figure 3: Satellite Image of Border Island

5 Script Programming

After all design and definition among all tables, application development process is proceeded with programming process. Interface programming process combining some programming tools as their characteristic, as the title of the project, some open source software applied for these process are:

- PostgreSQL, for database development
- Map server, for spatial database
- PHP, for interfacing
- Alternative database : PostgreSQL / PostGIS,
- Connection : PHP
- Support software for data entry processing : MapGuide Studio (format *.sdf), ER-Mapper (format *.ecw), AutoCAD Map (format *.tiff, *.dxf).

Since the built database must accommodate the availability to communicate with LOC's database which was developed using oracle 10g, shapefiles are selected as interface data.

5.3 Design Menu

The design menu is the front end display generated by programming tools. The quality of the front end design determines how far the application can communicate easily with the user. It depends on the capability of the programmer, since the open source suites still lack communication facility compared to commercial software. Design menu also describes each module inside application. The main consideration of design module generation is developed in a simple way but delivers more ease of use to the user, so the design menu must be consistent with daily use form as tools.



Figure 4: Main Menu Front Page

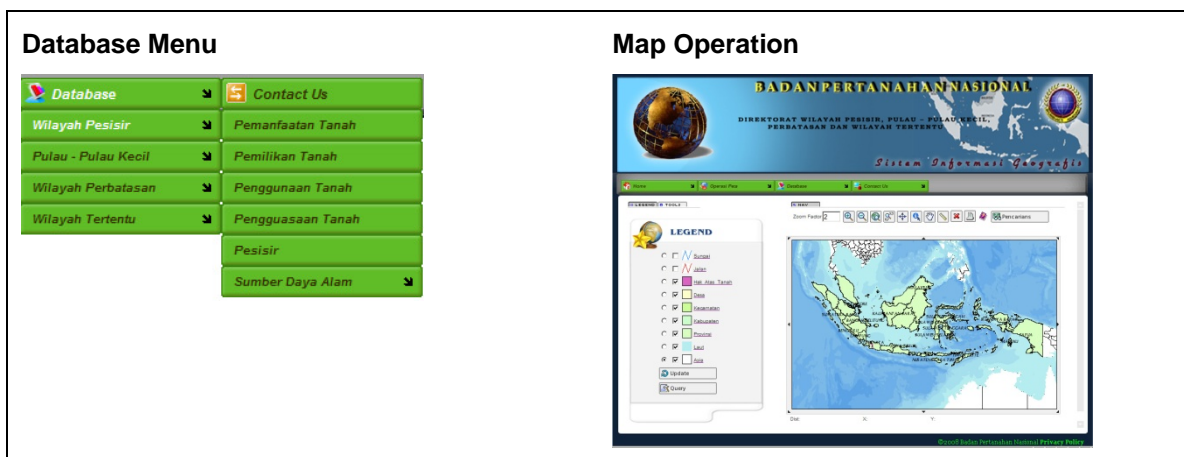


Figure 5: Transaction Menu

6 Conclusion

Open source application can be optimized by selecting good combination of several programming software.

For certain instances (like Indonesia Land Office) which develops general information systems called LOC (Land Office Computerisation) has specifications in requirement in selecting tools and database characteristic. For example the choice of using post gre where it is assumed that it can accommodate the nature of oracle 10g. Interoperability is the main consideration in performing data format which can be used by directorate and sub directorate.

References

- UN Publication, "Manual On GIS For Planners and Decision Makers' Economic and Social Comission for Asia and The Pasific.
- ISO / DIS 19135 (Procedures for registration of geographic information items). Draft of International Standard ISO / DIS 19135 year 2004.
- Ramez Elmasri, Shamkant B. Navathe, 2003; Fundamentals of Database System,; Pearson, Addison Wesley.

OPENSTREETMAP AND OPENLAYERS: OPEN GEODATA IN AN OPEN SOURCE MAP BROWSER

Franz-Josef Behr

Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
franz-josef.behr@hft-stuttgart.de

KEYWORDS:

Internet/Web, Open Source, OpenStreetMap, OpenLayers, Interoperability

ABSTRACT

Geoinformation deployed over the Internet is characterized by a high level of diversification: many different formats, systems, and services, offered by public and commercial suppliers. Interoperability of the services and of data is gaining increased importance.

In this presentation OpenLayers, a freely available mapping client is presented, where the emphasis is explicitly placed on the integration of different services and formats. The organisational framework conditions of this project may be considered to be exemplary with regard to other successful projects of this category. It is demonstrated how data can be loaded, integrated, and visualized. A general tendency is increasing convergence of open data and freely available software tools; this will be demonstrated with the example of OpenStreetMap, a project of high importance for developed and developing countries.

WEB GIS BASED 3D VISUALIZATION OF GEOSPATIAL DATA

H A Nalani

Sabaragamuwa University of Sri Lanka Dept. of Cartography, Photogrammetry, Remote Sensing & GIS
Faculty of Geomatics, Sri Lanka
nalani@sab.ac.lk

KEYWORDS:

Web GIS, 3D Visualization, Geo-processing, VRML

ABSTRACT

In web based geo-processing, the OGC specification Web Processing Service is used but only for simple sharing of spatial analytical functionalities. A variety of spatial data analysis can be made on the web-based application using distributed geo-processing communications so that these analyses can be used for the purpose of spatial decision support systems such as flood modeling, landslide, etc. Further, 3D geospatial data visualization in widely used web browser is implemented to support easy understanding of analytical results.

The aim of this research is to develop a new method that allows 3D visualization of geospatial data. Various open standard software is used to achieve this goal. VRML was used for interactive visualization. The system offers a browser only solution so that it can be used to visualize the existing data, gathered from distributed Web feature Service and Web Coverage Services. But also dynamic results offered through WPS can be accessed. The multi-layer distributed web service architecture is applied to implement this new system and also the system has been executed entirely using Free and Open Source Software. Therefore, the developed application can be used to analyze a variety of spatial data for spatial decision support systems and 3D geospatial data visualization. Also, it can be applied in different disaster applications that allow user to make better decisions so that can be used to decrease the effects or support preparation and also can be coupled with GIS functionality. In the experiments it has been used for flood model.

1 INTRODUCTION

The rapid growth of Internet has led to an increasing concern over the Web Geographic Information System (WebGIS). Also, the World Wide Web (WWW) offers new application areas. It access to geographic information so that it can be used to distribute information to a massive amount of users. Also, there has been considerable interest in geospatial data visualization through the web services employing geographical information system (GIS). Therefore, widespread availability of internet and related services such as WWW technology has been widely applied in geo spatial data visualization and in providing the general public channels to allow wide access to geo-referenced data or GIS services. Further, these technologies provide an advanced means to assist with visual data exploration and spatial decision making systems in contest of as landslide, earthquake, flood modeling and debris flow, etc.

There are several researches that have been accomplished concerning the WebGIS for 3D geospatial data visualization. Some of them related to the topic discuss briefly reviewed in the following.

Fairbairn and Parsley (1997) discussed the use of VR (Virtual Reality) technology and Virtual Reality Modeling Language (VRML) for cartographic presentation, and provided several examples to demonstrate virtual campus construction. Huang and Lin (1999) developed a client/server architecture system (called GeoVR) which enables interactive creation of 3D scene and VRML model from 2D geospatial data by integrating internet GIS and HTML programming. This paper has demonstrated how ArcView 3D extension, ArcView IMS, Avenue and HTML programming work together to provide a convenient environment for Web-based 2D and 3D visualizations.

Brown (1999) discussed the web-based geospatial visualization in 1999; it proposes a framework for integrating Java External Authoring Interface (EAI) and Virtual Reality Modeling Language (VRML) which is a file format for creating 3D virtual worlds, to produce a Graphical User Interface for Geographic Information Retrieval.

Brown realized that it is very slow and inefficient. Huang et al (1999) presented a 3D WebGIS using the Java EAI/VRML; called GeoV&A. It is an application for 3D visualization and analysis however, it was dependent on the level of interactivity offered by the VRML browser. As Java3D can be successfully used to apply a web-based environmental visualization tool, Huang (2003) proposed a hybrid client-server model for web-based 3D hydrological visualization using the Java3D API, called TOPMODEL. Gobe et al (2005) presented a tool which brings 3D GIS functionality to a standard web browser, without the need for specific plug-ins. It was an online visualization tool called GeoDOVE (Geospatial Database Online Visualization Environment). GeoDOVE was a 3D visualization environment for viewing and analyzing spatial information using an internet browser. It has attempted to highlight how to combine Java3D and open source database technology to development of 3D WebGIS. Further, it discussed how to enable RDBMS to store multi-band raster datasets. As this approach is platform independent, it can be used in any relational database.

In addition, Chao et al (2003) proposed a prototype of Web 3D GIS on the basis of 3D terrain visualization. In this paper, the tile-based selective visualization methods have employed to improve the real-time visualization for large-scale surface with VRML. Yu et al (2004) presented a web-based prototype viewer called GSN which has been designed and developed under a client / server architecture to enable the interactive creation of a 3D scene from 2D spatial data by integrating Internet geographical information system (GIS) and Java 3D technology. VR, Java, and Internet technologies to design and implementation of 3D web-based GIS focused on 3D geographical analysis have been applied in this paper.

As the Web has become a “Distributed Operating System (DOS)”, it allows building new applications by mixing and matching information. Also, the Open Source development and user communities have interacted with organizations so that it created a demand for spatial information and provide different tools. These tools make easy decision making in strategic planning processes. This is a world of multiple dimensions and geographic information, is a tool that can help for many applications. So that, This paper aims to implement a solution using various Free and Open Source Software (FOSS) that enable 3D visualization of geospatial data as VRML model. As the Web Processing Service (WPS) which is defined by the Open Geospatial Consortium (OGC) makes use of geospatial data and turns it into well-informed information for better decision system; it is intended as a solution for sharing geo-processing through internet’s application (Huang, 2003). The map generated using WPS could serve as useful information to monitor, evaluate and allow for making better-informed decisions. This system has developed under the multi-layer distributed web service architecture. It is use various open standards web services for 3D visualization of analytical data from geospatial modeling. Also, the technology and structure can be applied to develop different useful disaster prediction applications such as flood modeling, Landslide, earthquake and etc. In the experiments it has been used for flood modeling.

2 3D WEB-BASED GIS VISUALIZATION REQUIREMENTS

Geospatial data visualization mainly focuses on two domains: computer graphics and GIS data. The web-based GIS are found that visualization and rendering techniques have the largest usage. However, Rifaat (2004) described that the advantage of 3D lies in the way to see the information. The main purpose of interactive web-based visualization is to provide smooth navigation through large 3D GIS models. He pointed out six basic requirements of the visualization process to be used as the basic of the GIS client’s user interface: Display quality, Stable network and system performance, Modeling Efficiency, Interoperability that allow for data and system capabilities share with others, Reliability to the level that permits of having continued analysis and Security, that prevents from undesired intrusions. This 3D models help to improve public participation in a decision making.

3 MULTILAYER WEB SERVICE ARCHITECTURE

The system architecture for visualization of geospatial data presented here is a multilayer web service architecture approach. Its basic structure is described shortly in below:

In software engineering, multi-tier architecture / n-tier architecture is a client- server architecture in which, the presentation, the application processing and the data management are logically separate processes. The concepts of layer and tier are often used interchangeably. However, there is indeed a difference that a layer is a logical structuring mechanism for the elements, and a tier is a physical structuring mechanism for the system infrastructure. So, a multilayered architecture is using different layers for allocating the responsibilities of applications. It is separated into several layers. A whole range of services is used to provide specific features.

The most widespread use of architecture has the three layers: Presentation Layer, and Business Layer, Data Layer (Wikipedia, 2009).

Basically, the multi-layer web based architecture used in this development has the four layers: Client, 3D Rendering, Web Processing and Data Provider, which is described shortly as follows:

The client application of this system provides an HTML form which allows users to define the sufficient properties of 3D scenes, and to submit the collected values as a request in the form of URLs via the web server to the data processing service. After receiving and processing the request, the output will be visualized as a part of web application to the client for further navigation and interaction. The web mapping client application of this system is indicated in the front-end interfaces: map browsing tools, result map display, preview 3D scene of modeling result and network accessible address of manipulated results.

In the data processing service, all data obtained from distinction source are converts into attractive information. Then the results of geo-processing are incorporated and manipulated in a 3D scene by rendering service and the output are send to the client. All tasks of Data processing service and 3D rendering service, controls and illustrate using Web Processing service (WPS). The next layer is the Data Provide Service layer which is creates a web services to publish various geospatial data source. The standard OGC specification web Coverage Service (WCS) and Web Feature Service (WFS) are used to access the online geospatial data source through the network connection.

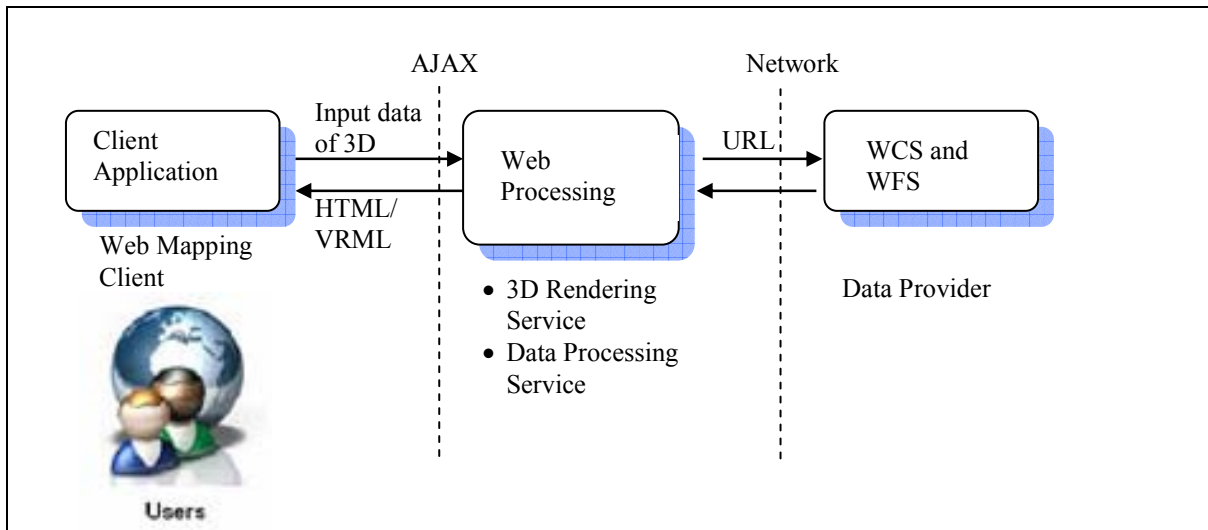


Figure 1: System Architecture

4 PROTOTYPE IMPLEMENTATION

In order to promote easy understanding of analytical results, 3D geospatial data visualization in widely used web browser is being implemented. In this research, a novel solution is realized using a variety of open standards and this solution can be used for 3D visualization of geospatial data as VRML model. As this system offers a “browseronly” solution, the existing data from distributed WFS and WCS can be visualized and also dynamic results offered through WPS can be accessed. The system has a clearly demarcated Service Oriented architecture (SOA) workflow that is scalable, transparent and distributed. The implementation of the system primarily is based on the four multilayer distributed services: client application, Data Processing Service, 3D Rendering Service and Data Provider Service (see section 3).

The datasets used in this study are related to the flood model of Ratnapura town area in Sri Lanka. This flood model is examined in this system.

The client-application was created to assist user interaction and visualize output results. The OpenLayers JavaScript API was used to build the web GIS functionalities. This system provides an interactive front-end interface for useful model data collection so that the user is first with the parameter input. Then the collected data are submitted to data Processing Service. This web application form connects with the data processing service via AJAX (Asynchronous JavaScript and XML) technology.

In the data processing service, the request get from the web application service is efficiently analyzed with the data, gathered from distributed geo-processing service. The collected all sufficient data are passed to the data

provider service via network connection. Then, the desirable geospatial data source of the model such as soil type, flow channel, land cover etc are accessed across the network connection using the standard OGC, WFS and WCS.

After whole process of geo-processing is completed, the results are integrated and manipulated in a 3D scene as exchangeable web-based standards VRML model by the 3D Rendering Service. Further, the data processing service provides the raster image which is presented as 2D map. Subsequently, the both results are forwarded to client application and saved in a place corresponding with a return URL location so that output products can be visualized on client application.

5 CONCLUSION

In earlier, geographic information system software, computer-aided design (CAD), and image processing systems have been used to create huge amount of digital spatial data (Huang, 2003). Although 3D GIS itself is now research-based stage so that this approach can demonstrate some advantages over conventional GIS's of 2D GIS, 3D CAD-based data generating system, and even Web mapping system. In most of disaster application project, the 3D visualization is obviously one of the important means for exploring the spatial data.

This paper has explored a cost effective solution for 3D visualization of geospatial data as VRML model and also it can be visualized as an X3D model. The design and development of the system enhances the accessibility to the current GIS 3D visualization. The design of the system, in general, adopts multi-layer distributed architecture system. The system has a clearly demarcated Service Oriented architecture (SOA) workflow that is scalable, transparent and distributed. The developed multi-layer distributed system is enable for 3D visualization of analytical data from geospatial modeling and also this visualization system is not only allows the visualization of real world of existing data from distributed service, but also the 3D visualization of other calculated model. The service based architecture supports a more elastic reconfiguration for the integration of the services. Further, the this web-GIS approach can be used for visualization of dynamic geospatial data as 3D scene so that it can be investigate by a user, from distributed processing service and data provider service.

Future work will continue to implement tools for easier generation of geo-processing and 3D visualizations of geospatial data in web GIS clients.

REFERENCES

- Brown, I., 1999. "Developing a Virtual Reality User Interface (VRUI) for Geographic Information Retrieval on the Internet." *Transactions in GIS* 3(3): 207-220.
- Chao Z., Eng C. T., Tony K. Y. C., 2003. "3D Terrain Visualization for Web GIS", www.gisdevelopment.net/technology/ip/ma03065.htm [accessed 11.01.2009]
- Fairbairn, D., Parsley, S., 1997. "The use of VRML for cartographic presentation." *Computers and Geosciences*, Vol 23 (4), 475-481.
- Gobe H., David F. & Philip J., 2005. "An Rdbms-Supported, Web-Based, 3D GIS, Visualisation And Analysis Tool", http://www.needs.ncl.ac.uk/needs/resources/ICC_2005.pdf [accessed 11.01.2009]
- Huang, B. and Lin, H., 1999. "GeoVR: a web-based tool for virtual reality presentation from 2D GIS data", *Computer & Geosciences*, Vol 25, 1167-1175.
- Huang, B., 2003. "Web-based dynamic and interactive environmental visualization", *Computers, Environment and Urban Systems*, Vol 27(6): 62-636.
- Rifaat A., 2004. "Utilizing 3d Web-Based GIS For Infrastructure Protection And Emergency Preparedness", In: *international Archives of Photogrammetry and Remote Sensing*, Vol. 35, Part B7, Istanbul 2004: 653
- Wang, Y., Bao, Q. and Tao, C.V., 2004. "GeoServNet 3D Analyst: Enabling Web-based 3D Visualization and Analysis" [Master's Thesis], Department of Earth and Space Science and Engineering, Faculty of Pure and Applied Science, York University.
- Wikipedia, 2009. VRML, <http://en.wikipedia.org/wiki/VRML> [accessed 11.01.2009]

QUICKER COMMUNICATION OF DISASTERS WITH SDI AND NEWER XML PROTOCOLS: A DISASTER MANAGEMENT MODEL FOR KERALA, INDIA

A.P.Pradeepkumar ^a and Riju Stephen ^b

^a Dept of Geology, University College, Trivandrum, India – geo_pradeep@yahoo.com

^b Health and Human Services, City of Houston, Houston, Texas, USA – Riju.Stephen@cityofhouston.net

KEYWORDS:

Disaster management, Response, Mitigation, XML protocols, CAP, EDXL, PostGIS, RARE, Kerala, India

ABSTRACT

Disaster preparedness is still an evolving concept in Kerala, a state in the southern part of India probably because Kerala is not as prone to disasters as other regions of the world. Still Kerala has to be prepared to meet any eventuality because costs involved in post-disaster rehabilitation work are enormous and the governments can save some money and prevent the disruption of life if there is sufficient warning before and immediately after disasters. An outline of a multi-layered disaster early-warning cum response system called RARE that makes use of new XML communication protocols, OGS-compliant FOSS GIS and WebGIS capabilities to generate early warnings that could be transmitted to 'Emergency Response Centres' (known also as 108 services in India) is presented. Such a system may be tested and could be of possible value in the absence of any such dedicated system in the state of Kerala for disaster warning. Precepts of good governance demand that technology be put to use to enhance overall well-being of the community that is being served.

1 Introduction

Quicker responses after a disaster as well as early warnings greatly reduce the lives lost and properties destroyed. It is precisely here that often the government fails to act, due to the absence of well-established dedicated communication networks as well as the absence of interoperability between various organizations entrusted with emergency response. Often an agency might be in the dark about the resources and data of others, or where the others stand in terms of a specific response. Real-time response thus needs two components: one, an emergency communication network which can alert all the agencies involved in disaster management as well as the people who would be affected by the disaster; and two, an interoperable system capable of targeted and synergistic response. Such a system can ease the burden of the state and its agencies from chalking out plans when lives are at stake; rather they can concentrate on putting all its efforts into the relief activities – time saved is life saved. The mechanism envisaged here is a communication network that includes various disaster response organizations including hospitals with capabilities to communicate and access data even at the field level.

Disasters in Kerala are usually Scope II disasters as defined by Gad-el-Hak (2008) and are of two types, as is the case the world over. Natural disasters which include floods and landslides, and human induced which include road, rail and water transport accidents, industrial accidents, construction site accidents, and fire. Contagious disease outbreaks such as dengue fever, chikun guniya etc., which are often triggered by lack of urban sanitation and proper garbage disposal, is also considered as human induced disasters in this study.

Even though Keralites are blessed with less climatic extremes as well as relatively lesser frequency of natural disasters of greater magnitudes; there have been growing concerns about people living under ever increasing risks of health hazards and irreversible environmental damage. After studying the Seveso industrial accident in Brazil (1976) and Bhopal in India (1984) Porto and Freitas (1996) theorized that the socio-economic and political set up of these countries and other developing countries elsewhere, put people in a more vulnerable situation to similar disasters. Such socio-political amplification of vulnerability is pertinent as far as Kerala is concerned, as it is on the path of industrialization and environmental degradation is a more serious issue than it was in the past. Hence, it is ever more important to be prepared for an impending disaster that might put many

lives in peril. Proper disaster management with the help of information technology would greatly reduce the number of lives lost in the event of a disaster.

The Government of India has accepted Disaster Management as an integral part of governance in the country. It has passed the National Disaster Management Authority Act (2005) and the Government of Kerala has recently set up a State-level Disaster Management Authority in accordance with the Act (The Hindu, 2007). But bureaucratic bottlenecks and inadequate technological inputs may haunt the current set up and may not deliver the desired results. In this context, a multi-layered disaster early-warning cum response model is proposed that can mount a quick response to emergency situations thereby becomes a management system that can give responses in real-time, unhindered by any organizational barriers. This interoperable system should be field tested before its implementation.

2 Some recent disasters

The most recent natural disaster was the tsunami that struck the Kerala coast in December 2004, which killed 171 people. The approach of the tsunami was not known to either the people or the government. When it struck the response was haphazard with no cogent plan of action. Even the term tsunami was unfamiliar to many and few could realize the gravity of the situation; people and the governmental agencies thought it was simply a tide with larger amplitude. Hence in the Kerala context there is a greater need for education in the emergency response system. The government could not issue any warning to the coastal population, even though it struck the coast in two different episodes separated by several hours. Effectively the people came to know of the tsunami through radio and in the television, which might not always have been factual. Though there were concerted efforts on the part of the emergency response agencies to alert the potentially affected population,, in the absence of an effective spatial disaster management system they did not have the tools to access the populations at geographically dispersed areas.

The most recent disaster-in-the-making is the outbreak of dengue fever in Trivandrum, which has already resulted in one death in April 2009. The people as well as the majority of the decision makers came to know of the issue through newspapers rather than through any public health surveillance or disaster management system. The outbreak is still not under control due to the absence of any emergency medical intervention that would have been deemed necessary. Any response appears to be stop gap. Very quick responses are needed to identify the dengue hotspots and apply pesticides to the stagnant cesspools that host the mosquitoes (Scott 2008).

3 Previous work

Disaster management systems deal with disasters and make risk assessments using geospatial tools, the utility of which relies on the existence of a Spatial Data Infrastructure (SDI). Based on the SDI a preparedness system can be developed which will have early warning systems and monitoring systems as components. The SDI involves metadata, sharing of data and its restrictions and the role of national/international clearing houses: the SDI is an evolving information system that helps collating geospatial information for use in the decision making at all levels. This is followed by an assessment of the damage and dissemination of this information. It is at these two stages that a system which can seamlessly convey information about a disaster and deliver the response comes in handy. In extreme disasters such as the terrorist strike at Mumbai in November 2008, information flow between a large array of stakeholders becomes essential. An SDI is inevitable as the framework on which such a system could be based. In most proposals the stress is on building up the infrastructure for the SDI. There have been previous studies on such systems in India, but none have so far been put in place. The foremost amongst these are the studies being done in the 'Disaster Management Support Programme' of the Indian Space Research Organization. Srivastava et al (2004) suggest a Disaster Management Support system built upon an SDI, remote sensing, modeling and networking. GIS specialists are often not directly involved in this process (Nayak and Zlatanova 2008) but their role is indispensable when it comes to making the right decisions.

In India the National SDI (NSDI) that was established in 2001 seeks to use GIS to merge satellite imagery and topographic sheets with data on physical parameters to derive 3D digital maps (NSDI 2009). NSDI can ultimately act as an online database with different spatial data layers and base maps that can be easily queried. The aim is to initially map 40 major cities on a scale of 1:1000 and later extend it to the whole country. NSDI will focus on: standards (interoperability; network, gateways, protocols), metadata, nodes (GIS-based spatial data servers), search and access protocols, clearing houses, user interfaces, and NSDI education program (Boos and Müller 2009). Kerala is yet to become part of the NSDI.

4 Structure of the multi-layered disaster early-warning cum response system

In Kerala, the telephone or the wireless networks have been the most important means of communication for the government agencies that are in charge of disaster response. Often these networks may not be reliable during an emergency situation, and are not based on any internationally accepted standards for data transfer and exchange.

The need of the hour is a system that can bring together all the components that are used by the different agencies in real time. The advantage in Kerala is that the government recommends the use Free and Open Source Software (FOSS) in all its offices and many have adopted this as a standard. Thus to an extent, data exchange and interoperability may not be a Herculean effort. A multi-layered disaster early-warning cum response system called Response Architecture for Rapid action in Emergencies (*RARE*), i.e., a framework for a subsystem of the NSDI or a system which relies on the NSDI - could be used as a model to design a disaster management system, which can help quick communication in real time of the disasters to the stakeholders. The model is based on the COMCARE model (COMCARE 2008) getting implemented in the USA and described by Woodhall (2007).

4.3 RARE design

The RARE design consists of layers that accommodate government policies, infrastructure, people, standards and networks (Fig.1). They include

1. DSS layer: It consists of a decision support systems and related software. Value-added data are generated aiding decision making. In this layer reside all the application programs to be used by the different agencies in emergency situations. It includes all levels of GIS functionality, other emergency management tools as well as any other application that can be critical in an emergency situation.
2. Policing layer: This makes interoperability possible, and sets permissions for transmission of information between different stakeholders, who are also identified by this layer. Sharing of information amongst the stakeholders is made possible by this layer. Multiplication of resources in different agencies is prevented by this layer. All shared services are routed through this layer.
3. Data layer: This layer ensures standardization of data formats, and uses non-proprietary XML formats that use simple object access protocol (SOAP) standards like CAP (common alerting protocol) and the Emergency Data Exchange Language (EDXL) for urgent data exchange.
4. Adjudicacy layer: It sets out rules/protocols/for sharing and routing information. At this layer decisions about the capabilities and responsibilities of stakeholders are decided. The role of each participating entity is defined exactly at this layer. India's '108' emergency centres then would know exactly whom to alert when a particular type of disaster happens or is impending.
5. Network layer: sets out the nuts and bolts of getting the information from one place to the other. All communication equipments rely on this layer for robust results. This layer will need reliable broadband connections to make the system dependable. Users communicate with each other through this layer.
6. Societal layer: the whole rationale of this layer is the service rendered to the society, hence without the societal aspects taken into account, this multi-layered disaster early-warning cum response structure cannot exist. The societal aspect is not discussed further here since the scope of this paper does not permit a socio-political analysis of disaster preparedness or responsiveness.

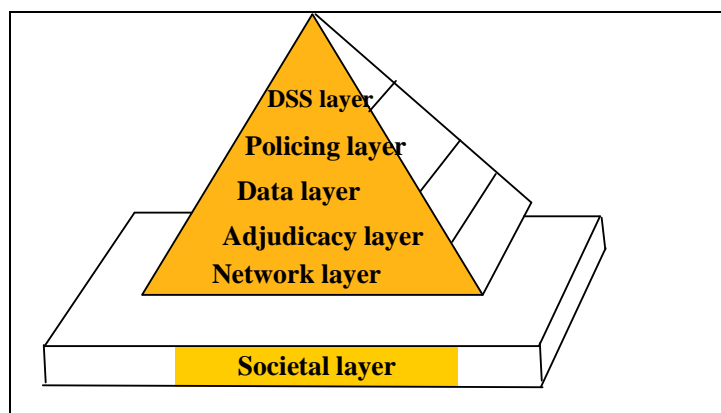


Figure 3: The multi-layered RARE system, supported on the societal layer.

RARE can succeed where all stakeholders including decision-makers and implementers – such as the government and its arms – the police, the executive, politicians, medical facilities, fire service, ambulance service, health

services, and transport departments, as well as non-governmental organizations (NGOs) are seamlessly integrated in the network. In tune with the Kerala government policies this network has to be on a FOSS platform and should also be interoperable. The foremost requirement would be to bring all the top decision makers in the stakeholder departments to work together and develop a spirit of sharing (PTI-GITA 2009). Some expensive proprietary solutions like the Capturx add-in for ArcGIS exists for emergency disaster communications and concomitant decision making but they maybe suitable only for local and isolated incidences (Adapx 2009).

The top three layers of the RARE system, the DSS, policing and data, depend on the robustness of the underlying layers. The data layer’s responsibility is to ensure data sharing between the departments, which would require a thorough check of the data structures stored within the different departments. The policing layer ensures sharing of services and the all-important emergency communications is part of this layer. The decision support systems rest with each organization which in turn can lead to collective action, and the adjudicacy layer ensures that the system attains interoperability.

The DSS layer is the one in which GIS, CAD, hospital information systems all come into play. Again XML-based standards and interfaces have to be adopted for efficient intercommunications. Thus individual arms of the government as well as other stakeholder organizations have to have their roles well-defined here as it involves decision making.

Next, a database of key personnel to whom the messages have to be routed and the time frame within which this has to be done is needed. In an Indian context persons are more important than institutions because of the top-down approach that is embedded in the Indian system and bureaucracy. Hence there is an additional need to keep this database current to the hour. Thus key persons in the database will receive the emergency messages based on certain criteria. The network layer has to be robust and based on reliable broad band connections for the success of this communication. The individuals can be classified according to their specialized roles/geographic location. For example, invariably in a fire accident, the fire force, the medical service, the police have to be coordinated and information should reach the three entities and should flow among the responsible persons involved. But in the case of medical emergency the fire force may have only a limited role to play and thus they may be exempted from receiving certain information. This selective dissemination helps in keeping the agencies alert and does not lead to false alarms. Thus the selected persons can decide in what sort of situations they should receive an alert.

4.4 RARE communication system

The communication system for the stakeholder identification and its database has a traditional structure and forms part of the RARE system within the ‘policing layer’. The communication system interacts with users and suppliers through the web services layer. The web services layer provides an interface as well as supplies data from within the communications system to outside users. The most important component of this layer is the GIS part which assists in the alerting of agencies by the RARE communication system. The GIS part assists in fixing areas of relevance to any particular stakeholder who in turn may correlate these with type of event, stakeholder responsibility and the temporal limits of response. The decision on which agency is to be notified is taken after careful analysis of all factors of interest. Thus the GIS is mainly one for defining the limits of an agency’s area of influence.

The standards used could be GML, Web Feature Service, Web Map Service and Simple Features SQL. The rudimentary framework of the communication system is shown in Fig. 2, the details have to be worked out at a later stage.

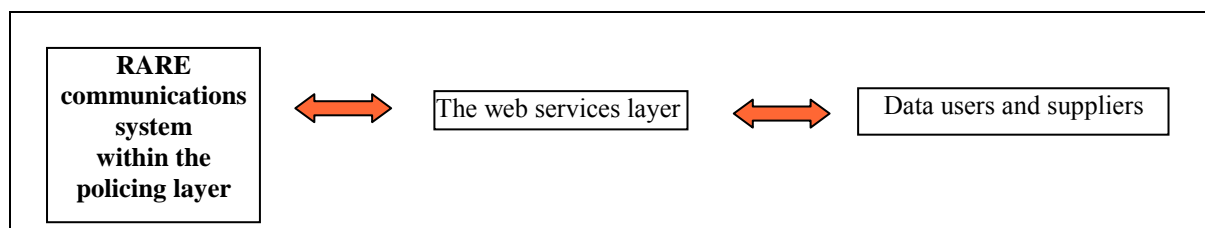


Figure 4: RARE communication system within the policing layer.

4.5 Protocols involved

Currently XML-based protocols are used in disaster early response elsewhere. These are accepted as standards and include:

1. The Common Alerting Protocol or CAP based on ITU Recommendation X.1303 which was adopted as a standard by the Organization for the Advancement of Structured Information Standards (OASIS) in 2004 (CAP 2009). OASIS states that CAP " ... standardizes the content of alerts and notifications across all hazards, including law enforcement [...] severe weather, fires, earthquakes, tsunami ... " (OASIS 2004). A CAP-based alerting system was field tested in the west coast of India, offshore of Kerala by World Space Radio, in 2005. Eighty boats with World Space India radios on board with pre-tuned assigned channels were used in this exercise. Warning messages in MP3 format were streamed via the Internet to the uplink site and from there onto the boats which were within 200 nautical miles in the sea (World Space, 2006). The drawback of CAP is that 'such free form text lacks the structural semantics that can aid in rendering and understandability of [...] critical information' (Häkkinen and Sullivan 2007).
2. The Emergency Data Exchange Language (EDXL) which aims at transcending the boundaries between states and organizations (Cover Pages 2009a). These two are open standards and open architectures and are the current, open, free digital message format for all emergency alerts and communications (Czarnecki 2007). There are more such protocols being developed, some of which are non-proprietary (Cover Pages 2009b).

All these free XML message formats use simple object access protocol (SOAP). In Kerala, or for that matter in India, there is as yet no endeavour where these are consistently used and there are no models to take content from. This is in contrast to the situation elsewhere, such as in the USA, where such message protocols can draw content from the Global Justice XML Data Model or Sri Lanka which was the first SE Asian country to field test a CAP profile through the Sahana network (Waidyanatha 2008)

5 Software used in the RARE communication system

The components of the RARE communication are: (1) any flavour of the LINUX operating system distributed across servers, (2) the web server which can be Apache HTTP Web Server, (3) the web container which can be Apache Tomcat, (4) the application server which can be the Red Hat JBoss Application Server, (5) SpatialPostgreSQL, which is the database, (6) the LDAP server which is OpenLDAP, and (7) PostGIS with GiST-Index, UMN MapServer with the WMS protocol which plays the GIS part (Open Geospatial Consortium 2009), Open Layers & FIST (Flexible Internet Spatial Template); developed by Univ of Northern British Columbia (UNBC 2006) or interactive mapping and production of map views and thumbnails. NASA's World Wind might be used to get an overview of the area of interest. (8) A suitable Open Source access and identity manager adhering to the Service Positioning Markup Language (OASIS 2003) has to be used (like, e.g., Provisioner (SourceForge 2008)). The system is as follows (Fig.3):

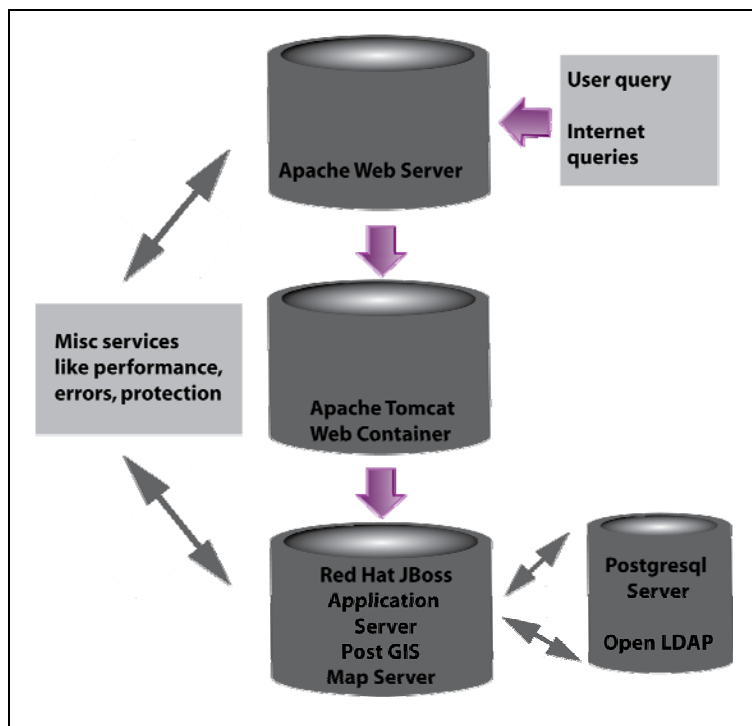


Figure 5: RARE communication system paths (modelled after Woodhall 2007).

In the RARE communication system described above, it is the GIS component that presents a public face. The interface would be simple so that it is easy to input queries for getting quick responses. The disaster response coordinators would be able to narrow down the number of stakeholders, who are required to respond immediately, and the capabilities expected of them, as well as their geographic extent of their response. Querying the database using the web based interface would make it possible for the stakeholders to send in spatial information to the disaster response coordinators using Well-known Text (WKT) format using the SRID (Spatial Reference Identifier). WKT is an OpenGIS specification that defines a standard way of expressing spatial objects (Wikipedia 2009) and can be used to query the Simple Feature Interface Standard (SFS) SQL.

When the spatio-temporal data of an impending disaster is entered into RARE, a response is generated in accordance with the geographic location and capabilities of the stakeholders. That is, when it receives a user query in WKT format, all the layers in the database are queried, stakeholders are assigned their responsibilities and the results are forwarded to the alerting network which sends it on to the assigned stakeholders. All this takes place in real time.

6 Discussion

The proposed RARE and associated communication system would be the most comprehensive multi-layered disaster early-warning cum response structure, and the first of its kind for disaster communication and management in Kerala. But the hurdles are many including lack of political will, resources, technological handicaps, institutional silos as well as skilled manpower. The system to be successful would require a certain amount of dedicated hardware and personnel, and to be on alert 24x7. The most devastating hurdle would be the silos in which government departments work, but which would certainly have to be broken or at least made porous for RARE to work. On the presumption that RARE system gets implemented, there could still be bottlenecks. Besides communication flows to and from stakeholders, the GIS unit is amongst the other vital links in the emergency response system. The stakeholders locate and determine the areas of interest based on the GIS locational information.

The problem in Kerala would be the availability of pertinent spatial data and accurate location information that is truly reliable and available across organizations. This is the aspect that can hamper emergency response efforts, even when the RARE system may be physically implemented. Though agencies like Centre for Earth Science Studies, Trivandrum, Kerala, India and others collect quite a lot of data these are not publicly available. Even the National Spatial Data Infrastructure website (NSDI 2009) has limited or no data available. Thus for the success of RARE the most laborious process would be to create an SDI for Kerala. Only in January 2009 has the

Government of Kerala thought about starting an SDI to support the National Spatial Data Infrastructure (ITMISSION 2009). It becomes evident that it would take quite some time and effort for a system like RARE to be up and running in Kerala. In the present situation, the RARE can be tested only in a rudimentary manner.

Another important aspect is regarding the precision and accuracy of the coordinate systems that may be used by the involved stakeholders, and the disaster response coordinators. In India the projection parameters of 1:50,000 scale topographic sheets have been moved to WGS-84 from the Everest Ellipsoid recently. Thus coordinate information is essential to be uniform or at least it should be known so that transformations can be made in real time. Error modeling (Veregin 1994) and exploratory data analysis would be needed to correct for any attribute errors that may be present in the data of the Kerala SDI.

7 Conclusions

Kerala has a long hard way to go to set up a RARE system, but the situation is conducive for planning about it. Presently the government is convinced of the need for disaster mitigation and has already set up its divisions to deal with disasters (the Institute for Land and Disaster Management), with dedicated personnel in these divisions. The ideas presented in this paper would be of value when the government decides to go in for a fully computerized and online emergency response system. If a beginning is made now, and if changing governments do not alter the objectives, then the system could be made functional in about half-a-decade, if entrusted with a dedicated agency working in mission mode, and with assured collaboration from different agencies. Else, this remains an unachievable milestone. With the emphasis on FOSS technologies, the initial setup costs are minimized and licensing issues are manageable. Losses due to disasters would become rare once RARE gets implemented.

References

- Adapx 2009 First responders with Capturx for ArcGIS GEOconnexion International Magazine 8(4) 30-32
- Boos S and Müller H 2009 SDI developments in the world's currently existing mega cities
http://www.fig.net/pub/monthly_articles/april_2009/boos_mueller_april_2009.pdf (accessed 5.5.2009)
- CAP 2009 CAP Cookbook http://www.incident.com/cookbook/index.php/CAP_Fact_Sheet (accessed 25.5.2009)
- COMCARE 2009 E-safety vision <http://www.comcare.org/ESafetyVision.html> (accessed 6.5.2009)
- Cover Pages 2009a Emergency Data Exchange Language (Technology reports)
<http://xml.coverpages.org/edxl.html> (accessed 6.5.2009)
- Cover Pages 2009b XML and emergency management (Technology reports)
<http://xml.coverpages.org/emergencyManagement.html> (accessed 6.5.2009)
- Czarnecki E 2007 Private sector roles are expanding for public alerts and warnings The Insider 6(1) 4-6
- de Souza Porto MF and de Freitas CM 1996 Risk Anal. 16(1):19-29
- Gad-el-Hak M 2008 Large-scale Disasters: Prediction, Control, and Mitigation Cambridge University Press
New York 576p
- Häkkinen MT and Sullivan HT 2007 Effective communication of warnings and critical information: application of accessible design methods to auditory warnings Proc. ISCRAM2007, Delft, The Netherlands 13-16 May 2007 (Eds. B Van de Walle, P Burghardt and C Nieuwenhuis)
http://www.iscram.org/dmdocuments/ISCRAM2007/Proceedings/Pages_167_171_30HCIS_10_A_Effective.pdf (accessed 28.4.2009)
- ITMISSION 2009 State Spatial Data Infrastructure (New Scheme)
http://www.itmission.kerala.gov.in/?option=com_content&view=article&id=223:state-spatial-data-infrastructure&catid=35:e-governance&Itemid=67 (accessed 4.5.2009)
- Nayak S and Zlatanova S 2008 Remote Sensing and GIS Technologies for Monitoring and Prediction of Disasters Springer Berlin 272p
- NSDI 2009 The NSDI vision <http://gisservr.nic.in/nsdiportal/gos> (accessed 2.5.2009)
- OASIS 2003 Service Positioning Markup Language
<http://www.oasis-open.org/committees/download.php/3032/cs-pstc-spml-core-1.0.pdf> (accessed 7.5.2009)

- OASIS 2004 <http://www.oasis-open.org/> (accessed 25.5.2009)
- Open Geospatial Consortium 2009 Web Map Service <http://www.opengeospatial.org/standards/wms> (accessed 7.5.2009)
- PTI and GITA 2009 Geospatial systems that support emergency and disaster operations: a case study guide for local government and utility first responders 76p.
<http://geodatapolicy.wordpress.com/2009/02/20/geospatial-systems-for-emergency-and-disaster-operations-new-guide/> (accessed 15.4.2009)
- Scott T 2008 Zeroing on dengue *Geospatial Today* 7(9) 43
- SourceForge 2008 Provisioner <http://identitymgr.sourceforge.net/> (accessed 14.6.2009)
- Srivastava SK et al 2004 SDI for DMS in India: a design perspective *Proc. GSDI 7*, 30 Jan – 6 Feb 2004, Bangalore, India <http://www.gsd.org/gsdiconfdocs/GSDI-7/gsdProceedings.asp> (accessed 25.4.2009)
- The Hindu 2007 <http://www.hindu.com/2007/05/10/stories/2007051001910500.htm> (accessed 15.5.2009)
- UNBC 2006 Flexible Internet Spatial Template <http://datashare.gis.unbc.ca/> (accessed 2.5.2009)
- Veregin 1994 Error modeling for the map overlay operation In. *Accuracy of Spatial Databases* Eds. M Goodchild, S Gopal Taylor and Francis London
- Waidyanatha N 2008 Common Alerting Protocol unheard of in Asia-Pacific except Sri Lanka
<http://limeasia.net/2008/12/cap-unheard-asia-except-srilanka/> (accessed 2.5.2009)
- Wikipedia 2009 Well-known text http://en.wikipedia.org/wiki/Well-known_text (accessed 1.5.2009)
- Woodhall J 2007 Geospatially enabled directory for emergency response interoperability In. *Emerging Spatial Information Systems and Applications* Ed. B N Hilton Idea Group Publishing Hershey 63-84
- World Space 2006 Digital satellite technology for disaster warning and management www.besindia.com (accessed 2.5.2009)

Acknowledgment

Prof. Dr. Franz-Josef Behr (HfT-Stuttgart, Germany) is thanked for the invitation to participate in the AGSE2009 and for showing me the possibilities of FOSS GIS and OSM. DAAD Germany is thanked for funding the travel and living expenses.

UDIG – AN OVERVIEW OF OPEN SOURCE DESKTOP GIS APPLICATION

Sandra Tress ^a and Abdurasyid Moestofa ^b

Stuttgart University of Applied Sciences

^a sandra.t83@gmx.de

^b r45h33d@gmail.com

KEYWORDS:

Open Source, uDig, Desktop GIS

ABSTRACT

Since 2004 uDig was introduced and supported by Canadian Government and continued in 2005 as an independent project under Refraction research. uDig itself is aimed to be a user friendly Desktop GIS, to create, viewing, editing and printing geospatial data sources for ordinary computer user and, of course, its an open source application.

The vision for uDig is to fill functional gaps in two technology communities: the open source geospatial community and the open standards geospatial community (as represented by theOpen Geospatial Consortium).

In present time, under the Refraction research and uDig user community, uDig is further developed and maintained to make it a better and more powerful application.

LiDAR Data Analysis

3D NAVIGATION SYSTEMS BASED ON SYNTHETIC TEXTURING

Behnam Alizadehashrafi ^a, Alias Abdul Rahman ^b, Volker Coors ^c and Thorsten Schulz ^d

^a Department of Geoinformatics, Faculty of Geoinformation Science and Engineering University Teknologi
Malaysia 81300

behnam5us@gmail.com

^b Department of Geoinformatics, Faculty of Geoinformation Science and Engineering University Teknologi
Malaysia 81300

alias@utm.my

^c Stuttgart University of Applied Science, Schellingstr. 24, 70023 Stuttgart, Germany
volker.coors@hft-stuttgart.de

^d Stuttgart University of Applied Science, Schellingstr. 24, 70023 Stuttgart, Germany
thorsten.schulz@hft-stuttgart.de

KEYWORDS:

Synthetic texturing, Pulse function, 3D urban modeling, navigation system, Lightweight geometry

ABSTRACT

Navigation system is the order of the day to pilot people to their destination. This paper focuses on the uses of mobile devices such as PDA's and smart phones without additional hardware to direct pedestrians based on synthetic texturing along with 3D modeling. Each facade is reconstructed by arraying small sized textures in respect to their geometries in different layers. In the process of texture generation cropping, rectifying, removing disturbing objects and exposure setting should be done in advance. Unlimited number of layers with different priorities and their horizontal and vertical pulse functions and texture files can be utilized for creating a simple square looking facade. Each 3D model is created by mapping the synthetic textures on the 3D geometries of each building's 3D model. The processes to create the synthetic textures as well as their usage in mobiles' context are described in detail in this paper.

1 Introduction

Different kinds of road presentations in navigation system devices are in use. They are based on 2D map, text, voice and pictures. People like to identify their world in the navigation system display to compare with their position and environment. MoNa3D⁸ is carrying out a project by use of synthetic texturing and pulse functions for 3D navigation purpose. The two main goals of the project are providing a cognitive semantic route description by using landmarks in 3D, which allow context dependent personalized navigation support and developing an approach to create suitable non-photorealistic building textures using image processing methods and synthetic textures along with a corresponding compression system for an efficient storage and transfer of 3D building models (Coors and Zipf, 2007). In particular, the generation and usage of synthetic textures are addressed in this paper.

2 The Motivation

The idea of having 3D navigation software on smart phones and PDA's along with limited resources on these devices, leads us to generate a small program with less overhead and high performance by means of combining photo realistic with pure synthetic approaches. For this issue an efficient rule of thumb is repeating a small and high quality texture in arbitrary vertical and horizontal direction. The texture image file even can be a pixel

⁸ MObile NAVigation 3Dimensional

which is actually a color map. The impression of having unlimited number of layer with different priorities, gives us the opportunity to generate any kind of complex and historical facades. The aim can be achieved from the behavior of raster based applications.

3 Related Works

Using landmarks in mobile navigation systems could improve way finding approach. In this field enriching way finding instructions by means of local landmarks is a reliable method. Simple instructions are defined like geometric data for street network and shape, color, visibility for a determinate facade as visual attraction parameters. Semantic attraction parameters of outstanding landmarks are defined as cultural and historical aspects, Level of importance and explicit marks e.g. street signs. By using these definitions and information, landmarks are extracted from dataset and provide Point of Interest (POI). In fact the POI is a hard coded and predefined data which is geo coded in spatial datasets (see Raubal and Winter 2002).

The decision for implementing 3D content into navigation system rose at the end of the nineties after a huge progress in hardware designs. First of all, generating 3D model of the urban area is necessary which can be achieved by creating wire frames out of filtered point clouds. Nowadays this procedure can be done semi-automatically out of laser data or stereo image pairs and photogrammetric methods (e.g. Epipolar match points and so on). High quality and rectified photographs from geometries are necessary for mapping on the wire frames. For this aim, disturbing objects must be removed from shadow less photographs. Finally mapping process can be done see Schulze and Horsel.



Figure 1: Mapping the images after rectification, obstacles removal and radiometric adjustment on the light weight geometry of Building 2 of Stuttgart University of Applied Science in VRML 2.0

The problems of conventional photogrammetry methods are disturbing objects, leaning geometries, shadows, and reflection, time consuming, expensive and “heavy” models, which make it unfit for the intention of navigation system devices. Another project for 3D navigation system purpose on smart phones is M-LOMA⁹ (Nurminen and Tuominen 2008). This application, programmed in C++, can be installed on smart phones and PDA’s for running VRML file. The visible part of the model can be rendered on the screen. Moreover lightweight geometries are used for the 3D modeling. In this issue VRML parsing is the first step in implementation process for only visible area on the screen. Texture processing for different LOD’s comes afterwards which are created and stored separately. In the next step the visibility calculations based on PVS¹⁰ algorithm is done. Then the visibility list encoding can be followed by geometry files packaging and compressing them in binary format.

Our aim is to generate a noble solution e.g. by enabling the creation of high quality and easy to describe facades for each object in respect to low memory and storage requirements.

² Mobile LOcation Aware Messaging Application

¹⁰ potentially visible set

4 Concept of synthetic textures and pulse Functions

Each building consists of polygons and for each polygon there are some pulse functions in x and y axes which controls the process of texture generation (Parish & Müller 2002). Pulse function can be easily defined with the logical values. In intersection of X and Y axes, TRUE means insert and FALSE means not to insert the texture (Coors and Zipf, 2007). In order to increase the flexibility, the number of layers of textures and pulse functions are unlimited and each of them has its own priority in respect to others. In the process of creating database for synthetic texturing method, we have to define lots of fields like number of facades which are generating an identical building, texture file name and path or directory; pulse functions and their related parameters and so on. In MoNa3D, for this issue we have defined an XML schema and we applied the same schema in this work Bauer et al (2008). Furthermore, we have created a user friend interface by means of JavaScript and ActiveX objects of Microsoft windows which can receive the parameters and generates XML file fitting to this schema. By using this JavaScript program (see Figure5(c), the distances between similar textures in horizontal and vertical direction are computed semi automatically in respect to the real geometry for pulse functions. The number of the layers for each facade can be defined by operators in respect to the requested quality or number of different and sparse textures. Figure 2 shows the generation of facade (in five layers).

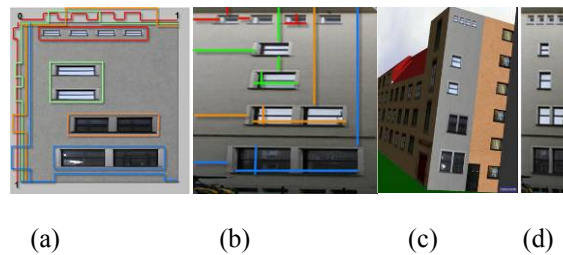


Figure 2: (a) illustrates 4 different layers of windows along with their related pulse functions and (b) is the real resized and rectified image of the facade used for measuring process and (c) is the final model without leaning problem and (d) is the rectified form of real image of facade.

5 Synthetic texturing

5.1 Identifying and Describing the Texture

We can extract texture heuristically according to the form of the facade. Normally it is possible to find a section on every building facade which is repeating exactly with the same size, form and shape. This part should repeat in horizontal or vertical direction with the same distance and often equal size. It depends on the taste of the operator and there is no strict rule and automatic method for selecting textures. It can be a vertical slice which is repeating horizontally or horizontal slice which is repeating vertically with a distance equal to zero or any calculated value in respect to the generated XML schema. Texture of the wall can be stretched in vertical direction or horizontal direction or can be a color map or a texture which is repeating in both directions [Bau06]. The texture of the window has also the same behaviors except stretching in both directions (see Figure3 (b)).

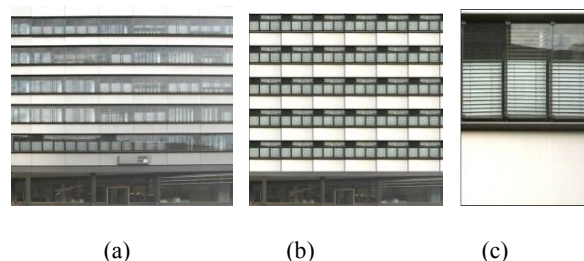


Figure 3: (a) is the rectified and resized facade (c) is the texture which is extracted from upper part of (a) and repeated in the upper part of (b) in vertical and horizontal direction to generate the model.

5.2 Cropping and Rectifying

After deciding which part can be extracted as our texture we have to follow cropping and rectifying procedure. For instance Figure 3 (c) is the window texture which is extracted from upper part of Figure 3 (a) and repeated in both directions in order to generate the model (see Figure 3 (b)). In many cases we need rectangle texture and the single point perspective effect of the camera can be removed by means of cropping along with rectification of the rectangle texture shape. In order to avoid leaning problems, it is also possible to crop and rectify the facade of the building and then crop the selected texture which is as perpendicular as possible to the exposure angle. For instance the window texture in Figure 3(c) was cropped from the rectified and cropped facade which is as perpendicular as possible to the exposure angle (see Figure 3(a)).

5.3 Removing the Disturbing Objects

To have a high quality texture we need to remove disturbing objects and undesired parts of the texture. For example the flying birds, moving cars, flags, signs and moving pedestrians should be omitted from the selected texture.



Figure 4: (a) is a vertical slice texture which is cropped and rectified from the perpendicular picture of the facade and (b) is the same texture after removing the disturbing objects (e.g. flying birds, moving cars and moving pedestrians and so on). To reduce the complexity, the inside geometries were neglected as well.

5.4 Radiometric Adjustment and Texture Size Settings

In order to increase the quality of the model some additional exposure settings, radiometric adjustments, color settings, contrast settings and also texture size settings, were carried out. The texture size is an important issue for generating output image file for different applications. Our Java program generates a square image file according to our Pulse Function and it is possible to change the size of output image file in Java program for each facade even to any shape. In order to have a simple and user-friendly Java program, the size of output image file is defined as a fixed size (256*256 for popular mobile navigation systems and 512*512 for the test on computer screen and VRML.2 environment) in the respective utilized hardware and software environment.

5.5 Generating the Facade Semi Automatically

Among the issues in generating facade semi automatically such as the geometries of the selected textures, two different issues can be preceded. Both issues depend on the form of textures and taste of the operator for choosing the texture. In the following examples we will illustrate these aspects in detailed.

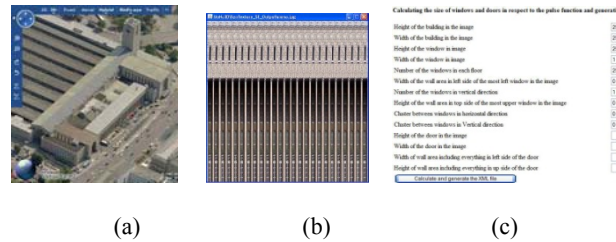


Figure 5: (a) is bird's view option of Microsoft Virtual Earth from main station in Stuttgart. (b) is the generated model of front part without knowing the Geometry of the texture in respect to the façade and (c) is the JavaScript user friendly interface for calculating the parameters and generation XML file which can be run in internet explorer

In fact, the generated texture in Figure 4 is repeated 25 times in horizontal direction. The distance between them are equal to zero. The out put image file is created without having knowledge of any parameters about the selected texture in respect to the facade.

In the next example in order to measure the parameters of texture in respect to the facade, we need to rectify and resize the original picture of the facade taken from any angle (see Figure 6 (b)) without having quality and completeness as shown in Figure 6 (a). Lets assume that window is our texture, now we can use different applications like Photoshop to measure the parameters like width and height of the window, starting point from left side, from upside, vertical and horizontal distance between them, starting point of the door from upside, from left side and so on. Figure 7 shows the comparison of the generated model of Figure 5 (see Figure 7(b)) with bird's view option of Microsoft Virtual Earth (Figure 7 (a)).

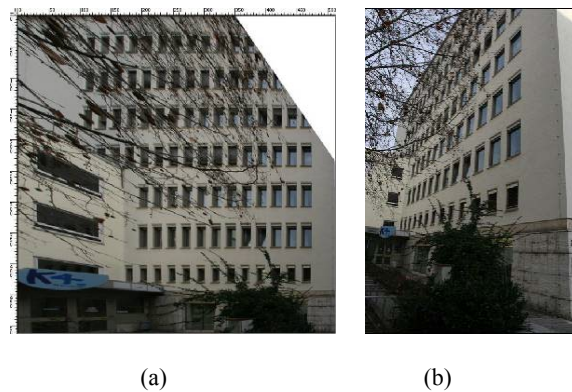


Figure 6: Right image (b) is a picture of facade from any angel and the left image (a) is rectified and resized form of (b) for measuring purpose.

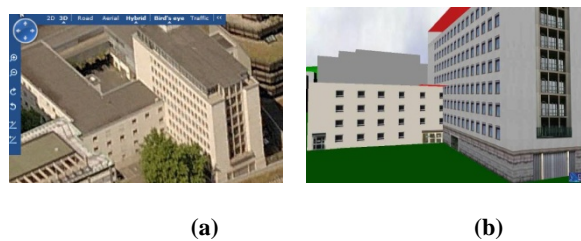


Figure 7: The comparison between the models of the buildings of University of Stuttgart (b) with bird's view option of Microsoft Virtual Earth (a).

5.6 Generating Lightweight Geometry

For heavy geometry on each surface we need to map a texture. To decrease system overhead for mobile navigation system, generating lightweight geometry is necessary. The geometries as the roofs and floors are less important and in many cases we do not need to map any texture on them except some special cases. For instance The *Mercedes isometric Star* of the main station which is rotating could also be helpful to identify the building (see Figure 9(b)). Normally, a small texture can be repeated or stretched or even one pixel color map would be

sufficient to generate the output image file to map on the light weighted geometry of roof. Removing unnecessary geometries is based on the taste of the operator which might be done heuristically. This is the main reason that we couldn't define any semiautomatic method for this issue and this step has been done manually. For instance for the front part of the main station (in our existing VRML file) there were 20 points for the walls and we reduced them to four points in outside which are enough for the mapping purpose (all the models are for outdoor 3D navigation systems and indoor geometries should be omitted). In addition, after removing the small geometries we can represent them with different radiometric adjustment and exposure settings (in this case the user can “feel” them as a small geometry (see Figure 8)).

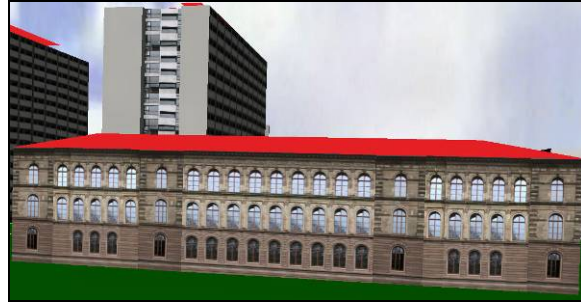


Figure 8: The representation of small geometries with different exposure settings and radiometric adjustments.

5.7 Mapping the Output Image on the Geometry

In the process of mapping output image on the geometry, we have defined the output image file of Pulse Function as a square shape. We noticed that if the height of building is less than half of the width of the building or width of the building is less than half of the height of the building, we will face with deformation and lack of quality in the process of mapping square output image on rectangle geometry. In order to deal with this problem we generated the output image for the geometry in a part of output image file and then used that section for the mapping and stretching on the geometry (Figure 9). In addition to above mentioned method we can also use different resolutions and shapes or transparent in our Java program to deal with the problem of deformation or lack of quality and strict square shapes.



Figure 9: The mapping and stretching a part of output image for the geometry.

6 Test Environment

25 buildings were modeled from the Stuttgart University of Applied Science to the main train station in Stuttgart and represented in VRML2 as are illustrated in Figure 10 (buildings around white line as a shortest path). The walls of some of models are generated with just one pixel or one color map which is repeated in vertical and horizontal directions. Many of other historical buildings like “Building 1” of the Stuttgart University of Applied Science was generated with a vertical slice of texture (which was repeated in horizontal directions (see Figure 11). In some of buildings’ models the pictures of the facades are resized and placed or mapped on the related geometry with respect to the drawing rules and level of details.



Figure 10: The white line represents the path of the 25 buildings, modeled from main station to the Stuttgart University of Applied Science.(Orthophoto mapped on DTM)

7 Conclusions

Synthetic texturing is one of the outstanding methods for the aim of 3D modeling of urban area which has been proven in this procedure. The pulse functions are very useful in texturing the facades in respect to their own priority in the representation for 3D mobile navigation system devices with high quality and small size for the 3D models. The concept of having unlimited number of layers with their own pulse functions and priorities, provides high flexibility and easy to generate any kind of desired façade for each geometry in the 3D model. Furthermore, this method is not time consuming compared to conventional photogrammetric methods.

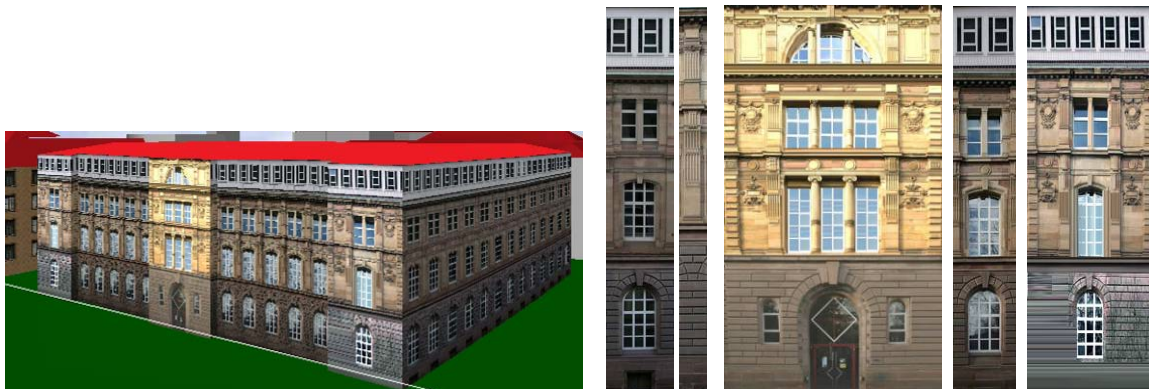


Figure 11: The model for “Building 1” of Stuttgart University of Applied Science via VRML2 and used textures.

References

- Bauer, M., V, Coors, T. Schulz & A.Zipf (2008) Zur Nutzung von 3D-Stadtmodellen für mobile Navigationssysteme. Proceedings of GI Days, Münster, 2008
- Coors, V. & A.Zipf (2007): MONA 3D -- Mobile Navigation Using 3D City Models. 4th International Symposium on LBS and Telecartography 2007. Hongkong
- Nurminen, A. & J.Tuominen (2007): Mobile LOcation-aware Messaging Application. Helsinki University of Technology Industrial Information Technology Laboratory-P.O. Box 9204, 02015 HUT, Finland-MSc
- Parish, Y.I.H. & P. Müller (2002) "Procedural Modeling of Cities," Proc. Siggraph, ACM Press, 2001, pp. 301–308.

Raubal, Martin & S. Winter (2002): Enriching Wayfinding Instructions with Local Landmarks - Institute for Geoinformatics, University of Münster -Vienna University of Technology, Austria

Schulze, M. –Horsel (2007): 3D Landmarks– Generation, Characteristics and Applications. ISPRS Conference – 3D Architecture 2007.

ACKNOWLEDGMENTS

We appreciate the Stadtmessungsamt Stuttgart for providing the data and Federal Ministry of Education and Research for enabling the project. We also appreciate the staff of Stuttgart University of Applied Science that they supported us during this study.

TWO REPRESENTATIVE PROJECTS ON LIDAR PROCESSING IN CHINA

Qi Wenjuan

^a Photogrammetry department, Hansa Geomatics, Hansa Luftbild AG, Room 501, Building 13, No. 498 Guoshoujing Road, Pudong Software Park, 201203 Shanghai, China, -wenjuan.qi@googlemail.com

KEYWORDS:

LiDAR, airborne, Laser scanning, Point clouds

ABSTRACT

In this paper, we show an introduction of the development situation of the LiDAR processing in China and some other countries. Two LiDAR projects taken place in China in recent years are mainly described in the second part. Views toward LiDAR technology are also mentioned.

1 Simple description of LiDAR technology in the world

1.1 History and development

Since the day Daguerre and Niepce shoot the first photo on 1839, people start using photos to make planar maps. In 1901, a Dutch scientist called Fourcade invented stereo Photogrammetric observation technology, which means that it is possible to observe 3D information of the terrain base on the 2D photos. After this great invention, Photogrammetry is considered as a reliable, and the most accurate observation technology in the world. Many countries utilize this technology to consist national relief maps.

Along with the development of the computer technology and scientific technology, digital stereo workstation went into the market and becoming a popular technology. At the same time, a new observation technology appears in the production process, too. This new technology is derived from NASA in 1973. It is consist of Laser, GPS and INS. It has a specialty to orient the object on the ground at the time it is observed by the detector. From 1988 – 1993, Prof. Ackermann from University Stuttgart was researching on combining the laser scanning technology and real-time location system. He created the first airborne laser-scanning system during that time.

After the appearance of the first LiDAR system, the development of airborne laser-scanning system is very frequent. Since 1995, the LiDAR system commercialized in the market. Nowadays, there are over 10 providers produce the LiDAR systems. The types of them are over 30.

2 Description of the Situation in china

2.1 First research

In 1996, a new type of airborne laser image mapping system (ALIMS) and its principle, technical structure and data processing methods was published by Professor Li Shukai from Institutes of Remote Sensing Application. It is a breakthrough of the LiDAR system research in China. In his paper airborne laser- ranging – Multispectral – Imaging Mapping System, he described about how to utilize the airborne laser scanning technology to achieve 3D orientation of remote sensing images. Possibility of assign the 3D coordinates to the corresponding pixel has been proofed and validated.

2.2 Development

After the ice-breaking research of the laser scanning technology in china, the attention of this kind of technology is increased. However, since it is just an underway research in the recent more than ten years, there is still a long distance to go before the system can be launched in the market.

3 Two representative projects on LiDAR processing in China

3.1 Types of different LiDAR Software in use

At present, some inland departments and companies have bought different kinds of laser scanning equipments and data processing software produced by different overseas companies. Although the laser scanning products are only used for the decision of electric power line's strike and creation of topographic maps at the moment, more and more departments and companies are interested in using this new technology for their spatial information processing and applications. These potential clients are in the field of mapping and surveying, land and resource, urban planning, electric power, transportation and so on. We will introduce two representative projects in the following section.

3.2 Laser Scanning project of City Nanjing

3.2.1 Working principle and process

On March 2006, Nanjing Institute of Surveying, Mapping & Geotechnical Investigation Co., Ltd used Optech's ALTM3100 to captured 10 km² area LiDAR data. Base on these data, they established the there dimensional electric map which fulfills the need of an alternant operation, searching and real time browse for the user.

Before the flight task of the project, a trapezoidal region of 10.4km² is chosen inside the city Nanjing. Figure: 1 shows the detail parameters of the region.

subject	value
flight height	800 m
flight speedy	160 km/h
measurement area	10.4 km ²
flight direction	East - West
strip number	12
laser impulse frequency	100 KHz
laser scan frequency	44Hz
laser scan angle	20 degree
laser point side overlap	44%
ground point interval	0.51 meter
laser type	narrow

Figure: 1 Flight parameters for LiDAR project

After initializing the aircraft to the required task, the flight task aimed to acquire the LiDAR data and the referenced image data is executed. The image data are captured simultaneously with the LiDAR data. They will be stored in TIFF format. Figure 2 shows the detail parameters of image data.

subject	content
camera type	normal
picture size	4096*4096
sidelap	38.9%
forelap	63%
scale	1:15000
capture time interval	4.5s
groud resolution	0.13 m
ccd resolution	0.009mm

Figure 2: Image data parameters

Besides, the trajectory and orientation parameters are recorded directly by the LiDAR system. A flow-chart in shows the process of how the execute 3D electric map using LiDAR technology.

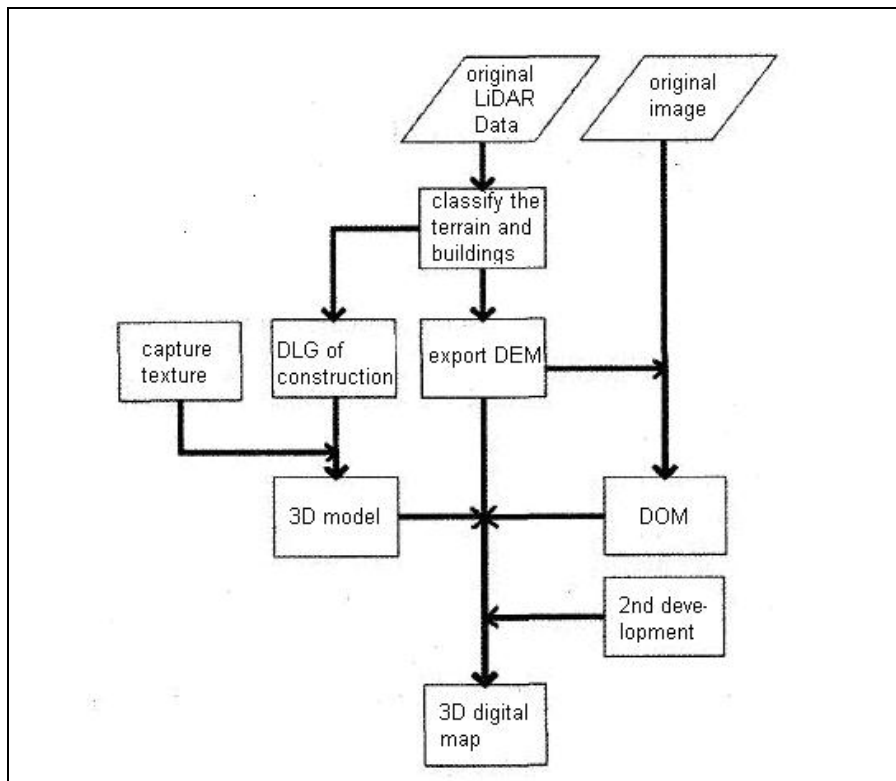


Figure 3: working process of electric map from LiDAR data

From the flow chart, we can analyze and divide work process to two main steps: outdoor work and indoor work. Outdoor work includes capture of LiDAR data by ALTM3100 and capture image data by digital camera for construction's texture. Indoor work includes LiDAR data processing, image correction, digitalization, format transformation and system integration. Then after this working process, people imports the DEM, DOM, 3D model and symbols from topographical map into a 3D platform software. A 3D electric map with alternant operation, searching and browse functionalities is accomplished.

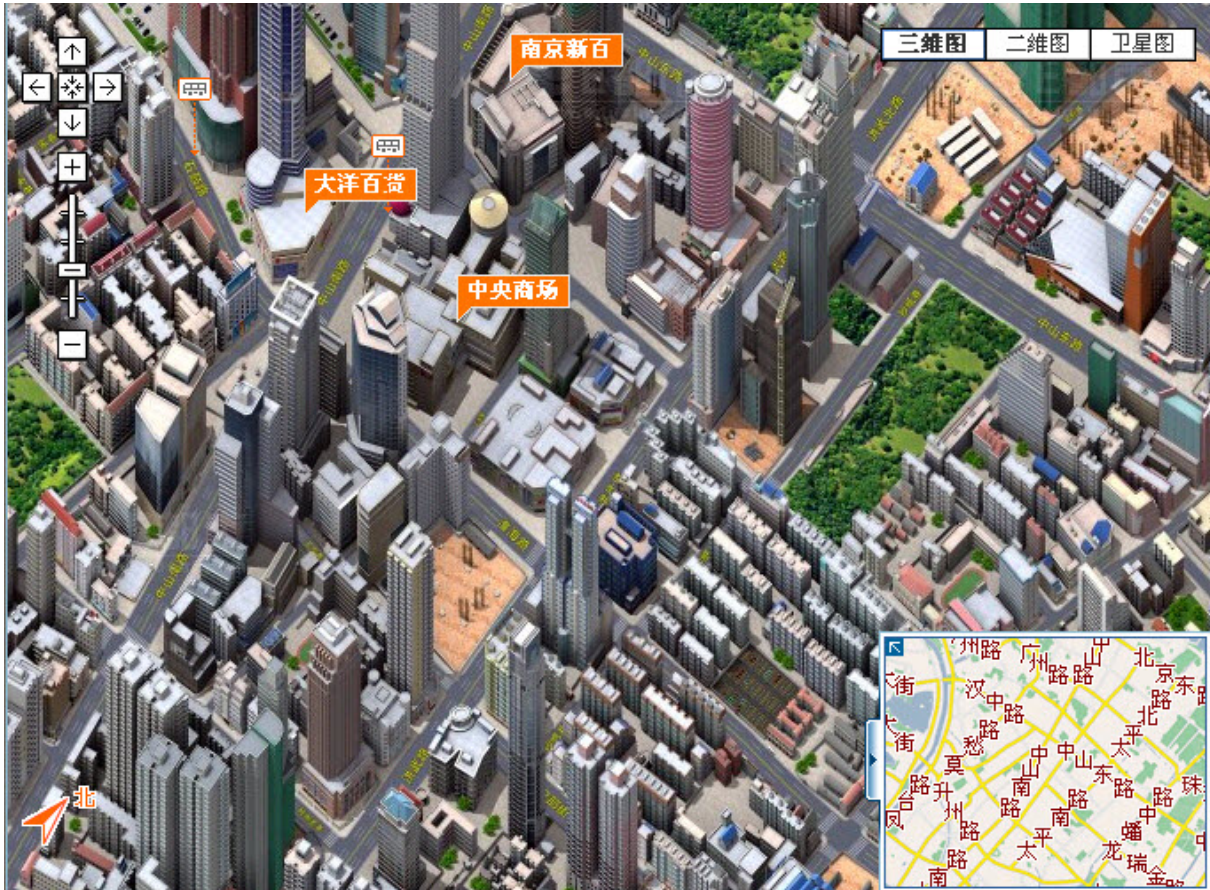


Figure 4: 3D electronic map of Nanjing

3.2.2 Evaluation

In this project, the author shows three main advantages to create the DEM, DOM, 3D model and 3D map by 3D LiDAR technology. First, according to the system accuracy of ALTM3100, the attitude accuracy of the buildings could be limited in 15cm. Analyze statistic is shown in Figure 5.

Number	East	North	GPS	LiDAR	difference
ld1	130 404.695	141 396.610	13.481	13.580	+0.099
ld2	130 583.982	141 141.073	21.471	21.560	+0.089
ld3	129 479.590	140 676.407	25.338	25.330	-0.008
ld4	130 206.297	140 877.628	26.185	26.240	+0.055
ld6	130 091.842	140 493.284	20.818	20.900	+0.082
ld8	130 742.662	140 383.073	16.641	16.620	-0.021
ld10	129 907.651	140 065.637	18.509	18.390	-0.119
ld12	129 363.992	141 286.615	32.422	32.490	+0.068
ld13	129 174.019	141 103.580	32.138	32.130	-0.008
ld16	128 673.826	140 009.613	32.409	32.560	+0.151
ld18	128 668.458	141 326.461	41.379	41.480	+0.101
ld19	127 558.540	141 322.459	27.658	27.670	+0.012
ld22	127 685.330	139 354.422	36.031	36.090	+0.059
ld23	127 586.736	138 688.504	24.400	24.410	+0.010
ld25	130 870.793	139 836.037	12.122	12.180	+0.058
ld26	129 426.492	139 102.398	23.945	23.910	-0.035
ld28	127 487.616	140 337.378	56.046	55.890	-0.156
ld29	127 879.356	140 594.842	55.038	55.140	+0.102
ld31	128 237.660	139 726.818	41.783	41.400	-0.383

average difference= 8 mm; RMS = 11.9 cm.

Figure 5: Height accuracy analyze

Secondly, DLG is no more necessary for creation of 3D model. Since the LiDAR technology gets the borders of the objects, people can form the outlines of the objects directly by using them. Thirdly, the roof of constructions can be represented more exactly.

On the other hand, there are still some limitations of the system. First, the texture information of the building facades is missing. Secondly, the spherical and actual construction can be formed exactly only after formed manual corrections.

3.3 Laser Scanning project in Province Jiangsu for Tidal Zone

3.3.1 Working principle and process

On 15th, January 2007, Jiangsu Provincial Bureau of Surveying & Mapping, associated with EarchData Pacifica (Beijing) Co. Ltd published their project of mapping Jiangsu Tidal Zone using LiDAR technology.

The Tidal Zone in province Jiangsu is one of the densest tidal zones in China. Usually for such kind of Zone, it is difficult to distribute ground control points since they are very flat and change the area obviously in the flood time. In this case, it is difficult to acquire the accurate geospatial information in these tidal zones by using traditional photogrammetric technology. So normally in such zones people are still using the old-time records which are captured during medium-term of last century. However, in the recent years the province Jiangsu has already established systematic and completed geospatial data networks for requirements of economic developments. The old time data for the tidal zones are no more match the new data networks. New technology is needed for updating the geospatial information in this area and it should solve the problem which people meets by using the traditional measurement methods before.

Compare to traditional methods, LiDAR technology has its advantage. It has relatively short-term production period, low influences by weather, highly automatic and accurate capturing capability and so on. Besides, people use the exact geoid to increase ground control and to avoid distributes too many GPS receivers on the ground. All these avoid unnecessary and difficult outdoor works.

In this project, people are aim to use LiDAR system to measure laser scanning points, using the GPS station next to the measure area simultaneously for achieving DGPS orientation. Figure 6 shows the flight parameter.

subject	value
flight height	6000 m
flight speedy	240 km/h
measurement area	295.715 km ²
flight direction	East - West
strip number	119
laser impulse frequency	100 KHz
laser scan frequency	44Hz
laser scan angle	20 degree
laser point side overlap	44%
ground point interval	4 meter
laser type	narrow

Figure 6: Flight parameter of project tidal zone

To make sure that the flight task is achieved successfully, people need to distribute the GPS station on the ground. There the GPS receiver, airborne POS system and the airborne GPS will measure simultaneously, and execute the dynamic DGPS phasic difference orientation. When the coordinates of the GPS stations are unknown, people need to execute static orientation of the station and compute the location of the station in

WGS84 coordinate system and in the second 1980 Xi'an coordinate system. To make sure the measurement accurate, ground control points are necessary for correction process. The amount will be 200 -300 points base on the actual flight route and post-processing needs. For the indoor (post-processing) work, there is a flow chart shows in Figure 7.

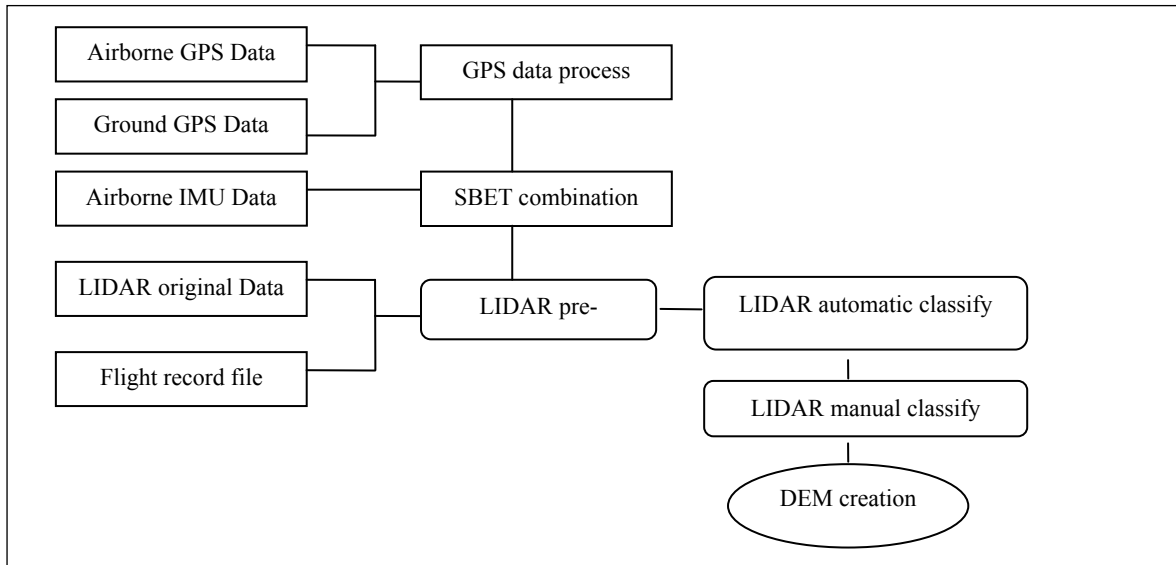


Figure 7: working process

After the flight task, people uses the airborne POS data and the DEM created after fore process of LiDAR system, the DOM data is computed. Then base on the DEM, DOM and the automatic formed contours lines, the contour in DLG is finished. After capturing the main objects base on the LiDAR data, the DLG is accomplished afterwards.

3.3.2 Key issues of the project

- Distribution of the calibration field, calibration of the light and calibration accuracy analyze: One of the key issues in this project is the accuracy calibration of the LiDAR system. Only when the LiDAR system is calibrated, the LiDAR point clouds, POS route data, EO data and images are accurate enough for creation of the productions.
- Usage of Geoid: The Geoid used in Jiangsu currently is the 7cm accurate Geoid. But the most area in this project is not covered by Geoid. So first, the extension of the original Geoid is necessary.
- Problems and solutions for non-stop GPS orientation server resource usage: Currently, Province Jiangsu has the GPS orientation server system under construction. Consider the dense of the GPS stations and the cover range, some DGPS stations are needed to make sure the fluent connection between airborne GPS receiver and GPS stations on the ground.
- Classification of LiDAR data: Automatic classification on the LiDAR data is the key technology of the process the data effective. From acquire the LiDAR data to finish the DEM; there is only a short term period process since the LiDAR data classify themselves automatically.
- Edition of LiDAR data: Base on automatic classification of the LiDAR data, some additional manual edition are executed to deal with the unclassified or wrong classified data, so that the quality of the DEM is increased. The task of the edition includes: identification and elimination of the noise points; identification and process of crops, water body, process of the point remained after automatic points classification; matching of LiDAR data and DEM, contour lines and DLG data.
- Design of Contours and DLG: Since the detection differs from the traditional methods, the design of Contours and DLG are different:
 - The system forms the contours directly by DEM.
 - Edition of the contours is manually.
 - Label the contours
 - Design the main objects of the DLG base on DOM, DEM and contour Labels.

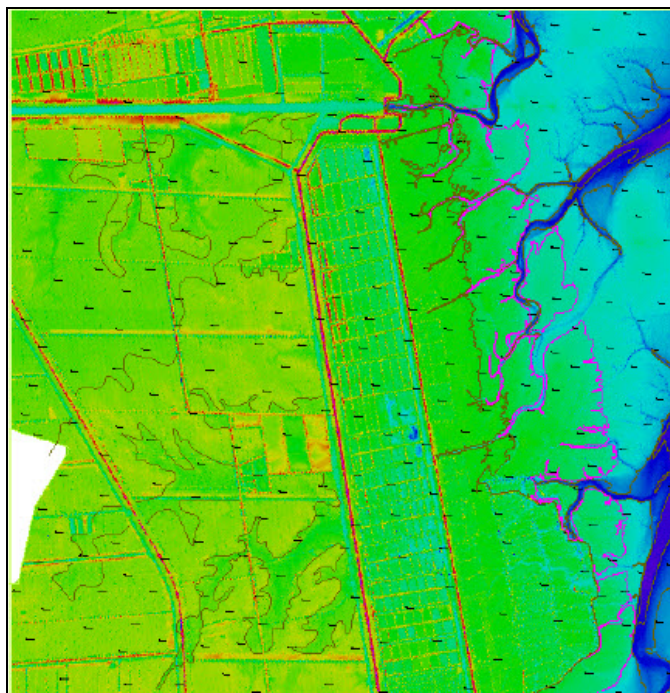


Figure 8: DLG, contour and Height points and labels (range : 8km * 8km, WGS84)

3.3.3 Evaluation of the project

In this project, a measurement region with 11,900km² area in scale 1: 10000 is accomplished. The researchers make the first project using LiDAR technology for Tidal Zone mapping and analyzing in China succeed. The result of the measurement is export in the form of DLG, DEM and DOM. After the quality verify, the resolution of DEM is 4 meter, the height accuracy achieved 0.33 meter, which have already fulfilled the accuracy criterion used now.

4 Summary

In this report, we described two main issues. Two projects using advanced LiDAR software Optech's ALTM3100 and Leica's ALS50 to perform real-time points acquisitions and DEM construction are described. Both of them are accomplished successfully.

After the first ten years attempting and exploration, LiDAR technology will come into the thriftily developing period in China. Now high attention and strong interests in doing different surveying and mapping project with LiDAR technology have been shown by many organizations and companies. Some of them have already started the first step, to acquire the point clouds data for further productions in different themes. A bright future of LiDAR technology in China could be seen.

References

- Du GuoQing □Shi ZhaoLiang □Gong YueXin □Li TieJun. Research on Application of LIDAR in Mapping of Jiangsu Tidal Zone. URBAN GEOTECHNICAL INVESTIGATION & SURVEYING 2007(5), pp.23-26
- Li Shukai, Xue Yongqi. Airborne Laser-Ranging-Multispectral Imaging Mapping System, JOURNALS OF WUHAI TECHNOLOGY UNIVERSITY OF SURVEYING AND MAPPING 1998 23(4), pp.340-344
- Han Wenquan □Hou Zhaotai □Liu Xingbo. Research on Production of Three Dimensional Electronic Map with LiDAR Technique. GEOMATICS & SPATIAL INFORMATION TECHNOLOGY 2008 31(2), pp.7-9

HIGH-QUALITY RANGE IMAGE REGISTRATION ON COMPLEX 3D SHAPES COMBINING LOCAL AND GLOBAL SPATIAL INFORMATION

Hongwei Zheng^a and Dietmar Saupe^b

Department of Computer and Information Science Universität Konstanz, 78457 Konstanz, Germany

^a hongwei.zheng@uni-konstanz.de

^b dietmar.saupe@uni-konstanz.de

ABSTRACT

In this paper, we present a novel approach for efficient and high-quality surface registration on large and complex 3D shapes based on the combination of local and global geometric spatial information. In this approach, instead of relying on one type of scanned data, we propose to use two types of scanning data provided that it can support both global and local shape information. The scanned low-resolution global 3D shape data supplies the global shape structural prior for registering the high-resolution local 3D surface patches. Local surface patches can thus be optimally registered requiring less overlapping and thus reducing redundancy. Furthermore, due to the restriction of hardware, we cannot directly process and register hundreds of scanned local surfaces to a global low-resolution shape model at one time. We segment the low-resolution global 3D shape model into several meaningful parts using a newly proposed variational 3D shape segmentation algorithm. The multiple local surface patches can be registered on these segmented parts respectively and all the segmented parts can be merged after registration. To verify the feasibility of the proposed approach, this approach has been evaluated for acquiring various real biological 3D models. Using only geometric spatial information from local surface patches and global shape model without using texture information, the results show that the proposed approach can achieve efficient and high-quality surface registration on large and complex 3D shape models.

LIDAR DATA VISUALIZATION USING IDL AND ENVI IMAGE PROCESSING AND ANALYSIS ROUTINES FOR THE CAMPUS AREA OF UNIVERSITY OF CALGARY

N. I. Abd El Hamed

R. A. at the Scientific Training and Continuous Studies Division,
National Authority for Remote Sensing and Space Sciences (NARSS)
23, Joseph Tito St., El-Nozha El-Gedida, P.O. Box: 1564 Alf Maskan, Cairo, Egypt
Nabila_gis@hotmail.com.

KEYWORDS:

LiDAR, IDL, ENVI, GUI, Widgets, ASCII, Raster interpolation

ABSTRACT

This research is focusing on how to model and visualize LiDAR data by using the programming procedures and routines of the Interactive Data Language (IDL) in conjunction with ENVI program. This project is divided into two major parts. The First part is considered as the real challenge to import more than 14 million points using a programming function to read the ASCII file and change it from the point format (X,Y,Z) to the raster format (Equal spaced grid e.g. 1m x 1m pixel size) using an fast interpolation method that achieve accurate result of the surface.

*The second part of the project is to establish a GUI and Widgets that can be used as program interface and show the results inside it. These widgets and GUIs should be interactive ones and easy for the user to deal with and can save his image processing and analysis results to external folder in format of images e.g. *.tiff or *.JPG etc.*

1 Introduction

Light Detection And Ranging (LiDAR) systems are considered as promising technology that provide accurate and precise measurement of the surface. The accuracy ranges between 10 cm up to 1meter depends on the system component and the project targets and goals. These data are representing well the Digital Surface Model (DSM) e.g. buildings in the urban areas which enable generating 3D city models. Also, it used in the forest application for the canopy for model the trees. The data was visualized and analyzed by writing codes and program using procedures and routines of the Interactive Data Language (IDL) and ENVI.

This project aims to achieve the following steps: Develop image processing and 3D display utility (GUIs and Widgets) for an X, Y, Z LIDAR data set (e.g. interpolation method to change the data format from points to Raster, etc). Develop menu with different methods of image processing tools. Build Contour Lines. Build 3D models e.g. 3D city Model.

2 LIDAR data calibration methods

There are around four different types of scanning methods for the LiDAR systems. An airborne laser scanning system reconstructed the surface by using the footprint centers which form a set of discrete points representing the surface. It is desirable in all directions to have equal spacing of the sampling points. The laser beam must be deflected in a certain pattern to obtain area coverage. Due to the moving aircraft the scan pattern is repeated many times at wherever changing locations. The most common working scanning principles are linear scanning (e.g. constant velocity-rotating mirrors, Oscillating Mirror (bidirectional scan)) and conical scanning (e.g. fiber-optical array (unidirectional scan), Palmer or elliptical scanner) as shown in figure 1.

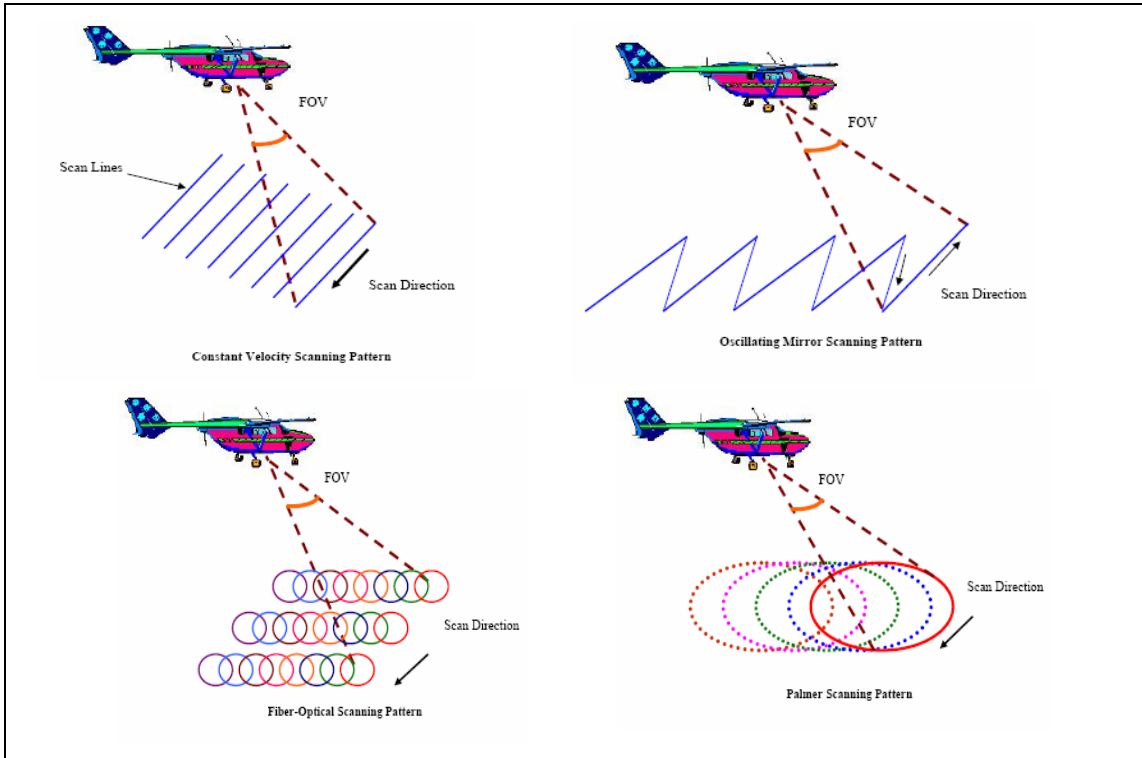


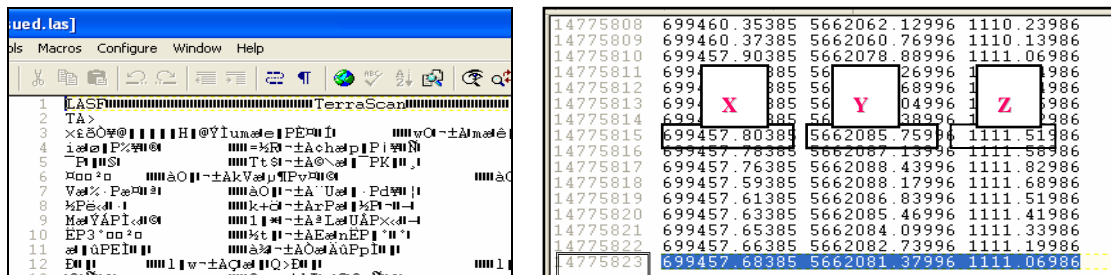
Figure 1: LIDAR Calibration methods

3 LIDAR available data format

Data Format

The data consists of different flight strips over the campus area to collect the LiDAR data. It is also very dense point's coverage to cover the building area. The Available data format of the campus of University of Calgary (UoC) has the following extensions:

- *.LAS it is Binary file (the row file from the flight), Big Size up to 166MB.(Not Our Target)
- Campus.TXT it is ASCII file, Size 549MB. As showed in figure 2.
- The Number of points are (14,775,823) around 15 million point .The Ascii file contain 3 column XYZ
- The file coordinate system is UTM ,NAD1983 ,zone 11.



a

b

Figure 2: a)Las format files, a)ASCII (txt, asc) format files

Other Data Sources

- ADS40 camera images: it is RGB High Resolution Images about 30 cm x 30 cm pixel size.The file coordinate system is UTM, NAD1983, zone 11. as showed in figure 3.

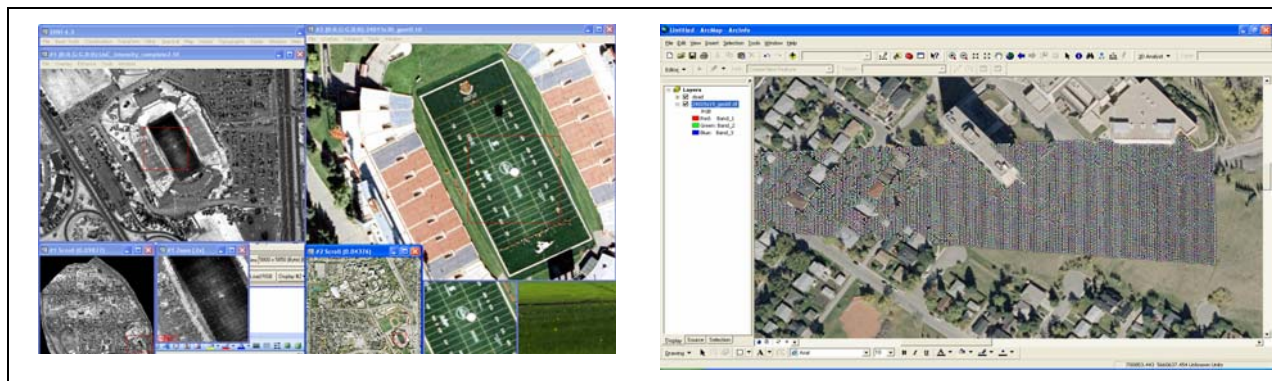


Figure 3a: LIDAR intensity image (left) and RGB image (right)

Figure 3b: LIDAR point coverage overlaid on RGB image to show point density

4 Methods /Pseudo Code

4.1 Project Structure:

The project consists from major code files as follow:

- The Main.pro: Creating a \$ MAIN\$ program in a text file allows you to combine the functionality of named procedures and functions with the ability to have command line access to variable data that is defined in the \$MAIN\$ scope.
- ASCII2img.pro: Is the procedure which responsible about importing the ASCII LiDAR files and change it from point shape (irregularly points) to raster shape (grid).
- Viewer.pro: This file contains the design widget and GUIs (interface and menus codes). These file work in conjunction with another file for calling event procedures that carries in the back the functions (e.g. Histogram and Edge detection procedures) that is assigned to the buttons. So when press a button to execute a function or method it works under the file viewer_eventcb.pro
- Fly.pro: This file contain codes to open an DEM image and overlay an RGB image on it and simulate it in 3D visualization view , also you can fly through the DSM model to have close view. This method is based on the fly through demo from IDL library.

4.2 1st Method: Import LIDAR ASCII (.txt) files (Main Part of the program)

In this project the real challenge is to import around 15 million points with size of 550MB. The challenge in finding method that can deal and handle the points in very easy manner and short time. Also, allocating enough memory for processing these data was very difficult with IDL routines for interpolation (normal methods, e.g. Bilinear, Kriging). Always I got an error message says you run out memory or insufficient memory for your process.

Thanks to Dr. Guillermo Castilla, we were able to write code to import the file and allow the user to select his files and then calling ENVI routine (ENVI_READ_COLS, File, Values). This procedure is used to read ASCII column data. It considered the Backbone of this project because it reads unlimited columns and rows. This procedure reads till now around 15 million points (the project data). Also this project considered the worst case scenario is to have data without the coordinate system information. So, Assume that you have only ASCII points file with (X, Y, Z) if you don't know its coordinate system and want only to draw the points as raster images.

After this stage of having a raster image in the memory; we start to save and define the coordinate system of the image by using ENVI edit header function and use the printed information from ASCII2img program like (false E, N). Hence, the image coordinate changed from pixel coordinate (indexed image) to real coordinate with X, Y and has Z value and draw in grey scale colors. Finally, we achieve our goal by changing the LiDAR points to a Raster image valid for analysis and ready to be used as Digital Elevation Model (DEM) and Digital Surface Model (DSM) in models and applications e.g. 3D City Models and Canopy Models (DCM).

4.3 2nd Method: Using IDL INTERACTIVE Widgets and GUIs for data visualization and image processing:

This interface design should meet the following criteria: open and read images with different format (e.g. *.tif, *.jpg,) in widget-draw window

Do image processing and analysis techniques:

- Show image histogram and use histogram functions and send the result to extra GUIs.
- Image smoothing and sharpen techniques.

Send image to icontour (IDL Itools) to show contour the image and show the contour over the RGB or DEM or DSM images.

Finally open the corrected images (RGB, DEM and DSM) using `d_flythru.pro` from IDL Demos Library. Then fly through the terrain using the DEM and DSM as surface input image and the RGB one as texture image.

4.3.1 IDL GUIBuilder:

The IDL GUIBuilder is part of the IDLDE for Windows. The IDL GUIBuilder supplies with a way to interactively create user interfaces and then generate the IDL source code that defines that interface and contains the event-handling routine place holders (IDL Help).

- The first part of the `LIDARviewer.pro` represents the Event- Handling Routines.
- The second part of the `LIDARviewer.pro` represents the Creation Routines.
- The second File of the `LIDARviewer_eventcb.pro` represents the IDL Event Callback Procedures.
- The rest of the menus and the button created using the same procedures as the code above. Only the `Import_ASCII` and the `Fly Through` buttons have separate code files. These files run or executed from the `main.pro` file.

The advantages and disadvantages of GUIBuilders are:

- It is easy to build your interface and choose the position want for your buttons freely without write positions for it. Also, it is easy to change your design and overwrite or save it as new file.
- The only disadvantage of the GUIBuilder is when you do changes in your design like add more buttons or delete it. When you save these changes that means you will overwrite the 2 files the `design.pro` and the `Event.pro`. But the `Event.pro` is more dangerous when you overwrite it because it deletes all the assigned codes to the buttons. So after doing the design changes, it is recommended to make backup from the old `Event.pro` and save the files with new names.

4.4 3rd Method: 3D Fly Model over the terrain valid for 3D city models as Virtual Reality.

This function is based over the demo `d_flythru.pro` from IDL demo's library. Then fly through the terrain using the DEM and DSM as surface input image and the RGB one as texture image. Then pass these inputs to `d_flythru` as surface input and texture input. Finally the data showed in 3D terrain model over laid with the RGB image and you can see the building as virtual reality and fly through it. As showed in Figure figure 4.

4.5 4th Method: Contour layer

This contour layer is done by selecting an image. Remove the zero values by using the min. z value as threshold. Then send this result to show it in IDL Iconour Tool. The threshold part is considered the only Problem if you select image and doesn't have z value. As showed in figure 5.



Figure 4: LiDAR point coverage over laid on RGB image to show point density

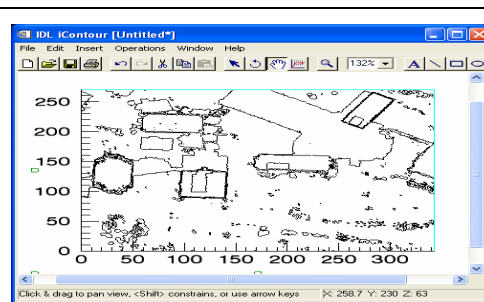


Figure 5: LiDAR contour layer using Icontour

5 The results from LiDAR Viewer program

This chapter shows the success of achieving the objectives and the goals of this project and we will put some snapshots from the final results.

5.1 ASCII2img. Pro results in ENVI

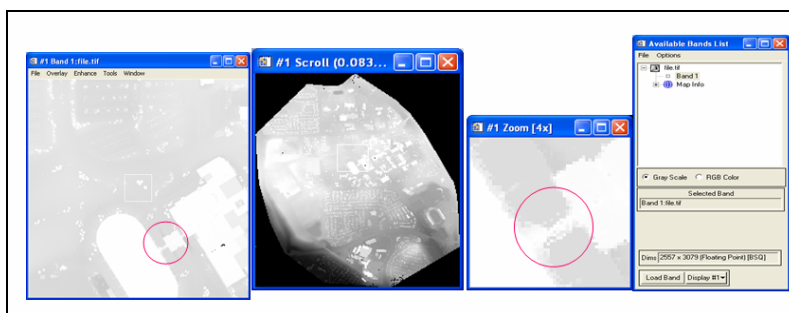


Figure6: the final result of importing the LiDAR points showed in ENVI

5.2 LiDARViewer, Pro results of the program interface

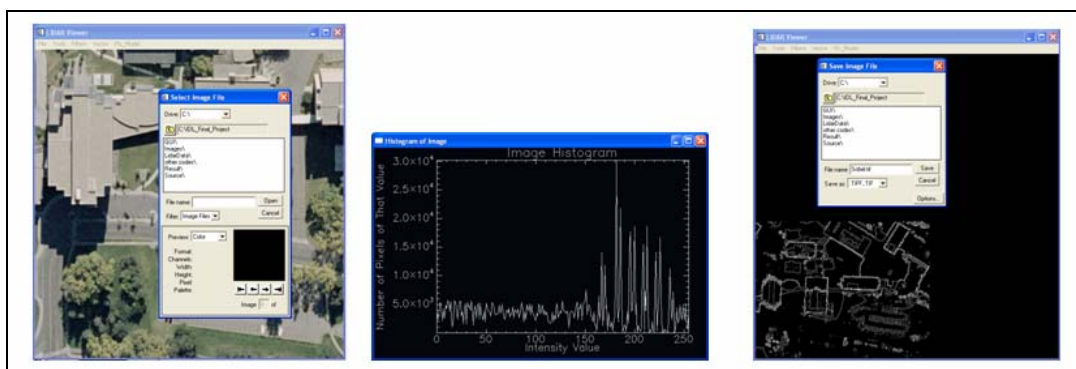


Figure 7: demo for showing the program ability to open images and its histogram. Also do Sobel edge detection filter on LiDAR Subset image

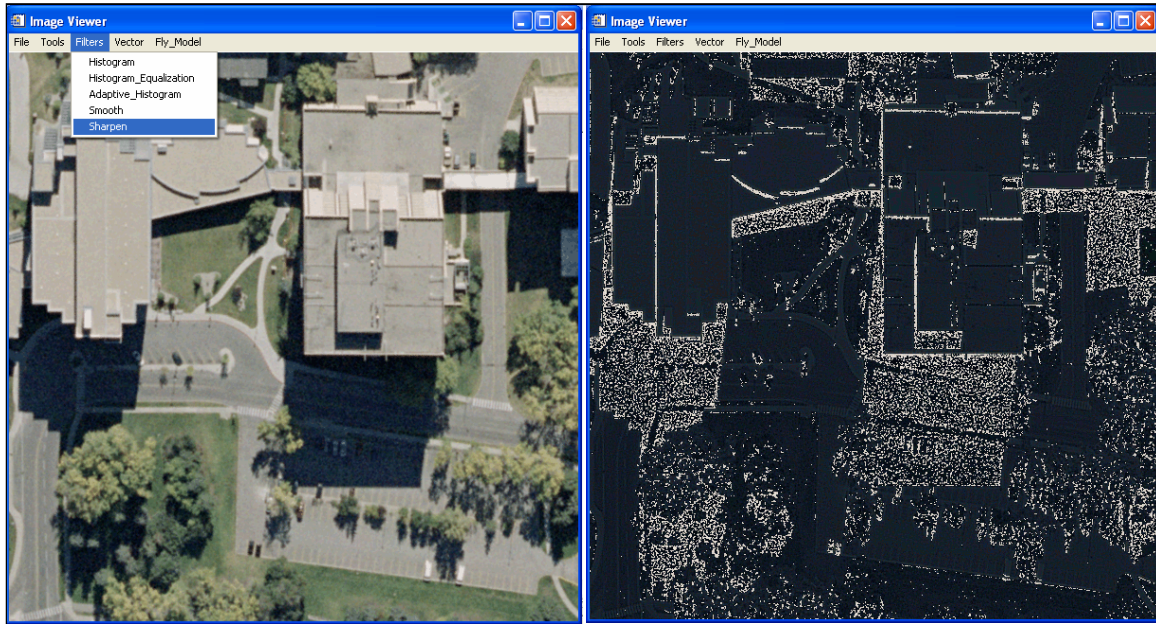


Figure 7: Demo of Applying Sharpen filter on RGB image

6 Conclusion

LIDAR is very interesting material for understanding how can you construct an image from only 3 col. (X,Y,Z) and several million of rows . This project face one of the biggest problem is how to import these huge lines (total points) to IDL or even other programs to read and interpolate it.

Using the IDL supported interpolation methods wasn't able and very hard to process this huge LIDAR file around 500MB in size and also IDL doesn't have sufficient memory to handle it (error message).

Another problem is to pass (go and back function) between IDL and ENVI then back again to IDL because IDL functions don't work in ENVI session and VS.

It is easier to define the coordinate system using ENVI Edit Header file. The rest is easy to Handle as normal Raster Images and do analysis and enhancement on it. To adjust the 3D model, The DEM and the RGB image should have the same coordinate system. Also, the min. elevation used as a threshold to get ride from the zeros in the image.

References

- Abd El Hamed , N (2006): Evaluating LIDAR Data in Geological and Geomor-phological Applications in Alpspitze Mountain Area, Southern Germany, HFT Stuttgart, Stuttgart, Germany.
- IDL.,(2005): Version 6.3, ResearchSystems, Inc.Help Files
- Leica Geosystems, (2006): “ADS40 Airborne Digital Sensor”. Leica Geosystems Inc. URL <http://www.lh-systems.com>.
- Schenk, T. (2004): “Digital Photogrammetry”, TerraScience LLC, Laurelville, OH ,vol II, HFT Stuttgart lecture notes (2005).

LIDAR TECHNOLOGIES FOR EFFECTIVE WATERSHED MODELING AND HURRICANE DISASTER MANAGEMENT

M. Taner Aktas

mtaktas@yahoo.com

KEYWORDS:

LiDAR, Arc Hydro, Watershed Modeling, Disaster Management

ABSTRACT

Florida has hurricane season every year during May to September. Many hurricanes left neighborhoods and towns inundated. Florida's non-dendritic surface drainage system makes it difficult to model with conventional systems. Thanks to airborne LiDAR data collection technology and enhancements in Arc Hydro model, watershed parameters can be calculated effectively. A study is done for Citrus County, Florida where various sources of LiDAR data are used for this purpose. LiDAR data is imported into GIS. Very large point cloud data are processed using advanced terrain modeling techniques developed, and then high precision surface raster data is obtained. Several 3D and spatial modeling steps are performed during Arc Hydro modeling stage. At the end, obtained watershed parameters are compared with the ones obtained with traditional methods. Data further entered into an enterprise spatial database where modern surface water models can use input data automatically from database. The results are then used to update the floodplains to show hurricane risk areas during hurricanes.

**Alumni Session: Experiences and Business
Development**

ENTREPRENEURSHIP IN GEOINFORMATICS: DEPLOYING TECHNOLOGIES OVER OPPORTUNITIES

Sajid Pareeth

35/847, AMRA 90, N Janatha Rd, Palarivattom, Ernakulam, Kerala, India
+91 484 2345500, +91 9446539650, - spareeth@gmail.com

KEYWORDS:

Geoinformatics, India

ABSTRACT

The field of Geoinformatics complemented by various IT technologies , has emerged as a s a front-runner among the various domains of technical and business development arena in the last decade. Even when the developed countries are facing a saturation in development, deployment, sales and maintenance of applications and products, many other developing and nearly developed countries present potential cases of vast opportunities to be tapped in the field of geo informatics.

India, being one of the most sought –after hotspot of IT and ITES services, has widely attracted the Geoinformatics community and has been seen as a major investment spot for the development of GIS projects. Apart from outsourced GIS projects, there is a great demand for carrying out government funded projects on different levels of local, state and national governance in India. This paper tries to identify different business opportunities in Geoinformatics from three levels of industry based in India and identify main drivers like latest technological trends and cost effective solutions for making it more than lucrative.

The three levels are:

- *. International*
- *. Indian Govt/State/Local administration funded GIS projects*
- *. Projects from Research/Academic institutions*

The remarkable increase in the funds allotted to the Geoinformatics domain by different levels of governance in India is triggered by rapid development initiatives based on systematic research and planning. The success factor of entrepreneurship in this field largely depends on how effectively the opportunities are tapped at various levels . Knowing and implementing current trends and technologies in a cost effective way is the key to the successful entrepreneurship, in a country like India.

GEOSPATIAL TECHNOLOGY TREND: EXTRACTING REALITY OF DEVELOPING WORLD

Satyendra Singh Yadav

singh@geovizdom.com

KEYWORDS:

GIS Industry, India

ABSTRACT

Geomatics has made rapid strides in the last 15 years globally and has today become a powerful tool for decision makers who seek improved management of their organization and resources. While GIS is reaching to new heights in developed countries such as Germany, USA etc, the progress of geospatial industries in India has been registering rapid pace as well. Previously, only government sectors were the most prospective clients of GIS companies in India, but now scenario is changing. From finding a good restaurant to locating the home of a long lost friend, India reaches up to a GIS provider though potential of geospatial technology however trends in India is still to see its full potential.

In the present state, the GIS industry is seeing a number of notable new developments and trends that are changing the industry and also sometimes its standards. Some of the significant trends witnessed are the entry of Internet based technologies and solutions, dramatic increase in of mobile and wireless computing applications, use of enterprise GIS, availability of remotely sensed high-resolution data, and mergers and acquisitions in the industry. While GIS Industry of India is still solving problems of places outside India it is need of the hour to address increasing problems of its own i.e. huge data unavailability and interoperability problems associated with available data. In the coming days one needs to think of addressing multiple problems at a time and evolve environments of multiple networked users etc. GIS industry in India is growing despite various challenges however its very important to make this growth a sustainable one and benefit the common man. In the recent past, there has been a huge investment made in this area by government, and corporate sectors but a clear change is yet to be seen.

GIS plays a significant role in almost every decision we mak: From selecting sites to targeting market segments, from planning distribution networks to responding to emergencies or redrawing country boundaries.

This paper is going to covers some of the key trends globally vis a vis trends in India, identifies opportunities for the GIS community that arise from these trends through technology transfer, cooperation etc, and suggests a few strategies that can solve the challenging issues of environment, global warming, human habitat etc.

SOME EXPERIENCES AFTER GRADUATION FROM HFT

Godwin Yeboah

^a RUDAN Engineering Limited, Box CT 828 Cantonments,
Accra, Ghana
kojob2@yahoo.com, dwin.yeboah@rudanghana.net

KEYWORDS:

RUDAN, TRANSVER, Alumnus, HFT, Engineering, GIS, LIS, Private Company, Daniel Akornor, Ghana, Germany, University of Applied Management

ABSTRACT

The writer has been fortunate to have some experiences in Germany and his home country, Ghana, and wish to share with you the reader. These experiences encountered encompass various work experiences in different companies as well as university. The companies shall include TRANSVER International which is a German based firm and RUDAN Engineering Limited which is Ghanaian based company. The university is called the University of Applied Management (UAM) which is based in Ghana as an extended campus from Germany. This presentation will highlight some experiences the writer captured. Also, some of the experiences encountered as an Alumnus and major projects and services will be shared. That said UAM semester lecturing experience will be highlighted.

1 Background

This paper shares some work experiences gathered so far by the writer. It will not cover every little detail. That would have been an almost impossible task and, even if he had succeeded, would have made it impossibly witless.

In the late 2001, the writer gained admission to Stuttgart University of Applied Sciences¹¹ to pursue Master of Science (MSc) programme in Geoinformatics and Photogrammetry. In the course of the studies, he got the singular honour to work, as part-time job, with the then course Director. He completed successfully and applied for admission to another degree programme in the same university even though he was first refused admission to study the second degree. After some rigorous interview process, which was to test his computer science knowledge, he was admitted and pursued the second degree which was MSc Software Technology. His multi-disciplinary background makes him a versatile professional. He eventually left the University early 2004. In all these, private funds were used except the part time job. As often said, it is easier said than done. However, a student studying in a challenging university environment can be quite promising for the future. It has never been regretted going through such a challenging moment with respect to well loaded programme, finances, as well as being handled by Lecturers who dislike mediocrity and continuously pushing the student to go beyond their limits.

The determination to quickly gain employment, which often is every student's challenge, was carefully planned and executed by first applying for a job which coincided with the timing of the MSc Software Technology thesis. It should be stated that it was very difficult getting a company that could satisfy this determination. The difficult was to the extent of sending exactly fifty (50) applications through the internet to German companies not to mention other applications sent to the United States of America and the writer's own country. Germany was the preferred choice at that moment because of the financial implications as well as future possibilities. It is always an interest to listen to the hue and cry by foreign African students in Germany not getting access to the job market in Germany. Often no effort is made at all by such students. This, however, is not to justify the fact that such difficult exist. Eventually, a company called TRANSVER interviewed and employed him to design and

¹¹ <http://www.hft-stuttgart.de>

develop a traffic information system called *TRANSBASEMAP*. It must be mentioned here that the outstanding support of the Academic Supervisor¹² as well as other people made it possible for the writer to get excellent work done and thereupon giving him the chance to be employed full time. Projects shall be shared in other sections. The experiences gathered in TRANSVER were mainly technical and very low managerial skills.

After the success in TRANSVER, the writer moved to one of the prestigious companies in Ghana called RUDAN Engineering Limited. Here, most of the managerial skills as well as technical skills were acquired.

In the early 2009, he had another opportunity to lecture Information Technology (IT) Infrastructure and Strategy in Master of Business Administration (MBA) programme being offered in the University of Applied Management (UAM).

The subsequent sections will elaborate more on these experiences.

2 Experiences at TRANSVER

TRANSVER was founded in 1995 with the aim of implementing scientific innovations in the field of traffic engineering and traffic planning in practice. The highly qualified teams of traffic and software engineers continually extend the wide range of TRANSVER procedures and software products. New quantitative models and methods for the detection, examination and evaluation of traffic data for the design, control and optimisation of traffic facility are employed.

The first project handled was called *TRANSBASEMAP*. TRANSBASEMAP was designed as an application to view traffic data from an SQL-database (MS-SQL-Server) using a Geographic Information System (GIS)-component (MapObject) with a newly developed front-end (based on Microsoft Access). Visual Basic for Applications (VBA) language was used to program the application. Even though the company was putting pressure to complete the project on time, the writer was to also complete his master thesis alongside. This was quite challenging but worth pursuing. The database and GIS experiences learnt during studies came very handy. In addition, German language knowledge was very vital and helpful in the successful execution of this project. The Supervisors were very helpful.

The second project was a Java Application Programming Interface (API) for traffic diagrams called *JTRAFFIC*. The project team was composed of the java programmer, traffic engineer and a mathematician. The traffic engineer and the mathematician were to always come up with an interface sketch on paper or as MicroSoft (MS) Windows Word format with a clear definition of the input and output scenarios and give to the programmer, the writer, who is to design and implement that in the JTRAFFIC API. At times, a complete work must be done overnight because of the need for users needs. In all, twenty one (21) classes were created and successfully implemented. Some of the classes are namely TimeSeriesInterpolation, ColorBarPlot, ColorChooser, MultipleTimeSeriesGraph etcetera (see Fig. 1 & 2). One of the things learnt, personally, was that once mentality and approach towards work is important and has influence in how the person organizes before, during, and after the project. The writer saw himself as a consultant and clearly defined his client as the company that has employed him even though the main client was outside the company. The ability to see once success in a project as a direct correlation to his or her professional success and even to some extent future possibilities can overwhelmingly improve in a positive sense once contribution to a project and own self development.

¹² Prof. Dr. Franz-Joseph Behr. Department of Geomatics, Computer Science and Mathematics.

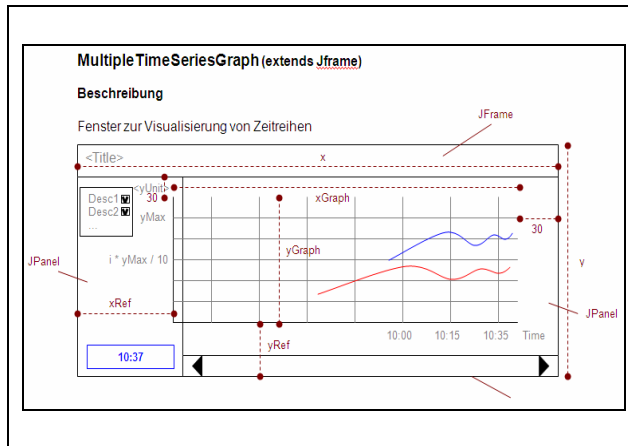


Figure 12: A sketch for a window to visualize a bar-diagram in JTRAFFIC

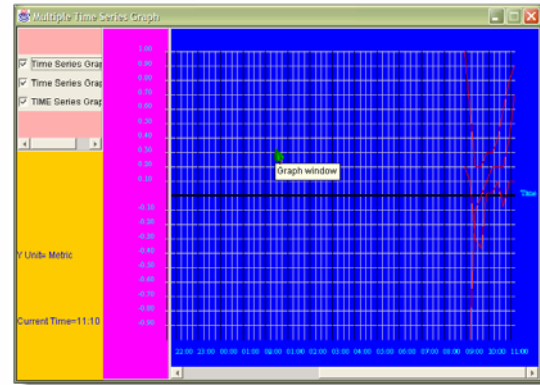


Figure 13: After integration into JTRAFFIC API

The third and last project was a display engine for generating traffic sign boards from eXtensible Markup Language (XML) configuration files called *VARIABLE MESSAGE SIGN (VMS)*. Basically, the engine which is a Java based application reads, analyses and generates a road-side sign board (traffic sign board) from an XML file. The sign board was to be generated into Scalable Vector Graphics (SVG). This project proved to be the most challenging among the three projects mentioned in this section.

3 Experiences at RUDAN

RUDAN Engineering Limited is a development consultancy company established in 1976. It is one of the leading firms in mapping, survey and engineering consultancy services in Ghana and the West African sub-region. It specialises in major industrial surveying, mapping and civil projects. RUDAN Engineering was founded by Mr. Daniel Akornor, a Ghanaian, as a Land Surveying Company with the name RUDAN Engineering Works in 1976. Being one of the first private survey companies in the country, RUDAN enjoyed patronage not only from private individuals but also public institutions like the ECG, SSNIT, SIC, VRA and even the Survey Department of Ghana. Today, RUDAN has become an all purpose engineering institution that renders services in construction, photogrammetry, survey, remote sensing, GIS/LIS and cartography. Most of the managerial skills as well as technical skills were acquired in RUDAN. The writer has been working in this company since March 2005.

The first unforgettable and challenging project was a project called *Consultancy Services for a National Feeder Roads Inventory Zone 2 (Brong Ahafo, Upper East and Upper West)*. The project was sponsored by the Department for International Development (DFID) in the United Kingdom. This was his first project in RUDAN after returning from Germany to my Ghana. The real challenge was not about the technical know-how but rather the need to convince the client, Department of Feeder Roads-Ghana Government, and the employer that he was capable of turning the project around and meeting the short deadline remaining. The GIS Specialist was no more available and the client was completely not so happy about the progress of the project. Within a week, all eyes were on him to deliver a presentation at the client's premises to turn things around. It was at the presentation, that again, the skills acquired at Stuttgart University of Applied Sciences became so handy. Questions from all angles were thrown at the presenter. The experience reminded me of the heavily loaded MSc Geoinformatics and Photogrammetry programme with well defined mini-projects. Even though students often complain of no time to rest it is hoped that such an intention would be maintained since it creates a feeling of working or studying under pressure. The roles that were given were Team Leader and GIS Specialist. Terms like Terms Of Reference (TOR), Terms Of Payment (TOP) as well as Request For Proposal (RFP) were appreciated for the first time. Enough of this project let us move to another project.

The second project to share is a multi-million euro project called *Provision of Digital Orthophoto Maps in Colour for various parts of Ghana*. This project is being undertaken by RUDAN Engineering Limited and FINNMAP International in collaboration with Survey Department (SD), Land Administration Project Unit (LAPU) as well as the Ministry of Lands and Natural Resources (formerly called Ministry of Lands, Forestry and Mines – MLFM). As a deputy project manager to the principal consultant, FINNMAP, what has been learnt is mostly effective planning and monitoring. It is always important to stick to the TOR and consider the availability of financial resources by respecting the TOP.

The third project to share is a multi-million United States dollar project called *BUI City Project* which has several major components. Three components are being handled by RUDAN. The first component comprise cadastral mapping of almost 1800 square kilometres. This component alone is employing over forty (40) workers. The second component comprises digital mapping while the third component comprise the preparation of parcel plans for individual land owners. The area will have a dam at the northern territory and city at the southern territory. The Bui Dam proposed for the Black Volta River will be the third major dam to be built on the Volta River in Ghana. The two others are the Akosombo and the Kpong Dams. The Bui Dam, which is expected to be about 400 megawatt hydro-electric project, is to be built at the Bui Gorge at the southern end of Bui National Park. The project is a collaboration between the Government of Ghana and Sino Hydro, a Chinese construction company. Due to the intermittent energy problems being faced by the country, the Government has decided to revive the Bui Hydro-Electric Dam Project which has been on the drawing board since the 1960s. Successive governments have not been able to implement it due to the huge costs involved. The Bui Dam Project which is to cost almost \$600 million is expected to increase the yearly generation capacity of Ghana's power system by approximately 1,000 GWh, an equivalent of about 10 per cent of the current energy needs of the country.

There are several projects also which space has made it impossible to share. However, what has been learnt through it all are mainly the managerial and technical skill covering proposal reading, understanding and writing, local and international bid opening experience, negotiation skills, project initiation till project closing, supervision skills, access to state of the art software and hardware as well as profound understanding of people with different culture, nationality and even religion. Opportunities were also seized to supervisor some foreign students from Germany and it was observed that they were very happy to be in RUDAN and Ghana.

4 Experiences at UAM

UAM is an institution which has been accredited by the Bavarian State Ministry of the Sciences, Research and the Arts, and is fully approved. The University of Applied Management offers the ideal conditions to develop one's personal, social, methodical, and technical competencies into a very unique, holistic competence profile. According to the University, knowledge alone is not power. Ability to exploit the knowledge one has makes the difference. The ability to "get things done" makes people attractive – for employers, colleagues, peers, and for society at large.

The experience here was mainly the opportunity to lecture in IT Infrastructure and Strategy. The content comprise the following: Introduction to IT Infrastructure, Strategy and implementation as well as Examination guideline, Developing IT Strategy and Implementation, Overview of IT Industry, Industrial IT – Systems, Investment Decisions, Organization issues, Information Management, Information Management, Internet and Standard Software. The interviewer after a successful interview immediately asked for a short period to deliver since the earlier lecturer could not submit the lecture notes. In order to meet the deadline, the newly appointed lecturer, the writer, had to challenge himself to deliver. It must be stated here that friends from academia did help in easing the pressure mounted. Also, it is very important for students to develop good rapport with both their lecturers and colleagues. Sometimes, support from friends could play an important role in ones career. The TOP was based on when results are handed over to the University.

5 Conclusion and recommendation

Three projects from TRANSVER, RUDAN and one from UAM were shared as well as some experiences gained from several other projects undertook in RUDAN were enumerated.

Experiences that a professional gathers in a foreign land or environment other than what he or she is already comfortable with cannot be underestimated and must be encourage especially considering the so called Globalization.

Students in Stuttgart University of Applied Sciences should be encouraged to undertake master thesis in firms. This could contribute immensely to enrich alumni portfolio and especially professionals from developing countries where state-of-the-art systems are minimal. Likewise, students from developed countries can go to developing countries.

It is very important for students to clearly define career goals and aspiration, preferably with guidance from a lecturer, beyond the campus life. This gives a profound commitment on the side of the student as well as sense of

satisfaction on the side of the lecturer for helping the student to achieve most of those goals and aspiration if not all.

Knowledge acquisition alone might not be enough unless one develops the courage and ability to utilise the knowledge.

Supervisors should endeavour to guide and encourage MSc students to write papers or possibly include them in some of the papers they write and publish. This becomes very important when students want to go into research and even further their education to the PhD level.

GEO-INFORMATICS IN SRI LANKA

V. P. A. Weerasinghe

Environmental Conservation and Management, Faculty of Science, University of Kelaniya, Sri Lanka. -
primali@kln.ac.lk

KEYWORDS:

Disaster management, GIS, GPS, Remote sensing, Tsunami

ABSTRACT

The application of Geo-Informatics in Sri Lanka has been very significantly developed after Tsunami in 2004. Because of Tsunami, Governments sector, private sector and educational institutions like Universities are actively engaged in Geo-Informatics in Sri Lanka for different renovation purposes. Traditional disciplines like surveying, cartography and photogrammetry have been replaced with GPS (Geographical position system) and GIS (Geographical Information System) technology due to easy digital data handling as well as quick complex analysis and visualization aspects of spatial data. Therefore GIS technology, data base management, spatial data modeling are gradually being incorporated into a wide range of management and decision making environments in Sri Lanka. As examples Urban Development Authority (UDA) uses GIS for planning purposes, Coastal Conservation Department uses GIS for modeling purposes etc. But still there is a big gap between available GIS functions and the current GIS application domain in the country. This is mainly because of fewer professionals in Geo-Informatics field and even engaged people do not have enough knowledge in Geo-Informatics to fit with the vastly growing field like Geo-Informatics. Geo-Informatics Society of Sri Lanka is established in 2003 aiming to initiate GIS teaching and GIS training by Geo-Informatics professionals in Sri Lanka. There is a possibility to do certificate courses and short courses as well as researches on remote sensing, GIS and GPS. Most of the universities and postgraduate Institutes also started undergraduate courses like GIS for Natural Resources Management, GIS for environmental management, Remote sensing for Resources Management, Statistics for Analysis of Spatial Data etc, diploma courses and postgraduate courses for Masters and M. Phil students. But still there is a great growing demand of Geo-Informatics professionals which is a big challenge currently in Sri Lanka.

1 Introduction

From the evidence presented by the sophisticated ancient irrigation schemes in Sri Lanka, the island must have had excellent surveying technologies in the past. However, the first surveying maps of Sri Lanka were produced only after the establishment of the Survey Department in the early 19th century. Geo-Informatics application in Sri Lanka is becoming more wide spread each day. Following on the pioneering work from the Survey Department in the early nineties, many government and private sector organizations as well as universities have adopted Geo-Informatics technologies into their workflow. After Tsunami disaster in 2004, all government and private sectors and the universities realized the importance of Geo-Informatics applications as well as geo-informatics education. It is very prominent here that the lack of professionals in this field. To solve this problem, the education of the Geo-Informatics should be encouraged. There are two types of education systems exist at the moment as formal and informal education in geo-informatics.

2 Geo-Informatics Education

2.1 Formal Education

There are 15 universities were categorized in University Grand Commission (UGC) web site as universities in Sri Lanka. Out of those 15 universities, only one university offers undergraduate degree in Geomatics. All other universities except 3 universities offer undergraduate courses in Geo-Informatics. Some of the universities offer postgraduate degrees in this discipline (Table 1).

University	Undergraduate		postgraduate	
	Courses Degree	Degree	Courses	Degree
University of Colombo	NO	NO	YES	YES
University of Peradeniya	YES	NO	YES	YES
University of Jayawardenapura	YES	NO	NO	NO
University of Kelaniya	YES	NO	NO	NO
University of Moratuwa	YES	NO	YES	YES
University of Jaffna	YES	NO	NO	NO
University of Ruhuna	YES	NO	NO	NO
Eastern University	NO	NO	NO	NO
South Eastern University	NO	NO	NO	NO
Rajarata University	YES	NO	NO	NO
Sabaragamuwa University	YES	YES	NO	NO
Wayamba University	YES	NO	NO	NO
Open University	NO	NO	YES	NO
Visual & Performing Arts University	NO	NO	NO	NO
Uva Wellassa University	NO	NO	NO	NO

Table 1: Formal Geo-Informatics education in Sri Lankan Universities

2.2 Informal Education

Because of lacking professionals in Geo-Informatics, informal education was started to popular. Most of the post graduate Institutes offer residential short courses for different professionals. This is very common and useful these days. With this kind of training, they can improve their knowledge in Geo-Informatics and applications. But this kind of training is useful mainly for the on-going projects. It is not to produce Geo-Informatics professionals. There are some Geo-Informatics awareness programs for school teachers and school children. The awareness and utilization of GIS technologies by Sri Lanka is very low as compared to other more developed countries. Therefore hopefully awareness programs will encourage the young children towards Geo-Informatics in early age.

3 Geo-Informatics Application

3.1 Tsunami

After Tsunami in 2004, there was a big boom in Geo-Informatics for disaster management related disciplines. Since it is very expensive for a developing country like Sri Lanka, there were lots of foreign donor agencies to help spreading Geo-Informatics in Sri Lanka. Geospatial information remains a key element in disaster management. Investments in planning and preparedness affect the ability of agencies and aid organizations to respond, especially when time is critical. The enormity and the reach of the tsunami event illustrate the challenges of data acquisition, integration, and sharing across jurisdictions and varying data systems. Interoperability remains a vital issue that was amplified by social and political differences. This complex, dynamic, and multidisciplinary event allowed the assessment of the technological approaches for disasters. Within these approaches, GIS is one of the high-end technologies that can help save lives and property. GIS has many advantages, but it was not utilized as it could have been in Sri Lanka.

The lessons learned from a GIS perspective are

- The database should be ready beforehand
- The imagery database should be kept up to date
- The GIS technology usage level should be more advanced to make better use of its capabilities.
- Country-based sociopolitical issues should be handled with care when implementing actions, especially for the recovery phase.

- Government, private and local agencies accompanied by international agencies should collaborate closely for emergency actions and employ GIS.
- International, national, and local agencies should go beyond investing in crucial life support and invest in GIS (ESRI, 2006)

There can be other disasters like earthquakes, volcanic eruptions, drought, famine, epidemics, floods, landslides, storms, hurricanes, and fires. The list could be extended to include technological and man-made hazards such as pollution and land contamination. Any of these hazards could be controlled and mitigated by effective disaster management through GIS. The amount of donations gathered from all over the world for the relief activities was outstanding. The United States, Japan, Britain, Australia, the Netherlands, and Germany were the leading contributors. International NGOs, local NGOs, government agencies, universities, and the public and private sectors were all working side by side to provide disaster relief. In general, these activities can be distinguished into three areas: Social activities (relief work, food, shelter, etc.), scientific activities that could support social activities and scientific activities that support research. The technology applied in these activities differs in context. For example, a better tsunami animation of the event would not be beneficial to relief workers. On the other hand, a detailed map of the damage area would be more functional. For relief work, computers, laptops, mobile phones (including satellite phones), GPS, and the Internet were used. The military and governments also used heavy equipment and technology (helicopters, planes, etc.) to clean up debris, find people, and identify usable routes. Scientific activities that supported the relief work employed computers, laptops, GPS, and the Internet. Moreover, scientists and relief workers were better able to implement GIS and RS. Preliminary usage included satellite imagery, which enabled mapping of damaged areas, and basic infrastructure data. Finally, scientific activities for research utilized high-end technology, software, and hardware. Examples of these activities are the simulations created by several university members. The following table shows the technology summary gathered from an e-mail questionnaire that was sent out to ESRI contacts who worked in the field (Table 2).

Hardware	Computers, Laptops, Mobile Phones, GPS, Tabular Forms
Software	ArcView, ArcGIS 9 (Military Analyst and Maplex extensions), MapInfo, ERDAS
Data Used	Topography, Census, Roads, Utilities, Bathymetry, Elevation, Geology, Land Cover, Landmarks, Hydrology, Administrative Boundaries, Tidal Datum, Orthophoto, GCP, LandScan (population), SRTM, DTED Levels 1 and 2, QuickBird, IKONOS, SPOT
Internet Usage	Interactive Maps (ArcIMS, Manifold, DM Solutions), Static Maps, Information Sharing for Coordination, Eroom and Groove Technology

Table 2: Technology usage in disaster area (ESRI, 2006)

Relief work has been taking place in the disaster area is categorized as follows: coordination and support services, agriculture and fisheries, education, food, health, infrastructure and rehabilitation, protections/ human rights rule of law, shelter/nonfood items, water, sanitation and livelihood. These areas are being covered by 200–300 international and local NGOs in the field and also by government and private sector workers. These NGOs have been responding to categories listed above.

In Sri Lanka, Urban Development Authority has been active from the beginning of the emergency. Using computers donated from the United States Agency for International Development (USAID) and laptops from IBM, GPS was employed to follow up on internally displaced people (IDP) (many GPS units were donated through Trimble and ESRI). Mobile phones and the Internet are also being used. ESRI (ArcView), MapInfo, and ERDAS software are the main source software used. Internet mapping technology based on ArcIMS was also implemented. IKONOS and SPOT were used for imagery data. Russian 1:50,000-scale topography and shapefiles, along with census information, were the main vector data used (ESRI, 2006).

The United Nations Joint Logistics Centre (UNJLC), Vietnam Veterans of America Foundation (VVAFA), United Nations Humanitarian Information Centre (UN HIC), Indonesia National Cartographic Section, Survey Service, national government disaster management efforts, and combined military collaborated in using GIS in Sri Lanka.

Because of this, Government agencies like Department of Forest Conservation, Department of Wildlife Conservation, Central Environment Authority, Marine Pollution Prevention Authority, Geological Survey and Mines Bureau, State Timber Corporation and Sri Lankan Wildlife Trust had lot of experience in Geo-Informatics. Other than those, there are some institutes like Arthur C. Clarke Institute for modern Technologies, International Centre for Geoinformatics Applications and Training and University institutions had opportunity to expand their knowledge in Geo-Informatics.

4 Data Collection

Data collection is the most costly part in Geo-Informatics. There are some problems with data such as lack of data, data sharing, communication, and standardization disturb the usage of Geo-Informatics in Sri Lanka. These problems also created duplication of data. Moreover, accessing data and up-to-date information was difficult and slow. Political obstacles in the government structure and lack of collaboration between agencies worsened the situation.

Like GIS data sharing, remote-sensing data sharing was not adequate. The reasons might be manpower requirements, procedural protocols, and domain security issues. Commercial imagery was widely used by the public but was of limited use to early responders and decision makers. In addition, the requests for higher-resolution imagery grew in importance in the recovery stages of the disaster.

Data flow could be coordinated by an appointed agency, such as in the case in the United States where Incident Command System (ICS) prepares all emergency responders to work together efficiently. The knowledge of ongoing international/national GIS projects could also help in the first phases of an emergency. In Sri Lanka, International Water Management Institute (IWMI) and Cornell University published important data online that could be accessed by any user. Using Manifold interactive mapping technology, they were able to show the data interactively on the mapping portal within hours of the tsunami (ESRI, 2006).

In social and general aspects where emergency management was also affected, country-based sociopolitical issues should be taken into consideration. Because of the security reasons, usage of GPS was banned in Sri Lanka in past couple of years. There should be a special permission to use of GPS from the Defense Ministry. Not only that but also some radar or microwave sensors were banned due to the security reason. Taking aerial images were stopped last decades due to the same reason.

5 Professional Body

The Geo-Informatics Society in Sri Lanka (GISSL) inaugurated on December 01, 2003 with the objective of bringing the professionals in Geo-Spatial Sciences and related disciplines under a common umbrella, aims at contributing, promoting and assisting furtherance of research for the development of Geo-Informatics in Sri Lanka. Other than that some Geo-Informatics awareness programs for the school teachers as well as school children are organized. GISSL will lead to establish an Institute for Geo-Informatics which will be very important to offer a degree in Geo-Informatics as well as to deal with all matters as a centre for Geo-Informatics.

6 Current trend of Geo-Informatics in Sri Lanka

After more than 30 years of civil war in Sri Lanka, the first priority is relief and rehabilitation of the Tamil civilians affected by the counter-insurgency operations. The second is post-conflict economic reconstruction in Sri Lanka as a whole and in the Tamil areas in particular. In this aspect, there is a very big demand for the Geo-Informatics. Because of Tsunami, there was a good Geospatial data collection for other provinces in Sri Lanka other than North and North-East. But now there is a big challenge to collect data and manipulate the geo database for the affected areas by the civil war.

The problems could be summarized into 2 categories as scientific problems such as lack of data, inadequate data sharing, poor communication of data, duplication of data and social problems such as political problems, government structure, relocation of people, and inequity. In this particular event after civil war, critical infrastructure data, such as transportation and locations of hospitals, buildings, and communications, was in great demand. In Sri Lanka, data sharing between government and nongovernmental agencies is not widely applied. Moreover, knowing which data was where and how to share and communicate it was also problematic. In such an ambiguous data environment, most of the agencies started to create the data they needed, which resulted in data duplication.

Identifying the key issues like assessment of risk, mapping the extent of the disaster, helping communities prepare, allocating resources, deploying personnel, monitoring emergencies in real time, saving lives, and protecting property that can be solved by GIS and applying its technology can assist in preventing catastrophic loss of life and property in the future. Sri Lanka will eventually fulfill the digital requirements necessary to implement GIS technology. Once this occurs, the benefits offered by high-end GIS technology can be fully utilized. With GIS models and analysis, emergency vehicle dispatch and tracking, evacuation routing, tracking response, search and rescue, damage assessment, and recovery coordination are possible. Basic technologies

used in the region are the Internet, satellite connection, GIS software, GPS, laptop and mobile GIS, and so forth (ESRI,2006). GIS agencies should take into account standard operating procedures, mechanisms for effective interagency coordination and cooperation in humanitarian crises, geospatial/imagery group devoted to diplomatic and policy activities for easy and efficient management. GIS as an enabling technology in e-governance and citizen information access as well as web GIS need to be developed in Sri Lanka.

7 Conclusion

The use of GIS technology for these applications will enable the agencies involved to save time and improve efficiency. The huge gap in technology implementation among countries should be solved to enable interoperability in emergencies. In all cases, basic databases for humans and their activities and habitat are a critical element in emergency preparedness and response. Consequently, through technology it is possible to identify and mitigate risk, be prepared, respond to emergencies, and recover from them. Managing the information needed for emergency matters is a challenge, and investing more in Geo-Informatics technology is important to increase the effectiveness of relief work in terms of time. It can assist rescue agencies and civil managers in assessing damage from an event and enable them to respond more efficiently. Efforts to facilitate worldwide use of GIS technology will ensure the success of these endeavors.

REFERENCES

- Official web site of Central Environmental Authority (CEA), www.cea.org
- Official web site of International Water Management Institute (IWMI), www.iwmi.org
- Official web site of University Grant Commission (UGC), www.ugc.ac.lk
- Official web site of ESRI, www.esri.com, ESRI white paper 2006.
- www.gissl.lk

ENDEAVOURS AFTER MPG GRADUATION

Naomi E. W. LITAA Y

Ambon, Mylasia
newlitaay@yahoo.com

KEYWORDS:

Business development, career

ABSTRACT

For the students who have done Master of Photogrammetry and Geoinformatics, 18 months in Stuttgart is more than a memorable period. Lots of lessons learnt in such a short period of times, ideas and perspectives formed or at least forming, with a great hope to implement them in the near future, once the school days are over and they get back to the workforce.

After a hectic “packing up” period most of the student would fly back home and get into situation when “what’s next?” questions pops up. For most, the question is asked long before the completion of the course and when they got back to their former place it evolves into “what’s the new experience awaiting for me”. To some, the adjustment into new environment, new adventures and new work life might not be simple.

There is a chance of disappointment or discouragement flocking in when the person find him/herself in contradicting situation. On one hand he or she is really keen to apply and implement the knowledge to the goodness of the people while on other hand, there is so little knowledge and appreciation in the environment/society of the use of Geoinformatics and Photogrammetry. In this case, it is important to look for people who have similar understanding and appreciation on the subject. It is crucial to stay connected with people and the industry so keep to “fan the flame” in the head and the heart.

Lesson 1: Networking is always handy.

Networking is also useful for job application, although not necessarily guarantee suitable job offer. Some students would try their luck to pursue further education by applying for higher degree program but often it would not eventuate due to one reason or the others, even after a lengthy correspondence and exhausting searches. In both situations it is easy to fall into great disappointment but there is always something to learn; if not for a big advantage, at least for new contacts that have been obtained which can be useful in the future.

Lesson 2: Keep the positive attitude during tough time.

Some would immerse into totally new experience that was never imagined before. Humanitarian aids or start-up companies dealing with local government, all are quite different worlds if you are coming from industry and business orientated background or a totally “technical person” before. To this new endeavour, one would be grateful for a multidiscipline applications of subjects learnt at school.

Lesson 3: Be flexible - MPG multidiscipline applications.

Then as the career progresses, hard works will pay off and one would excel to more responsibility and is required to be more accountable and most likely broader interactions with different people from different background and cultures. Culture plays important role in forming ideas, perspective and, of course, decision.

Lesson 4: Never miss your cultural integration class ☐

There are many others aspects beyond the four mentioned lessons. However it is up individuals to make use of them, to strive and to excel for a better future.

**Disaster and Risk Management,
Flood Modelling, Hazard
Prevention**

REMOTE SENSING AND GIS IN FLOOD RISK AND VULNERABILITY ASSESSMENT: TOWARDS CONCEPTUAL AND METHODOLOGICAL APPROACHES

D. C. Roy^a and T. Blaschke^b

^a Ministry of Planning, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
dulalroy@yahoo.com

^b Centre for Geoinformatics (Z_GIS), University of Salzburg, Hellbrunnerstrasse 34, A-5020 Salzburg, Austria
thomas.blaschke@sbg.ac.at

KEYWORDS:

Flood, Risk, Hazard, Vulnerability, Assessment, Remote Sensing, GIS

ABSTRACT

Flood is one of the most destructive, frequent and widespread disasters in the world. It causes huge loss of lives, property and infrastructure, social and economic disruption, environmental degradation, etc in the affected areas. To reduce the negative effects and loss of life and property, appropriate measures need to be undertaken in due time. In any effective flood management, flood vulnerability and risk assessment play a vital role and indispensable to take appropriate preparedness and mitigation measures. Conventional means are not sufficient to assess the vulnerabilities and risks to flooding. Over the recent years, Remote Sensing and Geographic Information System (GIS) technologies are being increasingly used for effective disaster management all over the world. Satellite imageries have been found very useful in monitoring the extreme natural events, making rescue, evacuation and relief operations, estimating damages, etc. For efficient use of remote sensing and GIS in flood risk and vulnerability assessment, development of proper conceptual and methodological approaches is very important. In this paper, the authors focus on different conceptual and methodological approaches of flood risk and vulnerability assessment using remote sensing and GIS.

1 Introduction

Almost all the countries in the world are prone to one or more forms of disaster. Among the different categories, flood is one of the most destructive and widespread disasters in the world (Islam & Sado, 2000). Frequent occurrence of floods causes huge losses of human lives, property and other infrastructure. It greatly affects the overall development of the countries causing socio-economic disruptions, environmental degradations, etc.

As occurrence of disasters like floods is almost unavoidable, the negative effects and loss of life and property can be reduced by taking appropriate measures in due time. For formulating any flood management strategy, the first step is to identify the areas, which are most vulnerable and exposed to flooding. Vulnerability and risk maps are very useful to the decision makers for adopting appropriate policies and actions (De Bruijn & Klijn, 2009). Thus, vulnerability and risk assessment are very significant components of effective disaster management.

Though vulnerability and risk assessments are very essential, these are not properly done and available in many disaster prone countries. For example, Bangladesh being one of the most flood prone countries in the world lacks proper vulnerability and risk assessment. The country faces floods almost every year resulting in huge loss of human lives and property. The leading factors for the country's vulnerability and risk to floods are the incompatible geographical position, low topography, heavy rainfall, unplanned development and the overall socio-economic characteristics. The populations of the country are most vulnerable and exposed to floods. But in maximum cases, the disaster managers mainly focus on the response phases of the disasters without paying due attention to assessment of vulnerabilities and risks. On this subject, Birkmann (2006a) stresses the need for a paradigm shift from the quantification and analysis of the hazard to the identification, assessment and ranking of vulnerabilities. Therefore, different physical, social, economic and environmental vulnerabilities of the elements at risk need to be assessed in a proper and comprehensive way.

For the last years, advancement in the field of remote sensing and geographic information system (GIS) has greatly facilitated the operation of flood mapping and flood risk assessment (Islam & Sadu, 2001). Remote

sensing has emerged as an effective tool for the mapping of the spatial distribution of disaster-related data within a relatively short period of time. Applications of satellite data to predict weather-related disastrous phenomena, such as floods, extreme storms and rainfall, are widely known and frequently utilized. Besides, satellite data can be successfully used in different phases of a disaster for prevention, monitoring, mitigation and relief operations.

GIS can play a great role in natural hazard management because natural hazards are multi-dimensional and the spatial component is inherent. Other, more ambitious disaster risk management objectives such as managing human resources of first responders, optimizing vehicle response times, planning ad-hoc communication infrastructures or evaluating disaster plans, are less developed (Zerger & Smith, 2003). The main advantage of using GIS for flood management is that it not only generates visualizations of flooding but also creates potential to further analyze this product to estimate probable damage due to flood (Hausmann & Weber, 1998). Though these technologies have been emerged as potential tools, adequate work needs to be done in the area of risk and vulnerability assessment especially in the flood prone and developing countries. This paper aims at focusing the conceptual framework of hazard, risk and vulnerability, and different methodological approaches of flood risk and vulnerability assessment using remote sensing and GIS.

2 Geospatial information in global disaster reduction initiatives

The international community stressed the fact that there is a collective requirement worldwide to increase the understanding of vulnerability and also to develop methodologies and tools to measure and assess vulnerability and risk. In this context, the final declaration of the World Conference on Disaster Reduction (WCDR) in Kobe, Japan in 2005, underlined precisely the necessity to develop vulnerability indicators in order to enable decision-makers to assess the impact of disasters (Hyogo Framework for Action 2005-2015, UN 2005). In recent years, various international communities and earth observation authorities have undertaken different useful initiatives to utilize the potentials of remote sensing, GIS and other information technologies in disaster risk reduction.

The European and French space agencies (ESA and CNES) initiated "International Charter Space and Major Disasters" following the UNISPACE III conference held in Vienna, Austria in July 1999. The international charter aims at providing a unified system of space data acquisition and delivery to those affected by natural or man-made disasters. An authorized user can call a single number to request the mobilization of the space and associated ground resources (RADARSAT, ERS, ENVISAT, SPOT, IRS, SAC-C, NOAA satellites, LANDSAT, ALOS, DMC satellites and others) of the member agencies to obtain data and information on a disaster occurrence.

In this area, the Group on Earth Observations (GEO), a voluntary partnership of governments and international organizations, is coordinating efforts to build a Global Earth Observation System of Systems (GEOSS) for 10-year implementation period 2005-2015. Disaster is one of nine 'Societal Benefit Areas' of GEOSS having the objectives to reduce loss of life and property from natural and human-induced hazards. The GEOSS is an ambitious programme of information for ecological security and durable development intended for mankind. Besides, GMES (Global Monitoring for Environment and Security) is a European initiative for the implementation of information services dealing with environment and security. GMES is based on observation data received from earth observation satellites and ground based information. These data are coordinated, analyzed and prepared for end-users.

As a new UN programme, "United Nations Platform for Space-based Information for Disaster Management and Emergency Response, UN-SPIDER" has been established with the decision of the United Nations General Assembly in December 2006. Its main focus is to ensure access to and develop the capacity to use all types of space-based information during all phases of the disaster. Besides, UNOSAT, a UN Institute for Training and Research (UNITAR) Operational Satellite Applications Programme, is delivering satellite solutions to relief and development organizations within and outside the UN system. It helps make a difference in the life of communities exposed to hazards and risk, or affected by humanitarian and other crises. Therefore, it is evident that the world leaders, international organizations and information societies are increasingly focusing on the uses of information and communication technologies like remote sensing, GIS, etc for disaster reduction, environment and sustainable development in recent days.

3 Conceptual framework of hazard, vulnerability and risk

For effective vulnerability and risk assessment, conceptualizations about hazard, risk and vulnerability among various scientific communities should be consistent. In many cases, different scientific communities define the terms differently and concentrate on various focal points.

UN-ISDR (United Nations-International Strategy for Disaster Reduction) defines risk as the combination of the probability of an event and its negative consequences. Risk is conventionally expressed by a function of hazard and vulnerability as follows:

$$\text{Risk} = \text{Hazard} \times \text{Vulnerability} \quad (1)$$

In the above equation (1), hazard is defined as a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (UN-ISDR). On the other hand, vulnerability has been defined as the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

Risk results from a future interplay of a hazard and the various components defining vulnerability. The conceptual superstructure of risk shows an internal and an external side (Bohle, 2001). The internal side relates to the capacity to anticipate, cope with, resist and recover from the impact (vulnerability), and the external side specifies the type and intensity of the hazard. The equation (1) describes general correlation, but displays an abstract approach not reflecting the complex interrelations of both the components and their various aspects. These abstract terms need to be systemized with quantifiable and measurable indicators. Generally the conceptual idea of vulnerability is based on equation (2) (White, 2005).

$$\text{Vulnerability} = (\text{Exposure} \times \text{Susceptibility}) / \text{Coping Capacity} \quad (2)$$

Vulnerability is seen as the interrelation of the exposure and susceptibility as stressor of the system with the coping capacity as the potential of the system to decrease the impact of the hazard. Exposure is defined as degree, duration and/or extent in which a system is in contact with, or subject to, perturbation (Kasperson et al., 2005). Susceptibility reflects the capacity of individuals, groups or the physical or socio-economic system to withstand the impact of the hazard. If resistance is low then even a small hazard can lead to system failure. The coping capacity is the ability to cope with or adapt to hazard stress. It is the product of planned preparation, spontaneous adjustments and relief and reconstruction made in response to the hazard.

Regarding this issue, Wood (2007) presented risk as a function of natural hazards and vulnerable systems indicating some important hazard and vulnerability indicators (Figure 1).

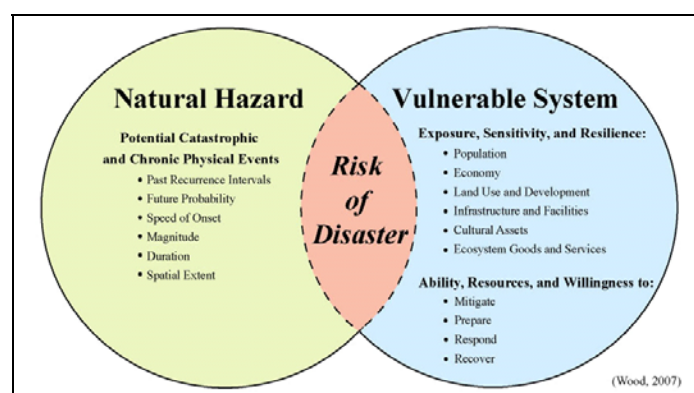


Figure 1: Risk is a function of natural hazards and vulnerable systems

Though assessment of vulnerability, risk and coping capacity to floods is an important precondition for effective disaster risk reduction, identification and assessment of hazard and vulnerability indicators are often difficult. To converge on the problem of assessing the complexity of risk and vulnerability, the rather abstract components of this meta-framework need further partitioning. Specifications are dependent on the considered system and the type of hazard.

A consistent systematization itemizes the components into a set of measurable indicators contributing to all the various stages of the risk management cycle. An indicator is defined as a variable, which is a representation of an attribute, such as quality and/or characteristics of a system. The quality of the indicator is determined by its ability to indicate the characteristics of a system, which are relevant to the underlying interest determined by the goal or guiding vision (Birkmann, 2006b). A hierarchical holistic framework conceptualizing hazards, vulnerability and risk to derive a selection of measurable indicators for a specified system is shown in Table 1 (Taubenboeck et al., 2008).

Conceptual framework		Components	Causes	Indicators / Variables
Risk	Hazard	Natural Hazard, human threat, phenomenon	Floods, Earthquakes, cyclones, landslides, droughts, tsunamis, fires, etc.	Magnitude, intensity, spatial exposure, probability of occurrence, duration, etc.
	Vulnerability	Physical Vulnerability	Location	Accessibility, distances, etc.
			Structural Exposure	Built-up density, building height, building material and construction type, building age, urbanization rate, open spaces, etc.
			Critical Infrastructure	Infrastructure network, public transport, pipelines, power plant, lifelines, etc.
		Demographic Vulnerability	Population structure	Total population, population density distribution, age pattern, gender, etc.
			Population development	Population growth rates, migration rates, etc.
		Social Vulnerability	Social status	Education, health, public awareness, etc.
			Accessibility to and supply of local facilities	Hospitals, schools, fire brigade, disaster shelters, etc.
		Economic Vulnerability	Financial potential	Per-capita income, insurance, relief budget, poverty, unemployment, etc.
	Political Vulnerability	Decision structure	Early warning system, crisis and information management, etc.	
Ecological Vulnerability	Natural resources	Forests, habitats, etc.		

Table 1: Selection of measurable indicators for hazard, vulnerability and risk for a specified system

The actual amount of flood damage of a specific flood event depends on the vulnerability of the affected socio-economic and ecological systems, i.e. broadly defined, on their potential to be harmed by a hazardous event (Cutter, 1996). Generally speaking, an element at risk of being harmed is the more vulnerable, the more it is exposed to a hazard and the more it is susceptible to its forces and impacts.

4 Remote sensing in flood analysis

Remote sensing technology has become a key tool for monitoring floods in recent years (Islam & Sadu, 2001). It is a reliable way of providing synoptic coverage over a wide area in a very cost effective manner. It overcomes the limitation of the ground stations to register data in an extreme hydrological event. In addition, multi-date imageries equip the investigators to monitor changes or reconstruct progress of a past flood. The selection of appropriate remote sensing sensors and data, digital elevation model, GIS and other auxiliary data depends on the requirements of flood analysis and timely availability of these datasets.

4.1 Optical remote sensing sensors

Satellite data from optical sensors are being used to monitor flooding and assess its damages for many years. In the initial stages, data available were mainly Landsat Multi Spectral Scanner (MSS) with 80 m resolution. From 1984 onwards, Landsat Thematic Mapper (TM) imageries with 30 m resolution became the prime source of data for monitoring floods and delineating the boundary of inundation. From 1986 on, SPOT multi spectral imageries were also used for flood delineation. SPOT imageries were used along with DEM for delineation of monsoon flood in Bangladesh (Sado & Islam, 1997). In recent years, MODIS Terra and Aqua imagery have also been used for flood detection in Bangladesh (Figure 2, left).

Apart from these sensors, NOAA Advanced Very High Resolution Radiometer (AVHRR) data have been also found useful for floods of a regional dimension (Islam & Sadu, 2001). Although AVHRR imageries are coarse in resolution and frequently contaminated by cloud cover, their merit lies in their high temporal resolution. This advantage helps monitor the progress of a flood in near real-time.

4.2 Microwave remote sensing sensors

The existence of cloud cover appears as the single most important impediment to capture the progress of floods in bad weather condition (Rashid & Pramanik, 1993). The development of microwave remote sensing, particularly radar imagery, solve the problem because the radar pulse can penetrate cloud cover. Apart from its

all weather capability, the most important advantage of using SAR imagery lies in its ability to distinguish between land and water (Sanyal & Lu, 2004).

Thresholding is one of the most frequently used techniques in active remote sensing to segregate flooded areas from non-flooded areas in a radar image (Brivio et al., 2002). Change detection can also be used as a powerful tool to detect flooded area in SAR imagery. It is generally performed by acquiring two imageries taken before and after the flood. Among others, RADARSAT, ERS and JERS imageries have been used in flood monitoring and flood area delineation. Werle et al. (2000) investigated the potential of Radarsat ScanSAR image in flood and coastal zone monitoring in Bangladesh (Figure 2, right).

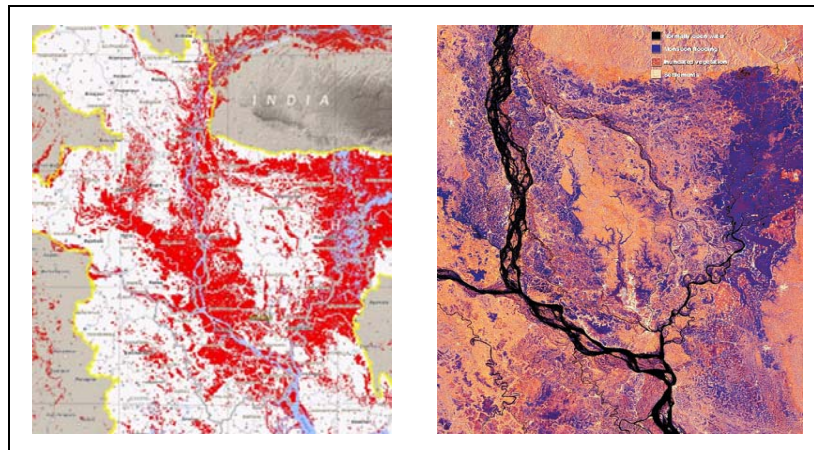


Figure 2: Flood detection in Bangladesh with MODIS Terra and Aqua on August 2007 (left) and Radarsat ScanSAR image on 1998 (right)

In recent years, flood-mapping efforts synthesize the advantages of both optical and microwave remote sensing technologies for better results. In some occasions, this approach leads to the formulation of better flood management strategy. For the prediction of floods, promising results have been reported recently on the use of NOAA images combined with meteorological satellites and radar data in the calculation of rainfall over large areas (Islam & Sadu, 2001).

4.3 Digital Elevation Models

In a majority of the studies dealing with the application of remote sensing in inundated area delineation and flood risk assessment, digital elevation models (DEMs) are used to visualize, measure, analyze and model the interface of flood water with the terrain. DEMs are used to simulate the flood depth from discharge data and very often the result is compared with actual flooded area derived from satellite imageries. An accurate DEM is essential for flood depth estimation. In a flat flood plain, where a vertical error of 1 m in the DEM may lead to an error of 100s of square kilometers in flood estimation. Thus, recognition of the magnitude of errors in the DEM is important in hydrological modeling (Sanyal & Lu, 2004). High-resolution satellite imageries or aerial photographs are needed for preparing an accurate DEM, which can meet the precision level of a flood depth investigation.

One of the recent developments in the application of remote sensing to flood related problems is the use of LIDAR (Light Detection and Ranging) sensor. LIDAR sensors can readily identify the vertical differences in the landforms and can be exploited as powerful instruments to create DEMs of exceptional accuracy. For instance, for the whole of the Netherlands, a LIDAR-derived DEM ('AHN-1') with one height point per 16m² is available and a developed 'AHN-2' with ten points per m² will be available for the whole country within 2011.

5 Flood risk and vulnerability assessment

5.1 Methodological aspects

An important aspect in flood risk management is to identify the area having higher risk potential to floods through proper vulnerability and risk assessment. For vulnerability and risk assessment, selection of appropriate hazard and vulnerability indicators, appropriate datasets and techniques is essential depending on geographic,

topographic and other socio-economic characteristics of the concerned area. The important and general indicators for assessing flood hazard and preparing hazard maps are flood frequency, flood extent, flood depth, flood duration, etc (Table 1).

Vulnerability assessment needs to be done following a holistic approach considering the necessary physical, social, economic, environmental or ecological factors. The important indicators to be used in vulnerability assessment are population density and structure, physical infrastructure, critical facilities, socio-economic factors, environmental factors, etc (Taubenboeck et al., 2008). A vulnerability index and vulnerability maps are usually prepared showing the vulnerable areas of different magnitude applying appropriate methodology incorporating all necessary indicators. Afterwards the hazard and vulnerability maps are finally combined to prepare the risk maps showing different risk magnitudes over the area.

Proper flood vulnerability and risk maps based on a comprehensive and holistic approach are lacking in many flood prone countries like Bangladesh. For example, Islam & Sado (2000) performed flood hazard assessment in Bangladesh using NOAA-AVHRR data with administrative districts and physiographic, geological, elevation and drainage network data. The categories of flood-affected frequency and floodwater depth were estimated using NOAA satellite data. Flood hazard rank assessment was made on the basis of land cover classification, physiographic divisions, geological divisions, elevation intervals and administrative districts. The major limitation of the study is lack of proper vulnerability and risk assessment incorporating important socio-economic and environmental indicators.

5.2 Some key considerations regarding use of remote sensing and GIS

There are some key issues that need to be taken into consideration for effective flood hazard, vulnerability and risk assessment using remote sensing and GIS. Spatial and temporal resolutions of the remotely sensed data are important to consider depending on the requirements. Some satellite sensors like Landsat and SPOT have high spatial resolution, but have relatively low temporal resolution (Sanyal & Lu, 2004). On the contrary, NOAA-AVHRR and MODIS offer medium to low spatial resolution but a high temporal resolution (almost daily global coverage). Temporal analysis of the flood requires high temporal resolution and detailed spatial analysis requires high spatial resolution. Besides, due to the dependence on cloud conditions, optical sensors are often not suitable to monitor floods. Radar data is therefore often more suited. So optimum sensors or sensor combination can be used depending on the requirements.

Flood depth is considered crucial for flood hazard mapping and a digital elevation model (DEM) is considered to be the most effective means to estimate flood depth from remotely sensed or hydrological data. In a flat terrain, accuracy of flood estimation depends primarily on the resolution of the DEM. So the high resolution DEMs need to be prepared and used in any flood depth estimation especially in the flat terrain.

Along with using geospatial data, communicating the concepts and outcomes of vulnerability and risk assessments to local people is important. In this case, participatory methods such as Participatory GIS (PGIS) or other methodologies like Participatory Rural Appraisal (PRA) can be used. Such methods can give the opportunity to actively involve the local people in the decision making process (Kienberger & Zeil, 2005). The prices of very high-resolution satellite imagery like IKONOS are comparatively high especially in the context of developing countries. In this case, the 'International Charter Space and Major Disasters' and other suitable programmes can be utilized so that necessary remotely sensed data would be available at a reasonable price and would be widely used for flood risk management to the flood prone and developing countries.

6 Conclusion

The conceptual framework of hazard, vulnerability and risk, as well as various aspects of remote sensing and GIS usages in flood risk and vulnerability assessment have been discussed in this paper. Flood risk assessment incorporating all the necessary indicators should be done properly and meaningfully by the planners to formulate strategies for saving lives and livelihood of millions of vulnerable people around the world.

Along with the available remotely sensed data, the connections between the data providers and the users and their capability to extract, deliver, receive and apply information should be developed. It is essential to integrate ground information with remotely sensed data. The availability of GIS and trained local personnel to facilitate integrating those data efficiently and assess flood risk and vulnerability is essential. Then very recent information regarding flood risk and vulnerability assessment can be provided in a differentiated way to the related authorities and the general public.

References

- Birkmann, J., 2006a. Measuring vulnerability to promote disaster-resilient societies: Conceptual frameworks and definitions, in: *Measuring Vulnerability to Natural Hazards- Towards Disaster Resilient Societies*, edited by: Birkmann, J., New York, United Nations University, pp. 9–54.
- Birkmann, J., 2006b. Indicators and criteria for measuring vulnerability: Theoretical bases and requirements, in: *Measuring Vulnerability to Natural Hazards - Towards Disaster Resilient Societies*, edited by: Birkmann, J., New York, United Nations University, pp. 55-77.
- Bohle, H.G., 2001. Vulnerability and Criticality: Perspectives from Social Geography, *IHDP Update 2/2001, Newsletter of the International Human Dimensions Programme on Global Environmental Change*, pp. 1-7.
- Brivio, P. A. et al., 2002. Integration of remote sensing data and GIS for accurate mapping of flooded areas, *International Journal of Remote Sensing*, 23(3), 429-441.
- Cutter, S.L., 1996. Vulnerability to environmental hazards, *Progress in Human Geography*, 20(4), pp. 529-539.
- De Bruijn, K.M. & Klijn, F., 2009. Risky places in the Netherlands: a first approximation for floods, *Journal of Flood Risk Management*, 2, pp. 58-67.
- Hausmann, P. & Weber, M., 1988. Possible contributions of hydroinformatics to risk analysis in insurance, In: *Proc. 2nd International Conference on Hydroinformatics, Zurich, Switzerland, 9-13 September*, Balkema, Rotterdam.
- Islam, M. M. & Sado, K., 2000. Development of flood hazard maps of Bangladesh using NOAA-AVHRR images with GIS, *Journal of Hydrological Sciences*, 45(3), pp. 337-345.
- Islam, M. M. & Sado, K., 2001. Flood damage and modelling using satellite remote sensing data with GIS: Case study of Bangladesh; In: Jerry Ritchie et al. (eds), *Remote Sensing and Hydrology 2000*, IAHS Publication, Oxford, pp. 455-458.
- Kasperson, R. E. et al., 2005. Vulnerable people and places, in: *Ecosystems and Human Well-being: current state and trends*, Hassan, R., Scholes, R., Ash, N., 1. Island Press. Washington D.C., pp. 143-164.
- Kienberger, S. & Zeil, P., 2005. Vulnerability Assessment and Global Change Monitoring: the role of Remote Sensing-Potential and Constraints for Decision Support, 31st International Symposium on Remote Sensing for the Environment 2005, 20-24.06.2005, St. Petersburg, Russia.
- Rashid, H. & Pramanik, M. A. H., 1993. Aerial extent of the 1988 flood in Bangladesh: How much did the satellite imagery show? *Natural Hazards*, 8, pp. 189-200.
- Sado, K. & Islam, M.M., 1997. Satellite remote sensing data analysis for flooded area and weather study: Case study of Dhaka city, Bangladesh, *Journal of Hydraulic Engineering*, 41, pp. 945-950.
- Sanyal, J. & Lu, X. X., 2004. Application of Remote Sensing in Flood Management with Special Reference to Monsoon Asia, *Natural Hazards*, 33, pp. 283-301.
- Taubenboeck, H. et al., 2008. A conceptual vulnerability and risk framework as outline to identify capabilities of remote sensing, *Natural Hazards and Earth System Sciences*, 8, pp. 409-420.
- Werle, D. et al., 2000. Flood and Coastal Zone Monitoring in Bangladesh with Radarsat ScanSAR: Technical Experience and Institutional Challenges, *Johns Hopkins Application Technical Digest*, 21 (1), pp. 148-154.
- White, P., 2005. *Disaster Risk Reduction - A Development Concern*, DFID.
- Wood, N., 2007. Risk and vulnerability to Natural Hazards, <http://geography.wr.usgs.gov/science/tsunamis.html> (accessed 14.04.2009)
- Zerger, A. & Smith, D.I., 2003. Impediments to using GIS for real-time disaster decision support, *Computers, Environment and Urban Systems*, 27, pp. 123-141.

GEOLOGICAL STRUCTURES IN GIS BASED LANDSLIDE HAZARD ZONATION

Gamini Jayathissa ^a, Dietrich Schröder ^b and Edwin Fecker ^c

^a Institute of Geosciences, University of Tuebingen, Hoelderlinstrasse 29, D-72076 Tuebingen, Germany
jayathissa777@yahoo.com

^b Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
dietrich.schroeder@hft-stuttgart.de

^c Geotechnisches Ingenieurbüro Prof. Fecker & partner GMBH, D-76275 Ettlingen Am Reutgraben 9, Germany
fecker@gif-ettlingen.de

KEYWORDS:

Landslide hazard zonation, Geological structures, GIS analysis

ABSTRACT

Among the natural hazards, landslides are attracting more and more attention due to its increasing effect on economic and human losses. Landslide hazard zonation maps are considered as a prior and important base to identify the vulnerable zones for designing early warning systems and adequate mitigation measures in landslide-prone areas.

Many techniques have been proposed in the literature for landslide hazard zonation (Hansen, 1984; Van Westen et. al.1997). These can be generally divided into two groups: direct or semi-direct hazard mapping in which the degree of hazard is determined by the mapping expert and, indirect hazard mapping in which either statistical or deterministic models are used to predict landslide-prone areas based on information obtained from the interrelation between landscape factors and the landslide distribution.

With the introduction of GIS, in particular indirect methods have gained enormous popularity due to the capacity of GIS to handle and analyze data with high spatial variability. In the statistical approach mathematical relationships between the observed landslide distribution and their controlling factors are made on the basis of polygons as mapping units. However, attitudes of geological structures are marked usually as linear or point measurements in factor maps. This holds e.g. for the influence of structural attitudes such as strike or dip directions and dip angles with respect to slope directions and slope angles, and influence of weak zones like fold axis, faults, joints. Even though these factors are considered very important for slope stability, they are often neglected or dealt frivolously in landslide hazard zonation analysis.

In this paper, a possible approach is discussed how GIS capabilities can be used efficiently to integrate the effect of structural attitudes for slope stability problems as an essential part of the final landslide hazard zonation mapping.

1 Introduction

The term landslides comprise almost all varieties of mass movements on slopes including rock falls, topples and debris flows that involve little or no true sliding (Varnes, 1984). Landslides or in broader sense mass movements occur when the critical combinations of many internal and external causative factors such as geological, morphological, physical, and human are met with a triggering event such as intense rainfall, earthquake shaking, volcanic eruption, rapid snow melt, rapid change of water level, storm waves or rapid erosion, that causes a quick increase in shear stress or decrease in shear strength of the slope material.

Though the process of mass movement is a part of the Earth's denudation process and thus considered as a natural phenomenon, slopes which stood safe for centuries are now frequented by landslides and hence socioeconomic losses due to its impact are growing. This is mainly due to expand of human activities into more vulnerable hill slopes under the pressure of rising population and associated demands for infrastructure facilities. The nations most affected by landslides are recorded as Japan, United States, Italy, and India (Soiters, R.,

Westen, C. J. van, 1999) with lesser annual landslide losses in many other countries severely affecting the sustainable development goals. Whereas, practice has shown that adequate hazard mitigation is possible.

Landslide Hazard Zonation (LHZ) involves one of the most complex analysis due to the heterogeneities associated with interrelated terrain factors such as lithology and the structural attitude of the rocks, weathering conditions, soil properties and their thicknesses, slope gradients and forms, hydrological conditions, land use and management.

The joint analysis of all these terrain variables in relation to the spatial distribution of landslides has gained enormously by the introduction of GIS, the ideal tool for the analysis of parameters with high degree of spatial variability (e.g. Van Westen, 2000). In a GIS based analysis, it is an essential part to have factor maps as area features (polygons) as mapping units such as land use or soil type to establish weight values and to determine relationships among factors. Whereas, structural data such as strike or dip directions and dip angles of foliation or bedding planes (Figure 1) and other lineaments constitutes non area features like linear and point measurements, which can not be included in GIS analysis using mapping units directly. This paper presents an approach of preparing factor maps of geological structures from line and point measurements of structural attitudes for the analysis in a GIS environment.

2 Slope instability hazard zonation and GIS

According to Varnes, 1984, the slope instability hazard zonation is defined as the mapping of areas with an equal probability of occurrence of landslides within a specific period of time. This includes assessment of terrain parameters for the likelihood of occurring such phenomenon and the determination of the probability that a triggering event such as major rain fall or earthquake occurs. Therefore, analyses of the degree of influence of different causative factors and factor classes are of major importance here. This requires the evaluation of the relationships between various terrain conditions and landslide occurrence. That means, we are looking at the conditions under which landslides have occurred in the past, and use the critical combinations of factors for predicting the possible occurrence of landslides where comparable terrain condition prevail, but which are still landslide free.

LHZ mapping is carried out using qualitative or quantitative approaches. In the qualitative methods, subjective decision rules which are formulated in the mind of the expert with the knowledge of an inventory of existing landslides and their field conditions are used in dividing geomorphological units into their degree of landslide susceptibility. The analysis of systematically collected data in GIS can support the expert opinion.

The quantitative methods in LHZ mainly involve statistical and deterministic models. In the statistical approach numerical relationships between the observed landslide distribution and their controlling terrain factors are made.

Statistical methods involve both bivariate as well as multivariate techniques. Commonly used multivariate statistical methods in landslide hazard assessment are linear regression, discriminant analysis and logistic regression. The bivariate statistical methods utilize the normalized landslide densities derived using the landslide occurrence in each factor class. Information value method and weights of evidence modeling are two common bivariate methods applied in LHZ mapping process (Mathew, 2007). Bivariate techniques are mostly preferred over multivariate ones as they enable to combine the professional experience of the expert into the process and provide the possibility of handling the analysis within the GIS environment itself unlike in multivariate techniques where usually external statistical packages are still needed.

Deterministic models in LHZ use sound physical models such as stability models as used in geotechnical engineering, or hydrological and hydrogeological models used to give an estimation of infiltration and pore water pressures. Here GIS can play an important role because of its computational power, e.g. in the elaboration of Digital Terrain Models (DTMs) and derived maps such as slope maps, aspect maps and slope length maps (Wadge, 1988).

In general, all above methods have characteristic advantages and disadvantages and hence applying the appropriate method or integrating several methods for the optimal preparation of LHZ maps are important. Though experts can assess the overall conditions and extract the critical parameter combinations like in the qualitative approach, objective procedures such as a statistical or deterministic analysis are often desired to quantitatively support the slope stability assessment. Therefore, GIS can be considered as an ideal tool for landslide studies where a combined analysis of terrain parameters which have a high degree of spatial variability in relation to the spatial distribution of landslide is concerned.

3 Factor maps in GIS analysis

3.1 General background

As mentioned above, for the prediction of landslides the assessment of the degree of influence of different causative factors for the likelihood of occurring of such phenomenon is of major importance. Therefore, collection of field data according to the considered causative factors at all places where landslides occurred in the past and preparation of factor maps for the whole area where prediction is to be done is needed. Commonly, lithology, geological structures, weathering condition of rock, soil type and their properties, soil thickness, hydrology and drainage conditions, morphological slope angle, slope aspect, landuse and management and landform are considered as major causative factors.

When GIS analysis is concerned, all the factor maps such as land use, soil type, slope category etc., where the basic mapping units are made up of areas can be directly used as uniform polygons in GIS and weights can be easily assigned. This holds not for geological structures where structural attitudes are marked as linear or point measurements in factor maps.

In the following sections it is discussed how the factor maps of geological structures are prepared for GIS analysis for the use of preparation of final landslide hazard zonation maps.

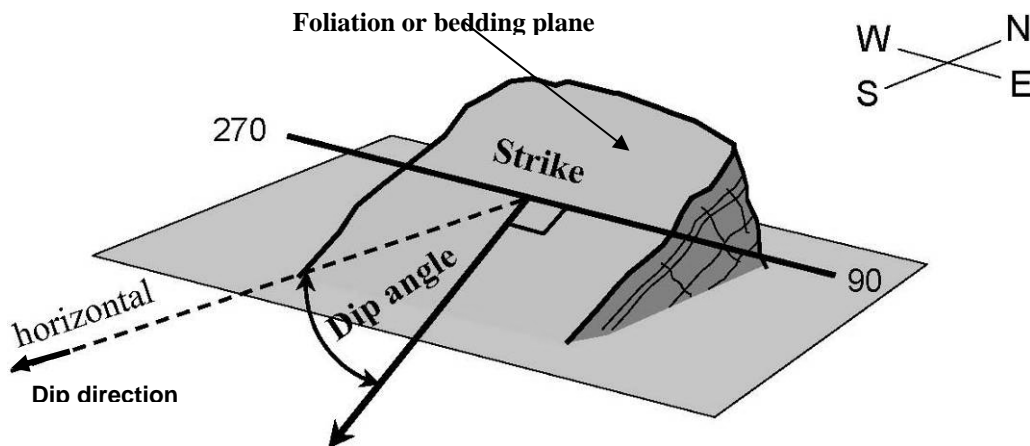


Figure 1: Strike and dip of an inclined bed. The structural attitude of a bed refers to its 3-dimensional orientation in space and is specified by measuring its strike or dip direction and dip angle. The strike represents the trace of an imaginary horizontal plane intersecting the bed. The dip is the measure of maximum inclination of the bed from the horizontal in a direction orthogonal to the strike line. The strike is recorded as an azimuth (compass direction in degrees from north) of the line and the dip as an azimuth and inclination angle (Boyce, 2007).

3.1 Factor maps of geological structures

Factor maps of geological structures constitute a major element of landslide hazard mapping. The most important aspect here is that unlike in other factor maps where basic mapping units are areas (polygons), structural data constitutes non area features such as linear and point measurements, which can not be included in GIS analysis directly.

Though the thoroughly interpolated surfaces of dip direction and dip angle layers defining breaklines where necessary can be directly considered as structural factors, the geometry of foliation or bedding planes of rock in relation to morphological slopes is the critical factor in determining the slope stability. Therefore, following combined factors are considered here as major structural parameters:

1. Magnitude of deviation angle
2. Magnitude of apparent dip (effective dip towards slope direction)
3. Under, over dip situations on dip slopes and under, over scarp situations on scarp slopes
4. Presence of other weak zones such as lineaments, fold axis, faults, joints

The concept of *deviation angle* (Figure 2) is a method of relating the slope direction to the attitude of the bed rock foliation. It is defined as the horizontal angle between the azimuth of the slope direction¹³, and the azimuth of the dip direction¹⁴ (NBRO, 1995). The resulting deviation angle varies in magnitude between zero and 180 degrees and can be used to group the slopes into different categories of dip slopes, intermediate (oblique) slopes, and scarp (reverse) slopes.

Measurement of the inclination of a bed along a direction other than the dip direction will yield an angle less than the maximum angle of dip, termed as an *apparent dip* (Figure 2). This is a method of calculating the effective dip angle towards the slope direction using dip angle and deviation angle. According to Fig. 2, apparent dip can be calculated as follows:

$$\tan\beta = (\tan\alpha) * (\cos\theta)$$

where β is the apparent dip, α is the true dip and θ is the oblique angle (deviation angle) measured in a horizontal plane between the two vertical sections of dip and slope directions.

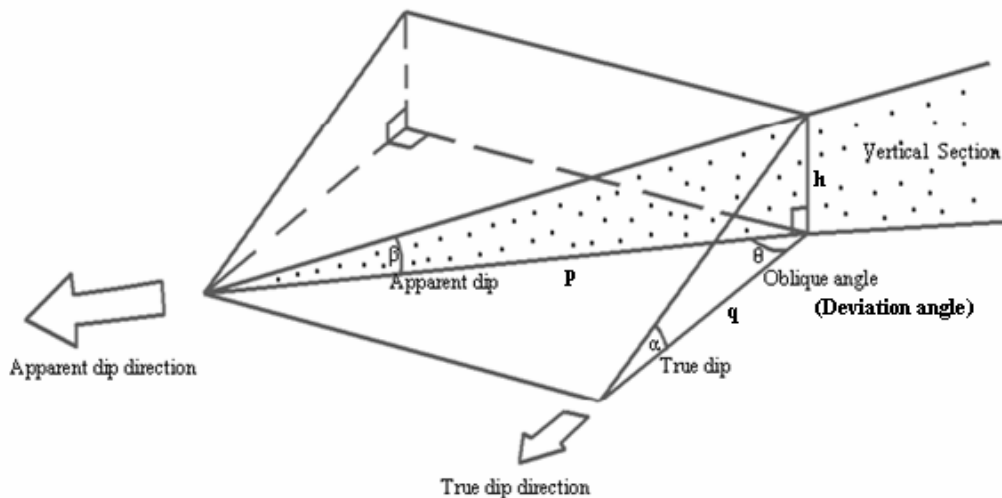


Figure 2: True dip, apparent dip and oblique angle (deviation angle)

One of the major types of landslide hazards is the dip slope failure. A dip slope is a slope where the dip direction of rock foliation or bedding plane is parallel or sub-parallel (i.e. small deviation angles) to the look direction of the slope. Such slopes are considered to be more fragile and sensitive to sliding than oblique or reverse (scarp) slopes.

A dip slope with a slope angle less than the dip angle is defined as *under dip* (Figure 3); here the foliation plane runs into the ground, thus one can presume more stable conditions. On the contrary, a dip slope with a slope angle greater than the dip angle is defined as *over dip* (Figure 3); here the foliation plane alights on the slope making relatively unstable situations. In addition, *under scarp* and *over scarp* situations can be termed similarly (Figure 3).

¹³ The slope direction is defined as the compass bearing in the downhill direction of the steepest slope.

¹⁴ The dip direction is the horizontal line orthogonal to the foliation strike, in the down dip direction.

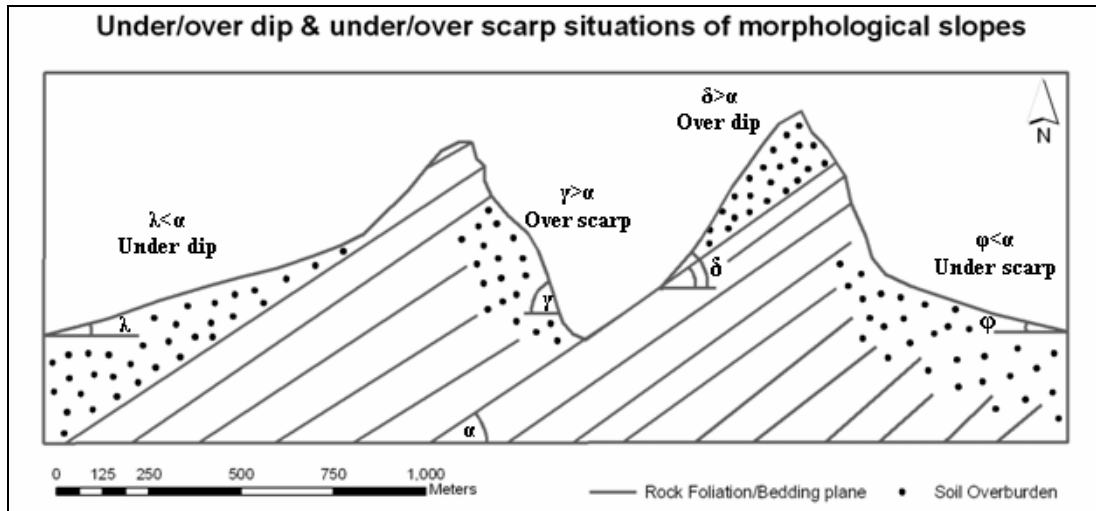


Figure: 3: Under dip, over dip, under scarp and over scarp situations of morphological slopes relative to rock foliation or bedding planes

It is evident that proximity to one major discontinuity such as a topographic lineament, fold axes, fault or joint increases the risk of slope instability. Therefore, this has to be considered as another structural factor in analysis.

3.1.1 Preparation of GIS based factor maps of geological structures

As input data for the analysis (1) a point feature class of locations of measurements of *foliation attitudes* of the rock with attributes of *dip direction* and *dip angle* measurements, (2) a line feature class of *lineaments* and (3) *elevation data* of the terrain are used. The analysis can be built on vector/ raster or raster data structures, here only the process for raster structure is discussed. For the geoprocessing in this project ESRI ArcGIS 9.2 is used, but in principle any system with capabilities for raster processing, in particular a raster algebra calculator, is suited. The steps are as follows;

- Prepare an *aspect* layer and an interpolated surface of *dip direction* layer (Figure 4a and b). Here, the method of Inverse Distance Weighting (IDW)¹⁵ is preferred over other interpolating methods. Information about faults or other linear structures can be used as barriers (breaklines). Then, calculate the *deviation angle* layer using the following logical expression in raster calculator (Figure 4c):
 - $\text{con}(\text{abs}([\text{Aspect}] - [\text{DipDir}] < 180, \text{abs}([\text{Aspect}] - [\text{DipDir}], 360 - \text{abs}([\text{Aspect}] - [\text{DipDir}]))$
 - Reclassify the output layer into suitable ranges of dip slopes, intermediate slopes and scarp slopes and use the resulting classification as a structural factor map.
- Prepare another IDW interpolated surface of *dip angle* layer (Figure 4d). Compute the *apparent dip angle* layer (Figure 4e) applying $\beta = \tan^{-1}\{\tan(\alpha) * (\cos\theta)\}$ in the raster calculator using both dip angle and original deviation angle (Figure. 4c) layers. Since deviation angles (θ) vary from zero to 180 degrees, calculated apparent dip angles (β) can vary from -90 to +90 degrees. Positive values ($0 \leq \text{apparent dip} \leq 90$) represent the dip slopes and negative values ($0 > \text{apparent dip} \geq -90$) represent the scarp slopes. In figure 4e, the values range from -80 to +80 degrees. The reclassified layer can be used as a factor of structural attitudes in GIS analysis.
- Use the *apparent dip angle* layer (Figure. 4e) and *slope angle* layer (Figure 4f) to get the layer of *under dip, over dip and under scarp, over scarp* situations (Figure 4g) using the following logical expression in the raster calculator:

$$\text{con}([\text{ApparentDip}] \geq 0 \ \& \ [\text{ApparentDip}] \leq 90 \ \& \ ([\text{ApparentDip}] - [\text{SlopeAngle}] \geq 0 \ \& \ ([\text{ApparentDip}] - [\text{SlopeAngle}] \leq 10, 1, \text{con}([\text{ApparentDip}] \geq 0 \ \& \ [\text{ApparentDip}] \leq 90 \ \& \ ([\text{ApparentDip}] - [\text{SlopeAngle}] > 10 \ \& \ ([\text{ApparentDip}] - [\text{SlopeAngle}] \leq 20, 2, \dots\dots\dots)$$

¹⁵ IDW is a deterministic interpolator that is exact. Therefore, pixel values in the interpolated surface do not go beyond the limits of input data, which is needed for dip directions (0°-360°) & dip angle (0°-90°) are concerned. The ability to control the power, number of points and barrier polylines are other important aspects to get representative prediction surface for data like angles and directions.

```
con([ApparentDip] < 0 & [ApparentDip] >= - 90 &
  (- [ApparentDip] - [SlopeAngle]) < - 40 & (- [ApparentDip] - [SlopeAngle]) >= - 50, - 500,
  con([ApparentDip] < 0 & [ApparentDip] >= - 90 &
    (- [ApparentDip] - [SlopeAngle]) < - 50 & (- [ApparentDip] - [SlopeAngle]) >= - 60,
    - 600))))))))))))))))))))))))))16
```

In the logical expression, categories are built with ranges of ten degrees like 0-10, 10-20, 20-30 etc. to which unique values are assigned. First, dip slope ($0 \leq \text{apparent dip} \leq 90$) is considered. Here the under dip situation (i. e. $\text{ApparentDip} - \text{SlopeAngle} > 0$) is reclassified into values from 1 to 9 and over dip situation (i. e. $\text{ApparentDip} - \text{SlopeAngle} < 0$) is reclassified to values from -1 to -6.

The remaining values ($0 > \text{apparent dip} \geq -90$) which represent the scarp slopes are then reclassified to under scarp and over scarp situations. Here the under scarp situation is reclassified to values from 100 to 900 and over scarp situation is reclassified to values from -100 to -600. The values in reclassified scarp slopes are used solely for distinguishing dip slopes from scarp slopes. In the figure 4g, again the legend entries are named as UD (under dip), OD (over dip), US (under scarp) and OS (over scarp) with their respective angel ranges.

The resulting layer represents the ranges of under dip, over dip and under scarp, over scarp situations of morphological slopes of the terrain and can be finally used as another structural factor in GIS analysis.

- Use the linear feature class of other weak zones such as lineaments, fold axis, faults, and joints. Calculate the Euclidean distance from weak zones and reclassify it according to distance (Figure 4h). The layer can be used as another structural factor in GIS analysis.

All the layers (figure. 4c, e, g and h) which have been prepared using structural attitudes can now be used as factor maps in GIS based analysis like many other factors such as landuse, soil type etc.. By crossing the factor maps with landslide distribution map, weight values and relationships can be established.

4 Discussion and conclusion

The presented study demonstrates a way of converting structural attitudes data into GIS based factor maps. The basic step here is the interpolation technique used. Subjective results in the interpolated surfaces (dip direction and dip angle layers) depending upon the selection of the interpolation method and the controlling of their parameters are expected. Therefore, thorough understanding of the data set, terrain structure and interpolation methods including the selection of a suitable grid resolution is important for creating the best representative model. Theoretically, the interpolated surfaces of dip direction and dip angle layers can be directly used as factors in analysis. However, considering combined factors in relation to the attitudes of morphological slopes are practically more desirable and meaningful when slope stability problems are concerned.

The deviation angle is a measure of the difference between dip direction and slope direction in the horizontal plane. Hence it offers a way to evaluate the influence of horizontal structural variations (strike or dip direction) in relation to morphological slopes, dividing them into different categories of dip slopes, intermediate slopes and scarp slopes. But, this provides no means of integrating the influence of vertical changes of structural attitudes (dip angle). Instead, by calculating the apparent dip towards the direction of slope, morphological slopes are divided mainly into two groups: dip slopes and scarp (reverse) slopes. Here, both deviation angle in the horizontal plane and dip angle in vertical plane are considered and the component of the dip angle towards the slope direction is calculated. Categories of the horizontal plane are fixed to the two directions, exactly to dip and scarp slopes, and vertical angles are divided into different ranges.

¹⁶ Here, to show the concept, only the starting and end segments of a lengthy logical expression is given.

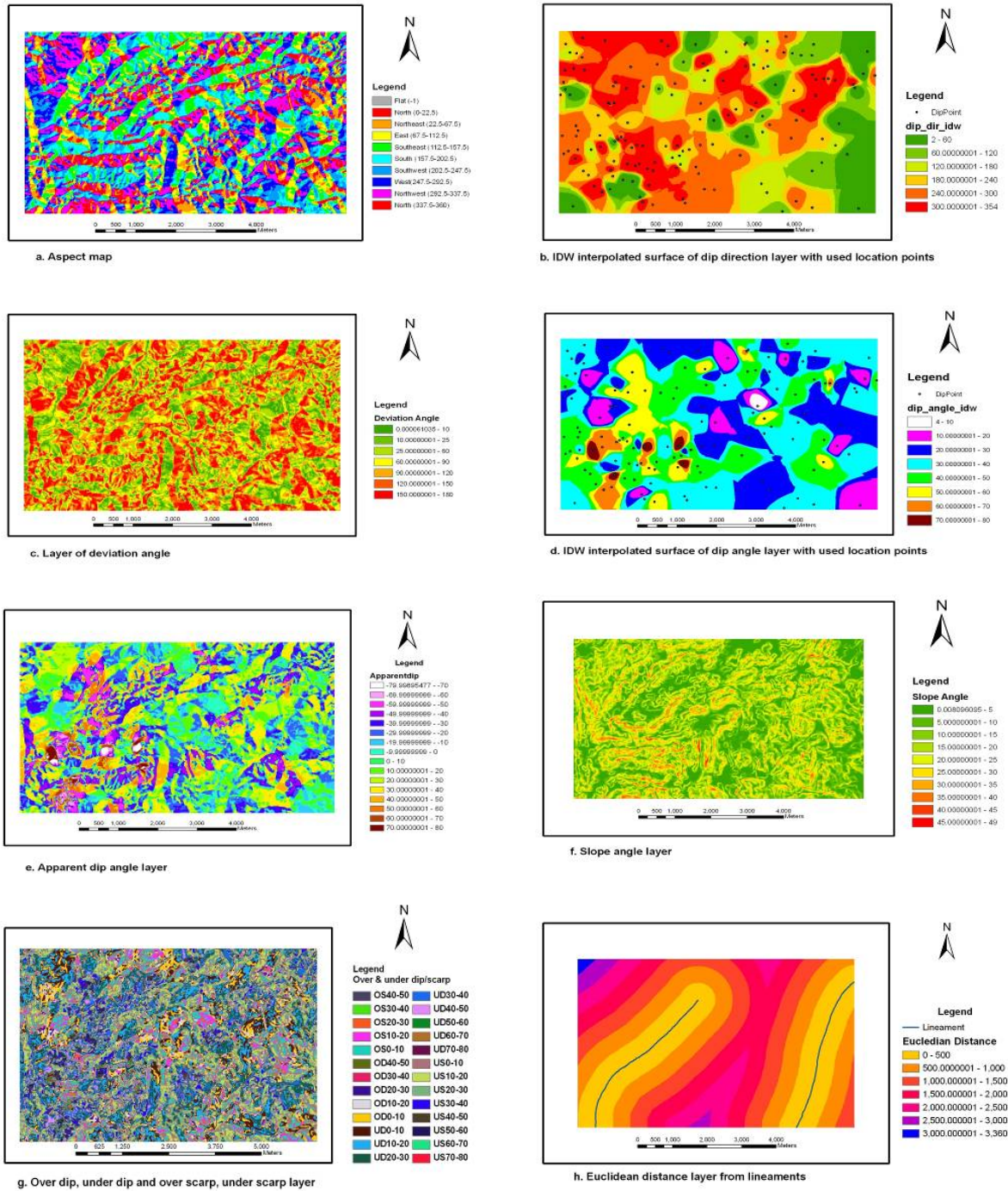


Figure 4: Steps of the preparation of structural factor maps

As the apparent dip is a trigonometric component of the true dip and the deviation angle, the same apparent dip values can result from many different situations (e.g. if the dip angle is zero with any deviation angle or the deviation angle is 90 degrees with any dip angle, the calculated apparent dip will be zero).

The automated procedure explained here can be also performed manually on paper maps by dividing the terrain into uniform polygons with respect to slope direction and slope angles and then assigning values to each polygon according to factors. Then these polygons have to be digitized to use them as structural factor maps in GIS. This work is of course very laborious and yields subjective results.

It can be concluded here that GIS has proved as an ideal tool which can be used to integrate linear or point measurements in LHZ mapping. The automated procedure is extremely efficient and effective compared to the manual procedure and it will definitely improve the quality of final hazard maps. Though, the approach

explained here gives an insight into a methodology which could be used to prepare GIS based structural factor maps, good knowledge of the mapping expert and verification through a field study is necessary.

References

- Bojce, J. 2007. Structure Mapping Tutorial. Lecture Notes, McMaster University Hamilton, Ontario.
http://www.science.mcmaster.ca/geo/faculty/boyce/3z03/docs/map_tutorial.pdf, accessed April 10, 2009.
- Cees J. van Westen, Enrique Castellanos and Sekhar L. Kuriakose, Spatial data for landslide susceptibility, hazard, and vulnerability assessment: An overview. *Engineering Geology*, Volume 102. Issues 3-4, 1 December 2008, Pages 112-131
- Hansen A. Landslide hazard analysis. In: Brunsden D. & Prior D.B. (eds.), *Slope Instability*, John Wiley and Sons, New York, 1984, 523–602.
- Hoek, E., Bray, J. W., *Rock slope engineering*, revised third edition (1981), chapter 2 & 3: P 18 – 63. Institute of Mining and Metallurgy. E & FN Spon, London and New York.
- Mathew, J., Jha, K. V., Rawat, G. S., (2007) Weight of evidence modeling for landslide hazard zonation mapping in part of Bhagirathi valley, Uttarakhand, India. *Current Science*, vol. 92, No. 50. P 628- 638.
- NBRO, Landslide studies and services division (1995) *Landslide hazard mapping in Sri Lanka*. User manual, landslide hazard mapping project, SRL 89/001.
- Soeters, R., Westen, C. J. van (1999) *Slope instability recognition, analysis, and zonation*. Chapter 8: 129-174. *Landslides investigation and mitigation, special report 247*. Transportation research board, National research council, U.S.
- Varnes, D.J., 1984. *LHZ: A Review of Principle and Practice*. Commission of Landslide of IAEG, UNESCO, *Natural Hazards*, No.3, 61 p.
- Wadge, G. (1998) The potential of GIS modeling of gravity flows and slope instabilities. *Int J Geogr Inf Systems* 2 (2): 143-152.
- Westen, C. J. van (2000) *The modeling of landslide hazards using GIS*. *Surveys in Geophysics* 21: 241-255. Kluwer Academic publishers.
- Westen, C. J. van, Rengers, N., Terlin, M. T. J., Soeter, R. (1997) Prediction of the occurrence of slope instability phenomena through GIS-based hazard zonation. *Geol Rundsch* (1997) 86: 4040-414, Springer-Verlag 1997.

MANAGING FLOODS IN THE KANO PLAINS USING GIS

Charles O. Gaya ^a, M.K. Gachari ^b and J.M.Gathenya ^b

^aDepartment of Civil & Structural Engineering, Masinde Muliro University of Science & Technology, P.O. Box 190 Kakamega 50100, Kenya
charlesonyango@gmx.net

^bJomo Kenyatta University of Agriculture & Technology, P.O Box 62000, Nairobi 00200
Kenya

KEYWORDS:

GIS, Flood Modelling, Disaster Management, Early Warning Systems

ABSTRACT

This paper discusses the efforts of developing a locally viable scientific tool for monitoring the flood-prone Kano plains of the Nyando river basin and providing early warning mechanisms for floods in the eastern Lake Victoria basin where perennial floods have been causing a lot of human suffering.

The study describes a simple hydrological model for the Nyando basin, developed to use a GIS user-interface and integrated with a geospatial database of the area so that it can be used as a flood management tool. The method involves the use of a Digital Elevation Model (DEM) of the area together with the soil types, land cover and daily satellite-derived rainfall estimation, as well as existing rainfall data to develop a GIS-based hydrological model which can be used in determining the areas affected by floods and forecasting areas likely to be flooded.

The historical daily rainfall data are used to validate the satellite rainfall estimates (RFE). The DEM is used to derive the runoff characteristics. For the purposes of modelling the hydrologic processes using GIS, the area is divided into small cells representing the spatial distribution of the parameters controlling surface runoff i.e. topography, surface roughness, soil infiltration and rainfall.

GIS provides the tools for visual interpretation and evaluation of flood distribution and offers new opportunities to develop and implement a user-friendly, interactive decision support system for flood forecasting and monitoring using dynamic spatial modelling.

1 Introduction

Floods are perennial problem in western parts of Kenya during most of the rainy seasons, resulting in loss of lives, property and production as well as affecting activities in the flooded areas. The flood prone areas of Western Kenya are located around the Lake Victoria Basin where the Nzoia and Nyando river systems drain low-lying plains that are also very heavily populated before entering the lake. The rivers are responsible for the flooding downstream in Budalangi area and Kano plains, respectively (Ogallo *et. al.*, 2004).

While solutions that are normally put in place for coping with the floods mostly involve construction of dams and dykes, an additional strategy using non-structural methods of mitigation of flood hazards, such as flood forecasting that involves the integration of streamflow forecasting models with a Geographic Information System (GIS), is necessary (Aziz *et. al.*, 2002).

The development of a GIS for flood management entails the use of a Digital Elevation Model (DEM) of the area. This, in conjunction with digital input maps of existing rainfall data and drainage patterns, soil types, land use as well as daily rainfall prediction using satellite imagery is used to develop hydrologic models for simulating streamflow in forecasting flood events.

The main problem in the developing nations is that accurate data is very often either not readily available or is expensive to obtain. Thus the main challenge is to identify and use readily and economically available information to produce a flood warning system.

Satellite rainfall prediction based on cold cloud duration (CCD) derived from remotely sensed data such as Meteosat thermal infrared imagery can be used in conjunction with GIS-based hydrologic modelling methods to improve the quality of flood forecasting efforts. The United States Agency for International Development (USAID) Famine Early Warning System (FEWS) has been supporting the production of 10-day rainfall estimates (RFE) data for Africa since 1995.

This contribution outlines an ongoing project to develop an accurate and locally viable scientific model for management and forecasting of floods in the flood plains of the Lake Victoria Basin using the economically available remotely sensed and existing ground data integrated with GIS.

The area of interest is the Nyando river basin where perennial floods in the lower Kano plains have been causing a lot of human suffering. The Nyando River is located in western Kenya and drains into Lake Victoria. The basin covers an area of approximately 2,646 km². The Nyando River basin is bounded by latitude 0°7'18"N and 0°24'36"S and longitude 34°50'48"E and 35°43'35"E. Lake Victoria is to the west, Tinderet Hills in the east, Nandi Escarpment to the north and Mau Escarpment to the south east. The Basin has a total population of about 750,000, based on the 1999 Kenya population census. The mean annual rainfall varies from 1200 mm close to Lake Victoria to 1500 mm at the foot of the Nandi Escarpment.

2 Methodology

The use of GIS to model hydrologic processes requires the spatial and temporal distribution of the inputs and parameters controlling surface runoff. GIS maps describing topography, land cover, soils, rainfall and meteorological variables become inputs in the simulation of hydrologic processes.

2.1 Watershed Analysis from DEM

The simulation of flood levels requires a Digital Elevation Model (DEM) representing the topographic surface in terms of a set of elevation values measured at a finite number of points and contains terrain features of morphologic importance such as valleys, ridges, peaks and pits.

The DEM for the Nyando Basin was generated from contour lines and spot heights of existing topographic maps. This area is covered by topographic maps at a scale of 1:50,000 and contour interval of 20 m. The method involved the assembly of contour lines from different map sheets. The DEM was derived from digitizing the contour layer and the hydrographic features layer of the existing topographic maps. Scanned topographic map templates were digitized using of raster-to-vector conversion software (R2V) and the resulting vector data carefully edited manually. The sheets were finally merged together to produce a single terrain model of the area using GIS software (ArcGIS). The resulting DEM was at a resolution of 20 metres.

The DEM was then processed using the Hydrologic toolset of ArcGIS to derive the runoff characteristics of the basin. It was first filled to remove depressions. A flow direction grid was derived using the D8 method, which assigns a cell's flow direction to the one of its eight surrounding cells that has the steepest distance-weighted gradient. This enabled the generation of a flow accumulation grid to record how many upstream cells contribute drainage to each cell in the basin. The stream network for the basin was then delineated using a threshold accumulation value of 500.

2.2 Rainfall Estimation

Spatially distributed rainfall is an important input for accurate flood forecasting. Conventional rain gauge estimation of rainfall requires a dense network of many gauges to accurately characterize precipitation over an area such as a watershed. The insufficient number of gauges on the ground can hinder this method. Some of these break down and take time to replace, thereby causing gaps in continuous data collection.

A technique for estimation of precipitation over Africa was developed to augment the rainfall data available from the relatively sparse observational network of rain gauge stations over this region. The method utilizes Meteosat satellite data, Global Telecommunication System (GTS) rain gauge reports, model analyses of wind and relative humidity, and orography for the computation of estimates of accumulated rainfall (Herman *et al.*, 1997). The RFE 1.0 algorithm, implemented from 1995 to 2000, uses an interpolation method to combine Meteosat and GTS data, and warm cloud information for the 10-day estimations. The RFE 2.0 algorithm, implemented as of January 1, 2001 uses additional techniques to better estimate precipitation while continuing the use of cold cloud duration and station rainfall data. The RFE subsets are flat binary images of 8 km square pixels, with the cell value

rainfall units in millimetres. With the RFE input into a hydrologic model, it is possible to simulate the hydrologic process 10 days in advance in order to forecast flood events.

In order to validate the RFE with rain station data over the Nyando basin, a VBA program was developed in ArcGIS to extract the values of the satellite rainfall estimates (RFE) at the positions of the gauging stations. The stations are first displayed in the GIS user interface. The program imports each day's RFE raster dataset in turn and loops through each station in the point feature class to obtain the cell value of the raster on that point. This routine was used to obtain the RFE data for the period 1995 to 2005 corresponding to the locations of 35 gauging stations in the basin. The values were compared with the observed gauge data for the same period.

Observed station data for 18 stations obtained from the Kenya Meteorological Department for the years 1997, 1998, 1999, 2001, 2002 and 2003 were used in this study. The number of gauge stations used in the particular years ranged from 2 to 12 gap-free stations. Daily precipitation fields were summed up to into dekadal fields for both sets of data for each station. The arithmetic average of the included stations was then calculated for each ten-day period (dekad) in both sets. Simple regression analysis was used to measure the degree of agreement between the observed rainfall and the satellite RFE. The root mean square error (RMSE) was also calculated to quantify the amount by which the satellite-derived rainfall estimates differ from the rain gauge-observed values for the 10-day accumulations.

Year	Correlation coefficient	No. of Gauges	RMSE (mm/Dekad)
1996	0.774	9	21.79
1997	0.903	11	16.79
1998	0.771	10	20.27
1999	0.629	12	23.37
2001	0.714	6	22.64
2002	0.775	4	25.11
2003	0.920	8	15.89

Table 1: Results of the correlation analysis between the satellite rainfall estimates and the observed station data for the selected period.

Regression analysis yielded on average a correlation coefficient (R^2) of 0.78. Two periods that showed the best match were 2003 and 1997 (Table 1); incidentally these two years saw some of the most extreme flood events of recent times in this region. Comparison by stations showed a high degree of association between and RFE and gauge data in most of the gauge stations.

The results suggest that RFE data can be used as the rainfall input in the flood forecasting system. Satellite rainfall estimates (RFE) fill in gaps in station observations. The gridded rainfall time-series give historical context, and provide a basis for quantitative interpretation of seasonal precipitation forecasts. RFE are also used to characterize flood hazards, in both simple indices and stream flow models (Verdin *et al.*, 2005). The Climate Prediction Center (CPC) produces precipitation estimates for Africa on the 1st, 11th, and 21st of each month (Herman *et al.*, 1997).

2.3 Deriving Runoff Parameters

The observed and recorded parameters of the hydrologic cycle, namely rainfall and streamflow were obtained from the Kenya Meteorological Department and Ministry of Water and Irrigation, respectively. Rainfall estimation was obtained from the validated RFE datasets.

The storage capacity (infiltration) of the soil is a major determinant of how much rainfall becomes runoff. Infiltration depends on the soil type, topography, natural vegetation and land use of the area. Land cover and land use map layers were obtained from evaluation of satellite images by computer-assisted classification using remote sensing software. The infiltration was estimated through GIS analysis of these map layers overlaid with the elevation layer and existing digital soil maps. Surface runoff was generated as infiltration excess.

For modelling purposes, the infinite variability of the parameters was averaged to a degree of finite elements (20 m square grids), which was then assumed to have uniform parameters (elevation, land cover, soils, etc). These were based on the 20 m resolution of the DEM.

The Africover Land Cover map of the area with descriptions of the land cover in Land Cover Classification System (LCCS) code was first translated into meaningful description using the LCCS software translator (Gregorio, 2005). The labels were then grouped into the major land cover types.

The digital soil map of the area with its table of attributes gives properties of the soil including proportionate extent of the component soils, soil depth and hydraulic properties, which are necessary for estimating infiltration parameters from soil maps

The soil types were classified from their attributes according to the Soil Conservation Service (SCS) of the United States (Maidment, 1993) into four hydraulic soil groups according to their infiltration rate. Group “A” consists of soils that have low runoff potential and high infiltration rates, Group “B” consists of soils that have moderate infiltration rates, Group “C” consists of soils that have low infiltration rates while Group “D” consists of soils that have very low infiltration rates.

With the grids of soil hydraulic groups, land cover and rainfall estimates, surface runoff from each cell was estimated by the curve number method of the Soil Conservation Service (Maidment, 1993). The approach estimates direct runoff Q from rainfall P and watershed storage S by:

$$Q = \frac{(P - Ia)^2}{P - Ia + S} \quad (1)$$

where Ia is the initial abstraction and S is the maximum potential difference between P and Q . Both Ia and S are affected by factors such as vegetation and infiltration. No runoff occurs when the precipitation is less than the initial abstraction ($P < Ia$). The parameters in Equations (1), (2) and (3) are in inches. Empirical evidence shows that $Ia = 0.2 S$ so that

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \quad (2)$$

The parameter S is defined by:

$$S = \left(\frac{1000}{CN} - 10 \right) \quad (3)$$

where CN is an arbitrary runoff curve number ranging from 0 to 100.

The CN value is dependent on the ground cover type and the hydrologic condition. The SCS have developed tables of CN values for various land cover types against the four soil hydraulic groups. The curve numbers grid was derived by assigning the corresponding value to each cell from the overlay of the land cover and soil hydraulic group grids. From the grid of curve numbers (under average moisture condition), CN the grid of surface storage S was derived for the basin.

The runoff depth, Q is calculated for each cell for each day to produce a continuous raster representing surface runoff from rainfall estimates (RFE), P for the basin for each day. This grid is used to weight the flow accumulation grid to estimate the amount of surface runoff that is incident on the surface, upslope from each cell.

3 Flood Management

3.1 Flood Hazard Monitoring and Forecasting

The simulated accumulations of surface runoff volumes driven by the daily rainfall estimates were compared with previous stream level records obtained from existing river gauging stations placed at sub-basin outlets. It was noticeable from graphical comparison of the plots that whenever the simulated runoff volume at the gauging position increased significantly, there was, in most cases, a similar incremental trend in the observed level of the river on the same day or one day later. This is illustrated in Figure 1 for Station 1GB11 which is a catchment outlet for a sub-basin of approximately 600 km² on the north of the basin.

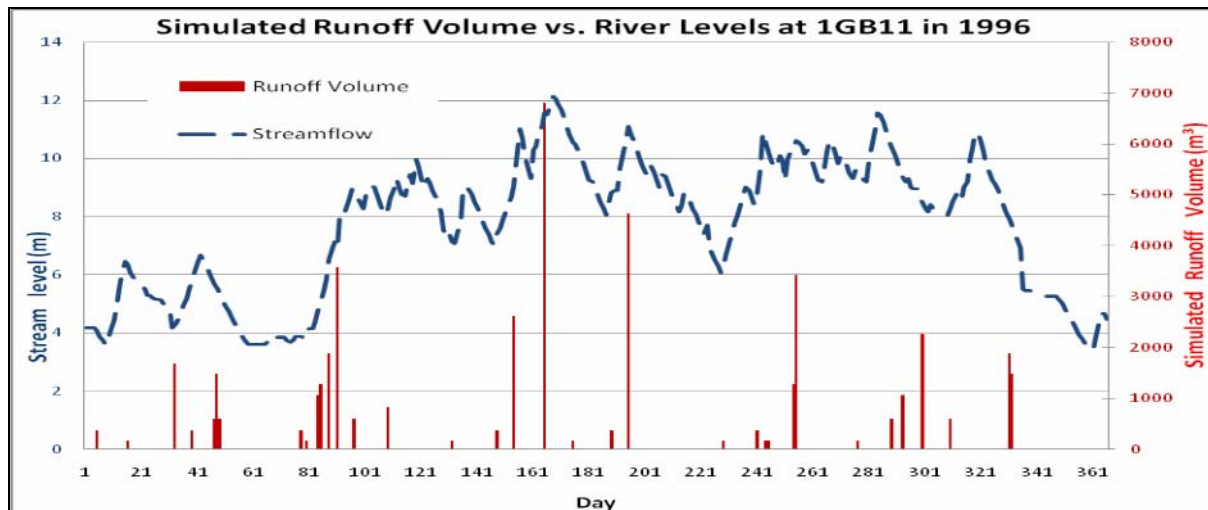


Figure 1: A graphical comparison between the simulated runoff volume and observed river levels at flow gauge 1GB11 for the year 1996.

Although not conclusive, these initial results show that from the input parameters of satellite rainfall estimates, soil map and land cover map, it is possible to simulate the surface runoff that is reasonably indicative of the variation in the stream level. Thus when there is forecast of a drastic surge in the runoff volume, a rise in the river level is to be expected. Depending on the river level before the rise, if the forecast stream level is higher than the historical flood level then it can be marked as warranting an early warning of flooding.

It is intended to use river gauge readings and hydrographs of previous flood events to determine flood warning levels. The simple model is to be run daily to provide several days' forecast of the river levels at the various river gauging stations. Using the forecast river levels in conjunction with recorded flood levels of each area, it should be possible to predict the occurrence of floods and issue early warnings.

3.2 GIS Database for Flood Management

Digital maps of the Kano flood plains were constructed from digitizing the physical features of scanned topographical maps at a scale of 1:50,000 and updated with field surveys using hand-held GPS. Public utilities such as schools, colleges, hospitals and markets in and around the flood zone have been captured. This data is overlaid with hydrologic data, administrative data, infrastructure data, settlements, etc which are all georeferenced.

Inundated areas can be mapped from satellite imagery such as radar, Landsat TM and ASTER. Multi-temporal satellite imagery can be classified to delineate flood extent and produce vector maps to be overlaid with administrative maps to show the past flood extents. The historical stream flow levels can be compared with past flood extents to estimate the extent of future floods.

Images from previous floods will guide on where dykes should be constructed. Ten-day forecasts of rainfall are input in the model to monitor the sufficiency of the dykes and advice on necessary emergency measures.

The GIS database can be integrated with agricultural, socio-economic, communication, population and infrastructure data. This is used, in conjunction with the flooding data, for an evacuation strategy, rehabilitation planning or damage assessment.

4 Conclusions

Satellite rainfall estimation is an attractive option in most of Africa, where rain gauge networks are sparse with vast areas un-gauged, while radar is not a feasible proposition on the grounds of cost, technical infrastructure and topography (Grimes and Diop, 2003). The validation results show that RFE; with operational estimates every 10 days, can provide a sufficiently reliable prediction of precipitation over the Nyando basin for flood forecasting purposes.

The comparison of the simulated runoff volume with the observed stream levels shows reasonable concurrence in the change in river runoff. This simple spatial analysis of the basin drainage parameters integrated with RFE

estimates over the basin has shown a relationship between the input RFE data and the eventual streamflow. It can be used to predict the variation in stream levels and thereby enable the forecasts of levels that may lead to occurrence of floods in the lower Kano plains.

Simulated scenarios of flood events will be obtained by running the model overlaid with the GIS database of the Kano plains. This will enable identification of the likely extent of inundation thereby assisting decision makers to initiate effective disaster mitigation measures in the identified areas before the actual flooding occurs.

References

- Aziz F., Tripathi N., Ole M. and Kusanagi M., (2002), Dynamic flood warning system: An integrated approach to disaster mitigation in Bangladesh. URL: <http://www.gisdevelopment.net> [Accessed 13/12/2007]
- Gregorio, Antonio D., (2005), Land Cover Classification System: Classification concepts and user manual, Software version 2, Food and Agriculture Organization of the United Nations (FAO)
- Grimes D. I. F. and Diop M., (2003), Satellite-based rainfall estimation for river flow forecasting in Africa, *Rainfall Estimates and Hydrologic Forecasts Hydrologic Sciences—Journal—des Sciences Hydrologiques*, 48(4), pp. 567–584
- Herman A., Kumar V. B., Arkin P. A. and Kousky J. V., (1997), Objectively determined 10-day African rainfall estimates created for Famines Early Warning Systems, *International Journal of Remote Sensing*, 18, 2147-2159
- Maidment, D., (1993), Handbook of Hydrology, McGraw Hill
- Ogalo L.A. Mutua F., Ayayo O. and Odingo R., (2004), Coping with Floods in Kenya: Vulnerability, Impacts and adaptation Options for the Flood Prone areas of Western Kenya, DMCN-UNEP Report
- Verdin J.P., Funk C., Senay G. and Choularton R. , (2005), Climate Science and Famine Early Warning, *Philosophical Transactions – Royal Society of London Biological Sciences*, 2005, vol. 360, no 1463, pp 2155-2168

USEFULNESS OF ADDRESSABLE RADIO IN EMERGENCY DISASTER PREPAREDNESS FOR COX'S BAZAR IN BANGLADESH

A. B. A. Imtiaz^a and Z. H. Siddiquee^b

^a Research Engineer, Bangladesh network Office for Urban Safety, Bangladesh University of Engineering and Technology, Dhaka-1000, Bangladesh
affifaimt@gmail.com

^bGIS Expert, Engineering & Planning Consultants, 7/4 Lalmatia Dhaka, Bangladesh
zh027@yahoo.com

KEYWORDS:

AREA, ASR, BMD, CPP, Early Warning, KII, RRA

ABSTRACT

Bangladesh is a disaster prone country where many lives are tolled along with property damages each year only because of natural calamities. The city of Cox's Bazar is located in the south eastern part of the country which falls in the High Risk Zone for tropical cyclones. However, the earthquake and the resulting tsunami have recently appeared as additional threats to this region. Recent series of disasters in Bangladesh and neighboring countries have posed an added concern on the importance of emergency alerts. Early Warning System is considered to be one of the most effective measures for Disaster Preparedness. In this paper the existing Early Warning Dissemination System of Bangladesh has been evaluated based on the response of the local vulnerable groups through the participatory questionnaire surveys KII and RRA. Based on the study a satellite based multi hazard warning system, WorldSpace AREA Solution, has been introduced in the Cox's Bazar area. WorldSpace Addressable Radios for Emergency Alerts (AREA) was developed to improve the "situational awareness" of all-hazards for communities at risk. The system is capable of disseminating messages using satellites through broadcasting digital audio & multimedia programs to the community within 10 seconds after issuing alert. In association with GIS technology the radios can be used for disseminating separate emergency alerts indifferent spatial extents. We cannot stop the natural calamities but we off course can have a better preparedness for any disaster that can mitigate losses.

1 Introduction

Many disasters like floods, droughts, cyclones, earthquakes, tornadoes strike the country almost every year. Bangladesh needs to develop a disaster reduction program as the Nation's commitment to reduce the impacts of hazards and enhance the safety as well as economic well being of every individual and community. Cox's Bazar, a southeastern district of Bangladesh, is strategically and economically very important area of the country. The longest unbroken sand beach of the world is located in Cox's Bazar. The area is exposed to the many devastating natural disasters of the country. Moreover Cox's Bazar and the nearby area fall in the High Risk Zone for tropical cyclones. Development of a Cyclone Preparedness Program (CPP) in the country for the area has resulted in a reduction of losses due to cyclones. However, the earthquake and resulting tsunami have recently appeared as additional threats. Historical records show that earthquakes having magnitude 6 to 7 have occurred in and around the district within the last fifty years. Therefore, it is essential to develop a disaster preparedness program for the region in order to reduce the losses likely from those disasters. Early Warning System is one of the most effective measures for Disaster Preparedness. It is the first and foremost step in disaster preparedness. Thus this study deals with the evaluation of the effectiveness of the existing Early Warning Dissemination System of Cyclone Preparedness Program for its applicability to other natural disasters based on the response of the local vulnerable groups through the participatory questionnaire surveys.

2 Overview of the Study Area

Cox's Bazar lies in the southeastern part of Bangladesh, beside the Bay of Bengal. The area is famous her outstanding natural beauty. The district consists of 8 administrative units (Uddin et al. 2005). The district has an area of 2491.86 sq Km with a population of 17, 57,321 (Banglapedia 2009). Cyclones, Tidal Surge, Flash Flood, and Earthquake are very common visitor. From the year 1960 to 1995, seven major cyclones hit the district. The most devastating cyclone of the last century hit Cox's Bazar on November 1970. People are mainly involved in agricultural, fishing and salt cultivation. Many people are also engaged in tourism and hotel business. The literacy rate in Cox's Bazar is the least among other coastal districts (Uddin et al. 2005).

3 Existing Warning System in Bangladesh

Bangladesh Meteorological Department (BMD) under the Ministry of Food and Disaster Management play the key role in generating warning in Bangladesh. They are responsible for generating warning for all hazards, disseminating the warning through public media and different preparedness units. They also make the follow up of the warnings at periodic intervals. For dissemination of the warnings BMD uses existing cyclone warning network. The network functions together with Bangladesh Red Crescent Society (BDRCS) and the Ministry of Food & Disaster Management.

3.1 Warning Equipment and logistics

BDRCS and the CPP units receive messages of warning from BMD through high frequency satellite radio. The unit Team Leaders of CPP is provided with a transistor radio for receiving the messages. CPP then disseminate the warning signals among the villagers through megaphones, sirens, public address equipment, signal lights etc. Signal flags are also provided to each volunteer's teams where number of flags on a mast indicates the severity of the event. The Cyclone Preparedness Programme operates an extensive network of Radio communications facilities, in the coastal areas, linked to its Head Quarter at Dhaka. The network consists of a combination of High Frequency radios to transmit and receive information related to the cyclone and the preparedness and Very High Frequency radios covering most of the high risk cyclone areas to receive and transmit messages from HF field stations to Sub-Stations. They also receive Meteorological information, cyclone warning signal and special Weather Forecast transmitted by Radio Bangladesh on regular basis. CPP operates a total of 142 Radio stations, among those, 64 stations are placed in cyclone shelters, built by the BDRCS, in the high risk cyclone prone areas (CPP, BDRCS, 2002).

3.2 Operational Method

BMD observes different meteorological parameters all over Bangladesh and collects satellite imageries round the clock for timely use in operational meteorology, monitors micro seismic events and earthquake for providing all forecasts and warnings. Figure 1 illustrates how the warning is disseminated from BMD to the local community through the network.

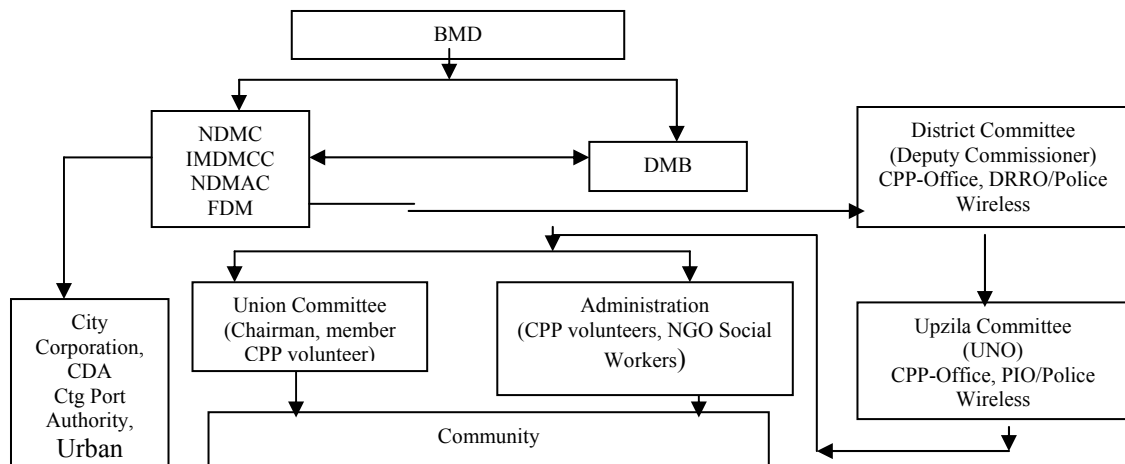


Figure 1: Governmental Organizational Chart for Disaster Warning (CPP, BDRCS, 2002)

3.3 Signaling System

Cyclone warning system is the only well-known warning system used in Bangladesh. The signaling system currently used for cyclone warning was inherited from British India. There were 11 numbers of signals for Maritime ports and 4 numbers of signals for river ports to indicate the severity of weather conditions. CPP has simplified the signaling system through introducing flagging system corresponding to maritime signals. Three flags have been developed to represent the whole range of Maritime Port Signaling System of British India. Meanings of first flag correspond to signal numbers 1 to 3, second flag corresponds to signal number 4 to 7 and the third flag correspond to signal numbers 8 to 11 of Maritime Port signals (Figure 2). While understanding of the meanings of these flags still remain questionable, increase in the number of flag on a mast generally indicates a greater severity of the cyclone event to the local community.

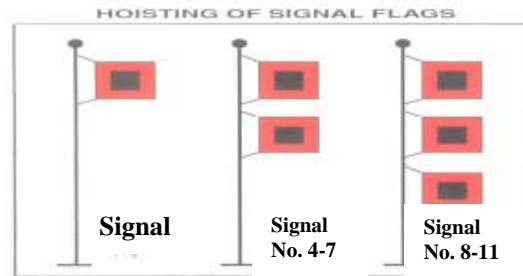


Figure 2: CPP warning system (CPP, BDRCS, 2002)

4 Evaluation of Existing Disaster Preparedness System

Two forms of questionnaire survey KII (Key Informant Interview) and RRA (Rural rapid Appraisal) were conducted throughout the selected locations of the study area in the year 2007. The key informant interview involved identifying different members of the community who are considered to be knowledgeable about the concern of the survey, such as different professionals, elderly personnel, and teachers. Rural Rapid Appraisal (RRA) was conducted for group level evaluation interview. It was performed on focused-groups to collect more detailed information on the issues that are of greatest importance.

4.1 Development of Questionnaire

Objective of this research was to evaluate the effectiveness of the warning system from the viewpoint of local community and hence to examine the potentiality of using those for other disasters. Two sets of questionnaire were developed for that purpose according to KII and RRA. For the disasters, major concern is the time to reach the shelter after receiving the warning. Thus, the issues of warning mechanism, time for warning and evacuation, medium used etc were focused during development of questionnaires. The Questions of the survey was developed on the basis of the considerations, such as Coverage, Acceptability, Warning Authority, Dissemination Media and Ease of Understanding.

4.2 The Participatory Surveys

The KII survey was conducted in different areas covering whole of the Cox's Bazar District. The sample population surveyed was chosen in a random manner but the inclusion of people from different age, class and profession was ensured. The survey was conducted among teachers, businessmen, housewives, fishermen, service holders, day laborers and people from other minor professions. Among the surveyed population of 17 locations in the Cox's Bazar District, total 1644 questionnaire were considered for analysis. Figure 3 shows the distribution of KII surveyed areas. Total 241 filled out questionnaire from six locations in the district were considered for analysis and producing graphs.

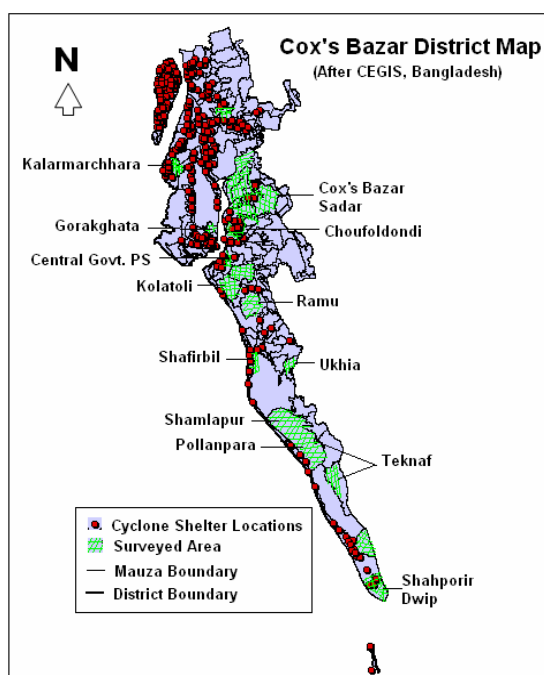


Figure 3: Surveyed Locations for KII

4.3 Data Analysis

The aspects considered for evaluating the existing warning dissemination system include whether the warnings contain relevant and useful information and address all hazards, the information is clear and useable, warnings reach all those at risk and whether the community itself understands the warnings. The information collected from the surveys was analyzed based on these aspects. Few interpretations from the results of the surveys are discussed here.

5 Do Warnings Reach All of those at Risk?

The questionnaire survey made an investigation about the fact whether the people at risk in Cox's Bazar District were warned or not. During the survey a comparative study was made among the cyclones of 1970, 1991 and 1997 to know about the medium and effectiveness of warning dissemination systems. Very few people could remember about any warning dissemination in 1970. Again, in case of 1991, people stated mainly radio and television where they heard the warning; some people also mentioned the use of loud speakers and few people could not remember anything about getting any warning. On the other hand, almost all the people could mention at least one medium of warning dissemination, in most of the cases even more than one media, regarding the cyclone of 1997. Along with radio, television, loudspeaker, people also mentioned about the activities of the volunteers and Red Cross Society and few other NGOs. Thus the present status of the situation is such that the people at risk in coastal region more or less get some information or warning about the upcoming disaster. Again, communication and accurate forecasting will be without benefit unless the information can be conveyed to the people at risk in a timely manner. Figure 4 indicates that most of the people might be informed about the disaster but at a late stage where mass response becomes ineffective

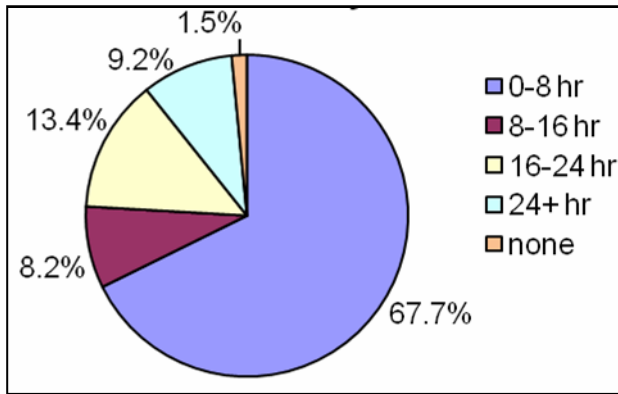


Figure 4: Warning Dissemination time before cyclone

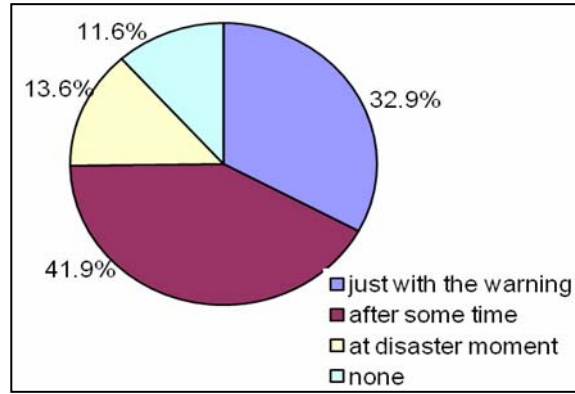


Figure 5: Response of people after getting warning

5.1.1 Are the Risks and the Warnings Understood?

The existing cyclone warning in Bangladesh has signal numbers inherited from British India. The survey showed that people are being totally confused about the numberings, only be aware about the increasing numbers of the warnings, neither their meaning in terms of risk nor the type that is whether it is for maritime ports or river ports or any locality. Moreover, the contents of the cyclone warning known as Special Weather Bulletin are not specific for easy understanding of general public. The same thing happens in case of signaling system through hoisting flags. So when the surveyed people were asked whether they understand the warning, almost all of them replied in affirmative but none could give any elaborate or explanatory idea on the risks implied. Figure 5 depicts how people react after getting warning.

5.1.2 Is the Warning Information Clear and Useable?

The warning in Cox’s Bazar area is broadcasted in formal Bengali language, which is not always understandable by the coastal people who are uneducated or use local dialect. The language of the Bulletin is also complex and often cannot clarify the exact situation through the disseminated information. The surveyed people often complained that the warnings are not precise, easy to understand or simplified as per people’s requirements.

5.1.3 Does it Address All-Hazards?

The existing warning system cannot distinguish between the possibility of a cyclone striking Bangladesh and the probability (beyond a reasonable doubt) of and fall or information on rainfall plus the intensity, likely target, timing and also when to start evacuation. Based on surveyed result it was found that the present warning does not address any specific Hazard or All-Hazards to general people which has resulted in Low People Confidence on Forecast.

6 Development of an IDEAL Warning System

It is revealed with reference to the tsunami warning system in Indian Ocean that Information bulletin on potential hazards are issued to the Indian Ocean countries including Bangladesh from Japan and Hawaii. However, final decision about the warning and preparation is pending on the regional countries. Thus development of a regional system for each country would an important role for a disaster preparedness program.

6.1 Concept of Operations

Anderson (2006) reviewed different aspects of a regional system required to make the disaster preparedness as effective. Three steps have been identified for an effective disaster preparedness program of a regional system as follows:

1. Reception and authentication of external hazard event and warning information by monitors located at the Disaster Risk Management Center and dissemination to targeted communities specially equipped with Hazard Information technologies.

The activities of Disaster Risk Management Centre are:

- Receiving an Event of Interest (EOI);
- authenticating/Confirming the EOIs with a Center Executive
- constructing a Message for the communities
- Relaying the message to Hazard Information devices in designated communities

2. Reception and authentication of messages by the Guardians in communities equipped with hazard information devices and dissemination.

3. Community response according to the message after receiving of the warning message

There are also some Global System requirements for an ideal Early Warning delivery:

- To be addressed by country, group, tier and also the current location of the receiver
- To be delivered with a latency of less than 10 seconds once the message is sent out
- To automatically trigger a siren/alarm even if the receiver is not under use

6.2 Reviewed Case Study on Hazard Information Devices

Five different Information and Communication Technologies (ICTs) were reviewed to evaluate their suitability in varied settings for “last mile of a national disaster warning system” for Sri Lanka (Anderson, 2006). The ICTs are shortly discussed below (Saha et al. 2008).

6.2.1 CDMA Fixed Wireless Phones:

The CDMA fixed wireless phones provide standard dial-tone voice phone services and are very useful, especially in rural areas that have limited or no wire-line services. They are relatively fast and dependable, portable and can be easily re-located. Further, usage requires little or no training. But they are vulnerable to congestion during periods of high intensity of traffic that may be generated by people’s responses to the disaster.

6.2.2 Mobile Telephones-Cell Broadcasting:

Cell broadcasting uses an existing function of cellular networks which allows a text message to be broadcast to all cellular phones of a particular operator in a given geographical area. It places a very low load on the network and also impervious to network congestion. It can support multiple channels for different message types and can be activated remotely by the network operator.

6.2.3 Addressable Satellite Radio (ASR):

ASR supports a variety of functions including text alerts, both short and extended, audio broadcasts of unlimited length, geographical, individual and group based message targeting. Further, because the receivers’ signals are fed from a geostationary satellite, and receivers can be DC battery operated, ASR can operate independently of local or national infrastructure. However, programming and loading message content into the system is still dependent upon having a reliable Internet connection.

6.2.4 VSAT-Internet delivered web/e-mail bulletins:

Internet access delivered to users in remote areas is possible with Very Small Aperture Terminal (VSAT) technology that uses a satellite connection as a high-speed digital link between the user and the Internet backbone. VSAT is a relatively robust and reliable communication link which is available at a reasonable cost.

6.2.5 Amateur Ham Radio:

During the Indian Ocean tsunami that destroyed electricity and communication infrastructure in the Andamans & the Nicobar islands, amateur ham radio amateurs were the critical link between the islands and the Indian mainland and helped in the coordination of rescue and relief operations.

Although CDMA and GSM technologies are available in Bangladesh but they are liable to challenges, especially due to network jam in emergency situation. Considering the challenges faced in Sri Lanka and the suitability for Bangladesh, the system with Addressable Satellite Radio appeared the most efficient one for deploying in Cox’s Bazar Bangladesh.

7 Addressable Radio for Emergency Alert (AREA)

Addressable radio for emergency alert is a technology, where, Digital satellite delivers signals into small and low cost receiving equipment that is very handy. The devices are deployed in public remote areas for awareness and preparedness. Worldspace Corporation has developed a new radio which is called Addressable Radio for Emergency Alert (AREA). There is a siren connected through a relay, which is activated when an alert is received. The AREA can be also be used for infotainment of the community during non-hazard times the system gets integrated to the daily lives of the community.

The receiver which is called DAMB-R2 is a low-memory radio with a small display and limited processing power. DAMB-R2 features dual channel reception, one of the channels always being a data channel called OAAC (Over Air Activation Channel). Through the OAAC channel the alert provider can send an alert message. DAMB-R2 has the capacity to monitor the alert, validate the message and perform the action. The action is generally to activate a relay for a siren, turning on/switch to WorldSpace channel for audio messages, displaying text regarding the alert and delivering a file to a computer connected to the unit.

DAMB-A2, which is a variant of DAMB-R2, incorporates all the functionalities of DAMB-R2 and is usually connected to the USB port of a computer. Figure 6 shows the overall schematic.

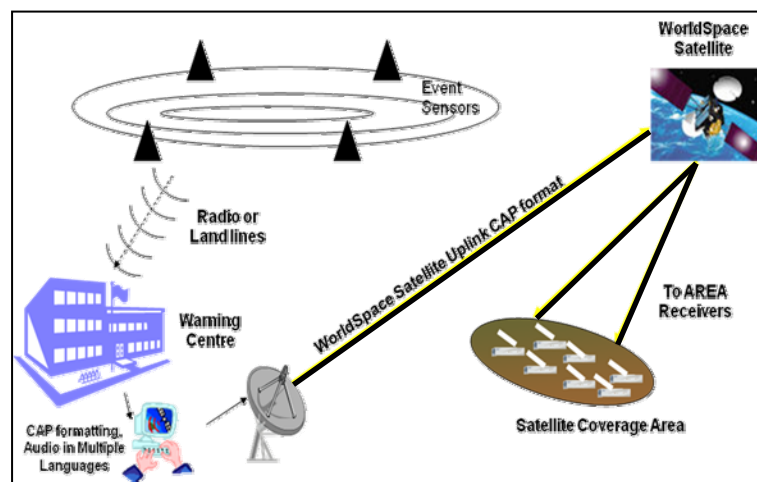


Figure 6: Schematic of WorldSpace Satellite System (Rangarajan et al., 2006)

An unobstructed path from the satellite to the receiver antenna is required in order to receive a clear signal from the satellite. The receiver antenna is positioned directly under the satellite. Radio Line of Sight (RLOS) is then assumed to exist between the satellite and the receiver antenna. The receive configurations in AREA is adaptable to the needs and conditions of the location where the service is intended. There are three different types of configurations. These are described as follows (Saha et al. 2008):

7.1 AREA-A

In AREA-A configurations a special satellite modem which is called DAMB-A2 is connected to an USB port of the computer. At normal non hazard times, AREA-A delivers various channels of audio to play out on the computer, and can provide the pipe for downloading multi-media digital contents of relevance, such as agricultural information, health information, and education, to the communities. A computer system with Pentium II processor and Windows operating system is required. The onset of alert is decoded by AREA-A which, in turn, activates a series of alarms and announcements on the computer. The alert generating software has the provision to automatically tune to any desired channel; this feature is available for switching to the datacast channel of WorldSpace to enable downloads.

7.2 AREA-M

Another configuration of the system is AREA-M that has a GPS receiver connected to DAMB-R2 with an external box. AREA-M can also be placed on any vehicle, including fishing boats. These units receive power from the vehicle and play the audio in its speaker system. When an alert signal is initiated by the proper agency the same receiver will sound an alarm, display the alert parameters and switch the audio to a different channel where more specific information can be provided. By using the GPS signal fed to AREA-M, the alert deliver can

be restricted to those receivers that are located within the risk zone identified by the agency responsible for generating the alert.

7.3 AREA-C

AREA-C configurations are suitable for a fixed location, with public address for the community. Figure 24 shows the system. In this configuration, the rechargeable battery provides immunity to the loss of AC power at the alert-instant. The automatic remote activation of the siren provides the capability to alert the community over long distances, typically one km. Besides the textual display and their updates, the radio plays the special alert audio channel to provide authentic information to the community.

7.4 Operation

When an emergency message is to be communicated the authority after due process of validation start broadcasting messages and feed contents to the AREA C and AREA M receivers. The radio will automatically switch its channel to a special channel and start relaying the broadcast message and also display the alert parameters.

Once the receiver recognizes the alert, an audio alarm is generated. In AREA-C configurations, it closes a relay which activates the siren which can be heard over a radius of typically 1 km. In contrast, AREA-A provides a computer generated warning signal, while AREA-M uses a buzz for drawing the attention to the alert. After the cancellation of the message all AREA receivers will switch back to its original mode. The AREA receiver has a provision to automatically switch on itself on the special broadcast, even if it is in an off mode (i.e. music not playing for any reason), and sound the alarm.

8 Installation of AREA in Bangladesh

Twenty sets of AREA were deployed in the year 2008, in Dhaka and Cox's Bazar on a Pilot basis (Saha et al. 2008). In Dhaka, the systems were installed in Bangladesh University of Engineering and Technology (BUET) premises, Comprehensive Disaster Management Programme (CDMP) office and Bangladesh Red Crescent Society (BDRCS) headquarter. The Government Administration Offices i.e. Upazila administration offices were found to be appropriate and secured place for deploying the systems in Cox's Bazar. Eight AREA C receivers were handed over to the Project Implementation Officer at eight Upazilas of Cox's Bazar district, one to the District Relief and Rehabilitation officer and another one to the Chairman of the Saint Martin's Island

8.1 AREA: Features and Advantages

The existing early warning dissemination system in Bangladesh has been successful in reducing loss of lives and properties. Considering the facts, an emergency early warning system, the WorldSpace Satellite System has been proposed and deployed in the study area on a pilot basis. This system appeared to be reliable and usable for multi-disaster approach while field-testing in Srilanka. It also showed very effective performance in disseminating warning from Dhaka to Cox's Bazar while test-runs after the deployment. It has been observed that the warnings reached to the target communities within a short period of time whereas warning disseminated by conventional step-by-step organizational network takes hours. Some features and advantages of AREA are discussed below:

8.1.1 Addressability

AREA has got a wide range of addressability. The existing satellite coverage of WorldSpace is spread over more than 130 countries worldwide (Rangarajan et al. 2006). The system rolls-out over wide areas rapidly (within 10 secs) even in the remote locations where conventional modes of communication or networks of information transfer often fail to reach. There is provision of geo-referencing and selecting specific areas for addressing any particular risk or information. It is able to disseminate warning in different forms and the information delivered can be chosen on the basis of the requirement of the different risk zones. This single system can be used for multiple hazards as well as for multiple alert providers at the same time.

8.1.2 Clarity and Understandability

The alert can be disseminated as Text and Audio messages. Descriptive and specific information regarding the hazard and the response mechanism can be addressed through the delivered alerts. The audio alert can be transmitted in local languages. At the time of alert, the receiver automatically turns ON and there is provision for connecting a siren through a relay, which gets activated when an alert is received. There is also provision of to display emergency attributes based on CAP standards. The web-interface for alert generation, updates and cancellation is also easy to use. All these features make this system favorable for generating understandable and simple warnings. This in turn makes the instructions and alert clear to the targeted community.

8.1.3 Scalability

The AREA Coverage already exists and it is very easy to roll out services. Being a broadcast service, its cost per site decreases as the network grows. It has the immense possibility of expanding to other geographical areas and to multiple sectors, like education or health.

8.1.4 Sustainability

AREA can be accommodated in Existing Space & Ground segment. The receive equipments are small, portable and affordable. It has the least dependence on terrestrial infrastructures, telecom or internet availability and functions even when the terrestrial broadcast infrastructure may get knocked off by the Hazard. No technical expertise is required to install, operate or maintain the system It can be configured even in places with poor or no Electric mains supply and would survive adverse environmental conditions. The Antennas are very compact in size and not prone for destruction in disasters. During non-hazard times, the radio can be used for infotainment.

8.1.5 Affordability

The system has got the lowest cost among all the possible satellite terminals and Lower initial cost than any other satellite-based system. Its recurrent costs are also very nominal and cost can be spread across multiple projects as the system can be reused. It consumes very less power and can be powered by small solar panels.

8.1.6 Global Acceptance

The other countries on the globe are becoming concerned and interested about AREA. Some deployments of the system are listed below (Rangarajan et al. 2006):

- Indonesia has 3 nodal agencies (BMG, KomInfo & Ristek) and all 3 have agreed to work jointly to include AREA in Banten pilot (Dec 26, 2007) to comply with Federal Disaster Law (passed in May 07)
- Asia Disaster Preparedness Center (ADPC), an Inter-governmental agency with 22 member countries has requested partnership with WorldSpace to promote AREA in the member countries
- Sarvodaya, a leading NGO, has drafted an MOU with the government of Sri Lanka (DMC) that includes sharing Sarvodaya's AREA solution to the government for Early Warning
- NDWC, Thailand has accepted the technical capabilities of AREA and included it in a competitive tender
- World Meteorological Organization (WMO) is testing AREA solution in parts of Africa
- India is installing AREA solution in Disaster prone Coastal regions in 2008

8.2 Challenges of AREA

Though having numbers of advantages, AREA has to face some unique challenges also. Sometimes the control on alert generation and dissemination becomes complex for developing countries like Bangladesh since the system can be distributed over vast geographical area from single source. If the source of alert generation cannot be restricted highly then there is possibility of broadcasting variant alerts from multiple sources and even multiplicity of disaster events. Shifting toward a new system has also proven to be time consuming and tough for a country like Bangladesh where most of the personnel associated to any authority are either hesitant or unwilling to cope with new technologies. The communities also sometimes are unwilling to get out of their conventional practices and accept a new system with ease.

9 Conclusions

AREA can be a model Early Warning Dissemination System for real disaster management situations on a large scale. It has already been successfully tested in field in different nations. The system is also under the process of continuous improvement. There is sufficient scope to modify the system according to the needs of the community and make it compatible to any condition. Revision of warning messages to include more specific information about the intensity, target area; evacuation time etc. would be helpful in this regard. Coordination among the multiple departments and agencies should be set in such a harmony that any confusion regarding the warning dissemination can be solved at the quickest time. Proper training as well as awareness raising programs are necessary for the responsible users or personnel regarding the system so that they can easily adopt and maintain it. Education among the communities through training program can be effective in making people supportive to the new technology. Thus the system is expected to contribute significantly in the overall disaster management situation of the country.

References

- Anderson, P., 2006. Last of the Mile Hazard Warning System (LM-HWS) ICT Assessment and Community Simulation Observation Report. LirneAsia, Colombo, Srilanka.
- Banglapedia, 2009. *Banglapedia: Cox's Bazar District*. banglapedia.net/ht/c-0364.htm [accessed 10.05.2009]
- CPP and BDRCS, 2002. Cyclone Preparedness Program, Bangladesh Red Crescent Society, 2002.
- Rangarajan, S., Soumagne, J., & Vignaud, J-L., 2006. Addressable Radios for Emergency Alert (AREA): A WorldSpace Solution for Effective Delivery of Alerts.
- Saha, R., Imtiaz, A.B.A., Dhar, A.S., Ansary, M.A., Sutradhar, K., Shamim, M., 2008. Disaster Early Warning System for Cox's Bazar: A Report to Comprehensive Disaster Management Programme (CDMP), Ministry of Food and Disaster Management, Government of the People's Republic of Bangladesh; Department of Civil Engineering, Bangladesh University of Engineering and Technology (BUET), Dhaka.
- Uddin, A. M. K. and Yasmin, A., 2005, "District Information-Cox's Bazar", Water Resource Ministry, Water Resource Planning Organization, People's Republic of Bangladesh Government.

RISK MANAGEMENT CHALLENGES IN EL SALVADOR: CASE STUDY OF COMASAGUA AND PUERTO DE LA LIBERTAD

Metzi Aguilar

Res. Altos de Sta. Mónica, poligono "B", senda 4, 74-B, Santa Tecla, El Salvador
+503 22873270, metzi.aguilar@gmail.com

KEYWORDS:

Disaster, Risk Management, basic human rights, NGO, El Salvador, History

ABSTRACT

El Salvador is a country that throughout its history has been exposed to several threats, particularly hurricanes and earthquakes due to its geographical location.

Disasters have been increasing over time due to the adopted economic model and global economic system that: 1) Do not guarantee basic human rights for the majority of the population, forcing populations to occupy unsafe areas for living; 2) Have introduced the mistaken idea of "development" which does not consider the coupling between social and natural systems and in El Salvador it is confirmed by a highly deteriorated environment. Comasagua and Puerto de la Libertad are two municipalities located at the Cordillera del Bálsamo that share a water basin. Comasagua, at a higher altitude, suffers each rainy season mainly landslides while Puerto de la Libertad suffers floods.

Disasters such as hurricane Mitch (1998), Stan (2005) and the two earthquakes in 2001 had devastating effects on this territory and triggered the interest of national and international NGO's whom have now been working there for eight years. The main objective of this paper is to evaluate and to set a discussion of challenges based on the understanding of Risk Management in El Salvador, using the case study of Comasagua and Puerto de la Libertad. These two municipalities have been working since hurricane Stan the field of Risk Management with the contributions of the local NGO Asociación Comunitaria Unida por el Agua y la Agricultura (ACUA) and a spanish NGO Geólogos del Mundo (Word Geologists, in english). ACUA and Geólogos del Mundo contributions include technical recommendations based on the oral history technique, field observation, Geographical Information Systems (GIS). Also, these organizations have supported community processes and have installed an Early Warning System in the water basin.

Limitations for the implementation of recommendations are: 1) The lack of will, capacity and interest of some majors and their team in order to solve the main problems for the communities 2) The welfarism promoted by some NGO which restrains an authentic local organization able to demand basic human rights 3) Some people that are in high risk areas are deep rooted and do not want to leave their home 4) Polarity in politics that affects municipalities and communities organization and 5) Difficulties for mitigation measures due to land ownership. Risk management in this scenario is a complex task for all who participate in this process.

The main challenge for future work is that rural communities, having developed an authentic organization process and being conscious of their basic human rights, coupling with natural systems and disaster history, are able to demand local municipalities based on their own experience and with the support of technical studies.

Key Notes

GLOBALIZATION AND THE INTERNATIONALIZATION OF EDUCATION

A. P. Pradeepkumar^a and F-J. Behr^b

^aDepartment of Geology, University College, Trivandrum, Kerala, India 695 003
geo_pradeep@yahoo.com

^bDepartment of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
franz-josef.behr@hft-stuttgart.de

KEYWORDS:

Education, Distance Learning, Internationalization, GIS, Geoinformatics, Stuttgart University of Applied Sciences, Photogrammetry, Remote Sensing

ABSTRACT

The catch word in education in the era of globalization is “Internationalization”. The key driver in globalization is economics, but the same is not strictly true about internationalization in education. Similar to the scenario in industry and commerce, where globalization means a diverse market, and a consequent enhanced income, internationalization of education has similar connotations.

Nevertheless, akin to globalization, internationalization will ultimately lead to competition and improvement in quality of education and enhanced transfer of skills between nations.

In this paper the state of education and international cooperation in southeast and south Asia are reported. The analysis shows the involvement of countries like Great Britain, Australia, and Russia.

It will be shown that German Universities should be engaged to a greater extent in international education for mutual benefits. Internationalization needs drivers and the foremost of these drivers are alumni networks. The Stuttgart University of Applied Sciences as an example realizes this and wishes to leverage it for the overall development of the University.

It is in this context that the idea of a Foundation for Internationalization of Education (FIE), a non-profit organization to be established jointly by the Stuttgart University of Applied Sciences (SUAS) and the alumni (through Active Alumni Groups) is exemplified mooted. Such a foundation primarily aims to bring about better international understanding of German science and technology excellence and also act as a catalyst for promoting techno-cultural exchanges with other nations, particularly in south Asia, south-east Asia and Africa. The findings are reported from the point of view of geo-scientists, but can be transferred to other fields of work.

WORKSHOP ON FREE AND OPEN SOURCE DESKTOP GIS

Dietrich Schröder

Department of Geomatics, Computer Science and Mathematics, University of Applied Sciences Stuttgart
Schellingstraße 24, D-70174 Stuttgart, Germany
dietrich.schroeder@hft-stuttgart.de

KEY WORDS:

Open Source, gvSIG, GIS, GDI

In recent years, a noticeable number of new Free and Open Source Desktop GIS (FOSGIS) have emerged on the market. As FOSGIS have been widely used in the field of Internet GIS/Web Mapping, this is still not true for desktop GIS. Here the market is still dominated by proprietary products. Even though there is the trend to shift also geo-processing to the Internet, for sophisticated analysis as well as rich clients in a GDI environment, there will be still the necessity for desktop GIS in the future. This holds in particular for many developing countries, where still the availability of broad bandwidth for Internet applications is a problem.

In the workshop, a short overview of the different desktop FOSGIS projects and their status of development will be given. This presentation will be followed by a hands-on workshop; here an introduction to the Software gvSIG will be given. An environmental analysis will be developed together with the participants, so that they will be able to gather their own feelings and impressions on the software.

FUNDAMENTALS AND TECHNIQUES OF SOCIAL NETWORK ANALYSIS

Kai Holschuh

Holschuh Consultants, Bunsenstrasse 8; D-76135 Karlsruhe, Germany; +49 171-8677528
kaiholschuh@yahoo.de

KEYWORDS:

Social Network Analysis, SNA, GIS

Convergent consensus among scientists considers social, economic and financial phenomena can be described by a network of agents and their interactions. Surprisingly, even though the application fields of Social Network Analysis are diverse, those networks often show a common behaviour. Better knowledge of Social Network Analysis can therefore provide insights and skills for practical use in many areas of research and endeavour, in particular ones involving electronic media. In the field of Geographical Information Systems, the building of geospatial data aggregators or geographic communities relies on identifying the dynamics of underlying social networks. In fact, almost any form of GIS intended to be used by the general public should consider the use of SNA to prepare product distribution, respond to user feedback or introduce updates.

Topics covered in this workshop:

- *origins and uses of Social Network Analysis*
- *tools and vocabulary of Social Network Analysis*
- *forms and techniques of interpreting Social Networks*
- *overview of software used in Social Network Analysis*
- *practice session*

OIL AND GAS EXTRACTION IN THE NIGER DELTA REGION OF NIGERIA: THE SOCIAL AND ENVIRONMENTAL CHALLENGES

Osayande Omokaro

Environmental Rights Action/Friends of the Earth Nigeria, eshudep@yahoo.com

ABSTRACT

The large-scale exploitation of petroleum resources from the Niger Delta region of Nigeria has adversely affected the ecological balance of the area and created serious social and economic problems for the local inhabitants. Decades of oil and gas extraction by multinational companies operating in the region has not only resulted in the pollution of the immediate environment, it has also led to the destruction of local sources of livelihoods such as farmlands, fishponds and economic crops.

Between 1976 and 2000 a total of 6,141 environmental accidents recorded from the oil industry in the region resulted in the spillage of approximately 3,019,465.90 barrels of crude oil into the environment. A comparative environmental performance study of three multinational oil companies operating in the Niger Delta also indicated that between 1991 and 2002, 3,544 cases of environmental pollution were reported, resulting in the spillage of 355,809 barrels of crude oil into the Niger Delta environment. Out of these incidents, production factors were responsible for 41.6%, sabotage/theft accounted for 35% followed by corrosion 19.9%. Other operational factors accounted for 1.7%, engineering related factors accounted for 0.4% and drilling contributed 0.4% of the oil spillages. Gas flaring has also been another environmental challenge associated with the Nigerian oil industry. Cases of acid rain have been reported and available data have shown that gas flaring in the Niger Delta is contributing significantly to global warming and climate change. Between 1997 and 2001 an average of 44% of associated gas produced in the oil fields of the Niger Delta was flared into the atmosphere

This paper examines the social and environmental problems associated with oil and gas extraction in the Niger Delta region of Nigeria as well as the poverty and conflict situation occasioned by the exploration of crude oil in Nigeria.

The paper also makes some recommendations concerning how to resolve the various problems currently bedeviling the people of the region.

UNIFORM GEO-DATA INFRASTRUCTURES (GDI) CHALLENGES FOR THE INFORMATION SOCIETY

Matthias Moeller

University of Bamberg, Austrian Academy of Sciences, matthias.moeller@sbg.ac.at

ABSTRACT

The access to information is an essential asset for our information society. Especially geoinformation nowadays is necessary for almost every action we undertake. The general public needs access to valid geo-information. This geo-information has to be provided through a network of services and data providers and is delivered to the consumer through an infrastructure that guarantees the access anytime and anywhere.

The talk will first differentiate between the data and the network as the basic components of GDI. In a second part the author will focus on different geo-spatial services and the acquisition of geo-information in real time from distributed locations. Finally he will face the differences in GDI between Western, industrialized countries with a well established networking infrastructure and those countries with a low GDP. We have to consider geo-data quality, data completeness and data acquisition. Recently started data collection services like the "Open Streetmap" (OSM) project may lead to more reliable geo-information which is available for free.

This talk will focus on the main challenges for the design of a unique GDI and it will address the problems especially in less developed countries. Using his practical experiences, the author will demonstrate the actual lacks and he will outline possible solutions to create and manage future uniform GDI all over the world.