Nepalese Journal on Geoinformatics

Number : 8

Jestha 2066 BS
May - June 2009 AD

Annual publication of Survey Department, Government of Nepal

Published by
Government of Nepal
Ministry of Land Reform and Management
Survey Department
Min Bhawan, Kathmandu,
Nepal

Price : Rs 100

No. of copies : 500

Nepalese Journal

on

GEOINFORMATICS

Jestha 2066, May-June 2009
Number 8

Product Price

The front cover
GPS observation on the bridge of Narayani river.

Features

Contents

Contents

Editorial

In an attempt to disseminate information, Journal is one of the effective media. Survey Department started to publish Nepalese Journal on Geoinformatics as annual publication since 2002 A.D. and the 8th issue is in your hand. We are trying to improve the content and quality of the Journal as it is getting older. In this issue, we added a new column: Professional Organization page which is allocated to each professional organization of Geoinformatics to incorporate their relevant information. At present, we could able to include only Nepal Surveyor's Association (NESA), Nepal Remote Sensing and Photogrammetric Society (NRSPS) and Nepal Geographic Information System Society (NGISS). The door is open to other such professional organizations for sharing their views with us. We hope that this will facilitate readers to know something more about the activities of the organization. Furthermore there could be a number of areas to improve so we request the readers to point out and suggest for improvement.

Durgendra Man Kayastha Advisory Council member provided an article titled Relationships among Spatial Objects Embedded in a Plane as special contribution for this issue. So I would like to express sincere thanks to him for his efforts.

All the journal published so far are available in the website www.dos.gov.np. We hope this provision will facilitate to all the readers specially students and researchers for updating the knowledge in the field of Geoinformatics.

I would like to express sincere gratitude to Rabin Kaji Sharma, in coming Chairperson of the Advisory Council for his valuable suggestions. Similarly I would like to express my sincere appreciations to all the authors, members of the Advisory Council, members of the Editorial Board and to all who contributed towards the publication of this issue.

Finally the Editorial Board hopes appropriate direction from the newly formed Advisory Council of the Journal in future.

June 2008 — *Jagat Raj Paudel*

Kathmandu — *Editor-in-chief*

Message from Director General; Survey Department

If we distribute the sacks of rice from a rice store continuously without any replacement, the store will get empty in one day whereas if we go on distributing knowledge it will never dried up. Journal is one of the means for sharing information and increasing knowledge in the related field. Nepalese Journal on Geoinformatics (NJG) is one of the publications of Survey Department and is beeing published annually in the month of Jestha (May-June) to create awareness in the applications of Geoinformatics for national development activities to the decision makers and user communities by including different information related to Geo- information Science.

For your kind information, I was Editor-in-Chief from first to fifth issue of NJG and now I am fortunate to be the Chairperson of the Advisory Council for the eighth issue. When I compare first issue with this issue of the NJG, I am pleased to notice that there is a substantial improvement in its outlook and quality. We are always looking forward for improving its contents, quality and standard to satisfy our esteemed readers of the journal. Hence we heartily invite our readers to feed us with their comments, critics and suggestions and standard articles for improving the status of the journal.

In the present context of building new Nepal, Survey Department needs to add new dimension to its activities. These could be: implementation of Digital Cadastre, development of 3D Cadastre system, determination of Geoid, adoption of mechanism for continuously updating the National Topographic Database, publication of National Atlas and widening the scope of National Geographic Information Infrastructure Programme to accommodate maximum number of stakeholders of its net. The outcomes from these activities will definitely support for national development.

As per the article 11(e) of Land (Survey and Measurement) Act 2056, Survey Department issued, first time in its history, the surveyor's license to the eligible candidates of the surveying and mapping professionals. This event is one of the mile stones of the Department. In this context, the license holder professionals formed Nepal Institution of Chartered Surveyors (NICS) to foster the Chartered Surveyors, to create homogeneity in their performance and to protect and expand their professional rights and welfare. Thus the Department believes that the NJG could play a role to increase knowledge in the field of Geoinformatics to the license holder survey professionals for delivering efficient service to their clients.

Finally, I would like to express thanks to all the Advisory Council members and Editorial Board members for their devotions and would like to extend appreciations to all the author of the articles published in this issue for their contributions.

Jestha 2066 *Rabin K. Sharma*

Applications of open source software in land administration: An initiation with land administration education

Ganesh Prasad Bhatta
Chief Survey Officer, Survey Department, Government of Nepal
Currently: M.Sc. (Land Administration) Student
International Institute for Geoinformation Science and Earth Observations, ITC
The Netherlands bhatta07954@itc.nl

Keywords

Land Administration Systems, Open Source Software, ILWIS, PostgreSQL, PostGIS, uDig

Abstract

The LA System in Nepal is quite traditional. The government has realized the need of modernizing the system and some positive efforts are underway at the moment. Introduction of Geo-ICT in the business system is one of the main objectives of these efforts.

Capacity building is an essential aspect to be considered before introducing modernisation in the system. Some efforts are underway in this aspect such as human resource development through Geomatic Education in the country. Recently, Kathmandu University (KU) has introduced a bachelor's degree level course in Geomatics Engineering, i.e. Bachelor's of Engineering (B.E.) on Geomatics, as a collaborative program with Land Management Training Center (LMTC). This new initiative would include Geo-ICT based land administration education. Application of Open Source Software (OSS) for the education could be a better choice for KU and LMTC to exploit all possible functionalities of the OSS in developing / supporting a Geo-ICT based land administration education

With this ground, the author carried out a study to overview the possibilities with Open Source Software (OSS) to apply for land administration in Nepal. The paper is developed out of the study.

1. Introduction

Advancement in Geo-Information and Communication Technology (Geo-ICT) offers an opportunity to make land administration efficient and effective. However, not all land administration organizations have been able to introduce its full applications in their daily business work, especially those of developing countries like Nepal, where traditional way of business process is still in practice. Introduction of Geo-ICT needs appropriate infrastructure, resources and capacities. If the case of Nepal is taken into account, land administration organizations in the country are lacking ICT, more specifically Geo-ICT, oriented human resources/capacities. Such limitations with land administration organization in the country have weakened its capacity to align the technological advancement with business strategy.

Some efforts are underway for human resource development through Geomatic Education in the country. Land Management Training Center (LMTC) is a governmental body (under the Ministry of Land Reform and Management) to conduct training courses on surveying, mapping and land administration/management. Recently, Kathmandu University (KU) has started bachelor's degree level course on Geomatics Engineering, i.e. Bachelor's of Engineering (B.E.) on Geomatics, as a collaborative program with LMTC. This new initiative would include Geo-ICT based land administration education. Application of Open Source Software (OSS) for the education could be a better choice for KU and LMTC to exploit all possible functionalities of the OSS in developing / supporting a Geo-ICT based land administration education.

This paper has overviewed the possibility of application of OSS, such as ILWIS, and PostgreSQL / PostGIS / uDig in Land Administration for the purpose of teaching at BE Geomatic Engineering.

2. Land Administration in Nepal

This section begins with referencing some definitions on Land Administration (LA) being adopted from (Enemark and Molen, 2008). FAO defines LA as "'the way in which the rules of land tenure are applied and made operational". It comprises an extensive range of systems and processes to administer the holding of rights to land (allocation, delimitation, transfer, disputes), economic aspects of land (gathering revenues valuation, disputes), and Control of land use (regulation, land use planning, disputes). In the UN/ECE Land Administration Guidelines (1996) LA is defined as the "process of determining, recording and disseminating information about the ownership, value and use of land when implementing land management policies". Dale & McLaughlin (1999) define the same as "the processes of regulating land and property development and the use and conservation of the land, the gathering of revenues from the land through sales, leasing, and taxation, and the resolving of conflicts concerning the ownership and use of land".

LA in Nepal is found somewhere around the above mentioned definitions, with some limitations in its operational part. Historical documents reveal that the LA in Nepal is as old as the human civilization, starting from Vedic period. The ancient LA was undertaken only for the purpose of revenue collection to support state affairs by then rulers (Khanal, 2006). Evolution and changes in state affairs gradually came up with changes in the scope and importance of LA. By now, revenue collection remains only a part of LA processes in the country.

LA system in Nepal is largely traditional. The system keeps parcel based information, spatial as well as attribute, on land in analogue form. Efforts have been made to practice the system in the line to meet most of the contents of the UN/ECE Land Administration Guidelines (1996), according to which a good land administration system guarantees ownership and security of tenure, supports land and property taxation, provides security for credit, develops and monitor land markets, protects State lands, reduces land disputes, facilitates land reform, improves urban planning and infrastructure development, supports environmental management, and produce statistical data. However, the result is not at a satisfactory level, even unsupportive sometimes. The traditional way of keeping land records, spatial as well as attribute, has diminished the reliability of information, land disputes are pretty common and land registries are overwhelmed with associated problems[1]. Despite the government's efforts on modernizing the LA Systems since 1990, the system is still waiting for its application in operational level. Efforts on building land information system (LIS) throughout the country are underway through digital archiving of land records, which is performed by scanning the cadastral maps and computerizing the attribute information. The LA system is challenging the statement from (Pieper, 2007); no digital LA System can ever said to be complete, having even not introduced the digital system into it as of the date. Application of Geo-ICT in this sector is still awaited fact for the country, which would probably enhance the efficiency and effectiveness of LA System for the betterment of the societies.

However, the government of Nepal is making its best effort to modernize the LA system. As the most recent effort is an initiation of a project entitled "Nepal: Strengthening Land Administration Services" with the technical assistance from Asian Development Bank (ADB). As per (ADB, 2007), the outcome of the project will be a more reliable, fair, and sustainable land administration and management process made possible by modernizing and improving business processes and developing a road map for a national comprehensive land policy. This outcome is expected to increase the effectiveness of the land administration system and, in the long term, improve social justice and the rights of the poor. The key outputs from the project will be (i) a revised business process; (ii) a strategy for the future with the use of technology in land administration; (iii) accessible, secure, and upgraded land records; (iv) an action plan and costing to implement the strategy; (v) pilot testing of the strategy in selected areas within districts; and (vi) a road map toward a comprehensive national land policy framework. It can be assumed that the modernization of the LA system in the country at present is in the state of 'wait and see' the outcomes of the project and the future beyond it.

3. Business Strategy versus Technology

Ministry of Land Reform and Management (MoLRM), Government of Nepal (GoN), is the ministry responsible for core business on land management and administration including surveying and mapping in Nepal. GoN has mandated the ministry the tasks of formulating plans, policies, and regulations for land administration and management activities in the country including their monitoring and evaluation, conducting land reform activities like distribution of lands as per the government's decisions, looking after overall land registration activities, looking after overall surveying and mapping activities and other activities of land administration and management as and when necessary. The mission of the ministry is to support good governance, social justice, environmental protection, improved productivity of land, poverty

1 www.molrm.gov.np/dept_lia.php

reduction and sustainable development through proper land management and administration. The ministry mentions its main objectives as to prepare policies and plan for overall land administration and management activities including surveying and mapping, to implement land related laws, acts and regulations regarding land administration, management and surveying and mapping activities in the country, to develop a modernized land ownership record system, to conduct activities for capacity building in its core sector, to develop LIS as well as Geographic Information System (GIS) essential for overall development of the nation, to carryout the activities of land reform and land development, to promote National Spatial Data Infrastructure (NSDI) in the country and to carryout other activities of land administration and management in the country.[2]

An explicit documentation on the business strategy of land administration in Nepal could not be found. However, an abstraction has been made out of above mentioned functions, mission and objectives of MoLRM, and current socio-economic and political situation of the country. Beforehand, it must be kept in mind that the country is in dramatic political transformation in recent years after a decade long inland violent conflict and implementation of an adequate land reform program, what the politicians term as progressive land reform program, is the national agenda at present. Very recently a Land Reform Commission has been constituted to deal with the matters concerning land reform.

Thus, the business strategy of land administration can be listed out as follows:

- Implement an adequate land reform program to assure justifiable access to land and land resources for all
- Support the government in establishing good governance and sustainable development
- Assure security of tenure
- Manage public and government lands effectively
- Implement proper land use plan
- Establish well functioning NSDI
- Develop institutional capacity in the sector of cadastre, land administration and management
- Empower local bodies in land administration and management sector

Unless adequately supported by the technology, effective and efficient implementation of business strategies cannot be expected. Unfortunately, the LA system of Nepal has various deficiencies, such as analogue system, lacking reliable land information, lacking necessary capacity to introduce modern technology such as Geo-ICT, lack of necessary infrastructure for building LIS, lack of ICT policy in LA domain, etc. Therefore, it can be concluded that the technological advancement in LA domain has not been adopted yet and the strategic alignment of business strategy with technology is not satisfactory.

The government's willingness to modernize the LA system as mentioned in previous section and opportunities available with Geo-ICT in the market can be integrated to align the business strategy with technological advancement. However, the job is not easy. Nationwide coverage of reliable land information supported by LIS, comprehensive land policy, and adequate capacity to make the system sustainable are the prerequisites for the success. The first two components are more or less based on capacity of the organisation. Capacity is the power/ability of something – a system, an organisation or a person to perform and produce properly. On the other words, capacity building has three levels: the broader system/societal level, the entity/organisation level, and the group of people/individual level (Enemark and Williamson, 2003). In the context of Nepal, the initiative from the third level of capacity building, i.e. capacity building of professional (an individual) is a must to modernize the system, which is of big challenge. A recent initiation of B.E. on Geomatics jointly by LMTC and KU is a positive step towards inland capacity building. The initiation brings an opportunity to introduce ICT based Geomatic education, more specifically LA education. However, the question again remains whether the availability of ICT infrastructure feasible or not for the education as well as its sustainable future while implementing in real life. One of the major components of ICT infrastructure is software component, which requires lots of investment, if proprietary software are used. Making use of proprietary software may not be feasible always for the days to come. Therefore, as the open source movement has attracted world-wide attention, and OSS is increasingly used as an alternative to proprietary software products (Pieper, 2007), the opportunity could be grabbed for Nepal as well.

4. Global Initiatives for OSS Applications

The free software movement was launched in 1983. In 1998, a group of individuals advocated that the term free software be replaced by OSS as an expression which is less ambiguous and more comfortable for the corporate world[3]. The Open source communities have successfully developed a great deal of software that has gained a

2 Summarized from (www.molrm.gov.np)

3 http://en.wikipedia.org/wiki/Open_source_software reputation for reliability, efficiency, functionality. But it is not free from a perception that OSS is less usable (Nichols and Michael, 2003). On the other hand, OSS tools have a reputation that they are difficult to install, run only on Unix-like operating systems and can be operated only through the command line. However, recent developments show that most OSS products are becoming more user-friendly, with Windows installers and graphic user interfaces (GUI) similar to proprietary software (Pieper, 2007). PostgreSQL, PostGIS, uDig and ILWIS are some of such examples. The major advantages of OSS over proprietary software are that it frees organizations from financial burden of license costs, and it can be customized to meet the organizational requirements.

Efforts are underway to exploit such opportunities available with OSS in LA domain as well. A project, Free/Libre Open Source Software (FLOSS) Project for Cadastre and Land Registration, funded by the Food and Agriculture Organisation (FAO) of United Nations (UN), in this endeavor has been referred for this study. A FAO-FLOSS Seminar Report[4] mentions several land administration projects in developing countries sponsored by the FAO in the past have failed, often due to high software licensing costs and inadequate information technology systems. Despite these failures, IT holds great promise for land administration systems, but only when introduced in a sustainable way. Such a situation motivated the Land Tenure Group of the FAO for the initiative to this FLOSS Project for Cadastre and Land Registration. The conceptual design of the project is termed as OSCAR (Open Source Cadastre and Registry) tool. As the intention behind the project is to develop a FLOSS tool taking the situation of developing countries into account, it is a point of motivation for the author to carryout a general overview on the possibility of OSS for LA system in Nepal, basically to introduce Geo-ICT in LA domain in a sustainable way.

5. OSS Application for Land Administration Education in Nepal

The main aim of the study is to overview of the possibility of OSS for LA education, which would, indeed, contribute in developing an effective LA system for implementation in real life. Therefore, the possibilities have been looked in teaching point of view. The study has been carried out in two phases; the first phase looked into the possibilities with ILIWIS, where as the second phase looked into the possibilities with a combination of PostgreSQL, PostGIS and uDig.

4 Free/Libre Open Source Cadastre and Land Registration Shell Seminar (FAO-FLOSS Seminar) May 8th – 9th, 2008University of Otago, Dunedin, New Zealand

ILWIS (Integrated Land and Water Information System) is an OSS developed by International Geoinformation Science and Earth Observations, ITC, the Netherlands. It is a Geographic Information System (GIS) package with image processing capabilities. Its powerful image processing functions make it a highly useful tool for natural resources management and for organizations that need to process orthophotos or satellite imagery for base mapping (Pieper, 2007). Therefore, it has been overviewed with its possibilities for land use mapping.

PostgreSQL is a powerful, open source relational database system. It has more than 15 years of active development and a proven architecture that has earned it a strong reputation for reliability, data integrity, and correctness. It runs on all major operating systems, including Linux, UNIX, and Windows. It has full support for foreign keys, joins, views, triggers, and stored procedures (in multiple languages). It also supports storage of binary large objects, including pictures, sounds, or video. An enterprise class database, PostgreSQL boasts sophisticated features such as Multi-Version Concurrency Control (MVCC), point in time recovery, tablespaces, asynchronous replication, nested transactions (savepoints), online/hot backups, a sophisticated query planner/optimizer, and write ahead logging for fault tolerance. It supports international character sets, multibyte character encodings, Unicode, and it is locale-aware for sorting, case-sensitivity, and formatting. It is highly scalable both in the sheer quantity of data it can manage and in the number of concurrent users it can accommodate. There are active PostgreSQL systems in production environments that manage in excess of 4 terabytes of data.[5] Research shows that when comparing PostgreSQL versus proprietary database software (MS SQL Server and Oracle), the FLOSS products are not far off from the proprietary ones and can truly compete. When comparing the software installations, it appears that PostgreSQL is easier and faster to install than Oracle. PostgreSQL includes most of the advanced database features that Oracle has (Pieper, 2007).

PostGIS adds support for geographic objects to the PostgreSQL. In effect, PostGIS "spatially enables" the PostgreSQL server, allowing it to be used as a backend spatial database for geographic information systems (GIS), much like ESRI's SDE or Oracle's Spatial extension. PostGIS follows the OpenGIS "Simple Features Specification for SQL" and has been certified as compliant with the "Types and Functions" profile. PostGIS has been developed by Refractions Research as a project in open source spatial database technology. It has been added with

5 http://www.postgresql.org/about/

user interface tools, basic topology support, data validation, coordinate transformation, programming APIs and much more.[6] As repository for spatial data, PostgreSQL with PostGIS comes closer to the sophistication of Oracle Spatial than MySQL (Pieper, 2007).

User-friendly Desktop Internet GIS (uDIG) is developed by Canadian-based Refractions Research, the same company that is taking the lead in the development of PostGIS.[7] Compared to other FLOSS GIS products, uDIG lacks quite a few options that are normally expected in a GIS such as buffering or calculating the area of a polygon (Pieper, 2007). It supports vector formats like shapefiles, and raster formats like TIFF, JPG, GIF.

has been referenced in this phase, which focuses on using PostgreSQL with PostGIS as a spatially-enabled database backend, with a platform based on uDig for developing graphical tools that interact with the database. Of particular interest is how to implement these in a way that enables the capture of events and process as changes occur in a cadastral database, while being flexible for supporting variations in land administration processes in different countries or jurisdictions. The underlying model for this approach focuses on several core elements, which can be primarily generalized into agents, documents, events, and objects[8]. The design developed out of the project can be expected of potential application in Nepalese case.

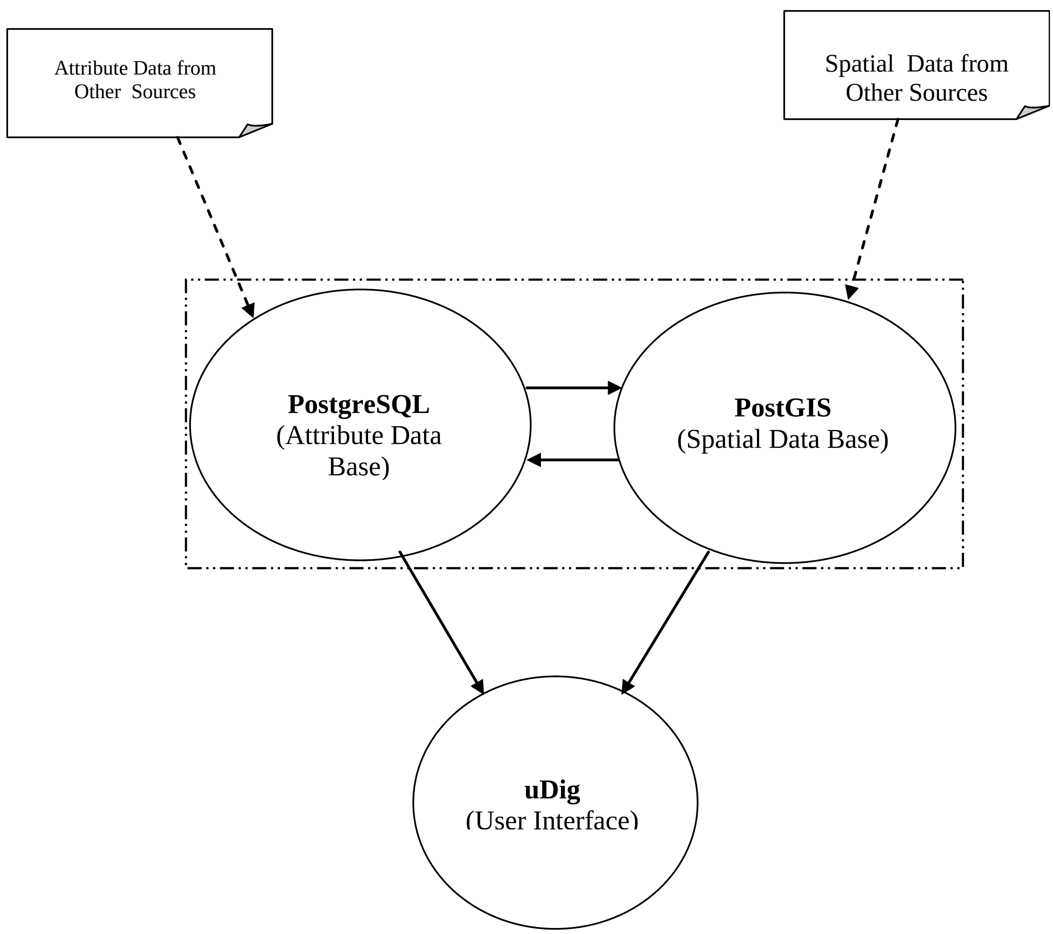


Figure 1: Combination of PostgreSQL, PostGIS and uDig

The possibilities with the combination of above mentioned PostgreSQL, PostGIS and uDig for LA systems have been overviewed during the second phase of the study. The approach proposed in the OSCAR Project Wiki for applying open source tools for OSCAR

6 *http://postgis.refractions.net/*
7 *http://udig.refractions.net/*
8 *http://source.otago.ac.nz/oscar/OSCAR_Home*

6. Conclusion

The LA System in Nepal is quite traditional. Despite the government's initiation to modernize the system since 1990, it is still not able to exploit the opportunities offered by Geo-ICT for their daily business work. As a result, the system is not able to fully cope with the business strategy of the government. The government has realized the need of modernizing the system and some positive efforts are underway at the moment. Introduction of Geo-ICT in the business system is one of the main objectives of these efforts. If we consider the sustainability of the system, financial requirements can be of prime importance for the future. In this respect, making use of proprietary software may not be feasible always for the days to come. Therefore, as the open source movement has attracted world-wide attention, and OSS is increasingly used as an alternative to proprietary software products (Pieper, 2007). This idea has been considered for the capacity building of the professionals.

A recent initiation of B.E. on Geomatics jointly by LMTC and KU is a positive step towards inland capacity building. The initiation brings an opportunity to introduce Geo-ICT based Geomatic education, more specifically LA education. It has been assumed that application of OSS for LA education at LMTC and KU would be a better choice for this endeavor. With this assumption, possibilities with ILWIS and combination of PostgreSQL, PostGIS and uDig have been overviewed. ILWIS has been overviewed for its application in Land Use Mapping and the latter for LA systems.

References

1. *ADB (Asian Development Bank), 2007*; Nepal: Strengthening Land Administration Services, a Technical Assistance Report
2. *Enemark, S. and Molen P., 2008;* Capacity Assessment in Land Administration (FIG Publication No. 41)
3. *Enemark, S. and Williamson, I., 2003*, Capacity Building in Land Administration – Conceptual Approach
4. *Khanal, G.R., 2006*; Redesigning and Optimization with Workflow Management System for Land Administration Processes in Nepal, an IFA report, ITC, The Netherlands
5. *Nichols, D.M., Michael B.T., 2003*; The Usability of Open Source Software (http://firstmonday.org/issues/issue8_1/nichols/index.html)
6. *Pieper, G., 2007*; Scoping Paper on the Use of FLOSS in Cadastre and Land Registration Applications (Open for Change: FAO Land Tenure and Management Unit (NRLA), FIG Commission 7, World Bank Thematic Group on Land Administration)
7. *UN/ECE, 1996;* Land Administration Guidelines, With Special Reference to Countries in Transition, New York and Geneva
8. *Wheeler, D. A., 2003*; Why Open Source Software / Free Software (OSS/FS)? Look at the Numbers!, United States

Development of educational courses on space science technology in Nepal

Krishna Raj Adhikary
Executive Director
Land Management Training Centre
Ministry of Land Reform and Management
Government of Nepal
Email: krishna_adhikary@hotmail.com

Keywords

Space Science, Geomatics, Atmospheric science, Remote Sensing, satellite communication, Global climate, modules, image processing

Abstract

Space science and Geomatics education in Nepal is recently started on some of the training institution and university of Nepal. Preliminary subjects required for space science and technology have been introduced into science curricula at the higher secondary level of the Nepalese's school, however the benefit of space science and technology have not been appreciated enough. Facilities and resources of teaching science and technology at educational institutions are not yet developed. Attempts have been made to incorporate the elements of space science and technology into undergraduate level of education of the university.

This paper start with the discussion on the space science education in Nepal at the school and college level and mainly focus on initiation taken by the training institution and university of Nepal to introduce the subjects of space science and technology at their curriculum on geomatics engineering and other engineering education. Some recommendation have been made to introduce the different type of educational courses and/or training on space science and technology, which will meet the needs of development to built a general capability in space science as a necessary support for infrastructure development of Nepal and consequently will help to promote the educational activities on space science education in the country.

1. Introduction

Nepal, a sovereign independent Country, is bounded on the north by the Tibetan Autonomous Region of the People's Republic of China, and on the east, south and west by India. The total area of the country is 147181 sq km. The length is 885 Km in east west and breadth varies from 145-241 Km north south. The country can be divided into three broad geographic regions, High Himalayan, Mountainous and Plane region. The country has 5 administrative regions, 14 zones and 75 districts. Population of Nepal as per Census 2001 is 23 million. Land is the only immovable property which can be used as a means for agriculture production as well as a means for financing industrial or commercial enterprises. Space science and technology plays an important role in managing our land, water resources and natural resources. Recently the advancement in space science and technology has given the opportunities for extraction and analysis of required information for the development of day to day activities of all the sectors of the government and private business. Governmental organizations, non governmental organizations (NGO), international non-governmental organization (INGO), private consultants and universities are using space science and technology in the fields of education, agriculture, land management, forestry, bio-diversity, tourism, health medicine and research & development etc.

Space science and technology could address to resolve the major issues such as population growth, environmental degradation, resources management, poverty reduction, urbanization etc. Now a days many sensors are available, which produce the image having resolution from 0.6m up to 90m. The sensor like IKONOS has 1m. Image resolution, Quick Bird has 0.6m image resolution whereas Land Sat has 30 m resolution and thus, for cadastral use Quick Bird / IKONOS image is applicable for high accuracy. Similarly The Global positioning system(GPS) could be used for strengthening Geodetic network, densification of control network, international boundary surveys and helping on various measures for prediction, mitigation and management of disasters by earthquake, avalanche, landslides, floods etc. which occurs very often in Nepal. Thus the space science and technology is very much useful for post earthquake detection, environmental preservation, mapping to create digital maps, to formulate spatial analysis, to detect damage area of disasters etc. However, due to lack of technical expertise, proper higher education in the field of space science and technology, financial support etc. organizations have not been able to realize their full growth and application potential of space science and technology.

2. Education and Awareness in Space science Technology in Nepal:

Space science and technology education is pursued into science curricula in Nepal at the school level. However, schools are not well developed and the challenges are of a higher magnitude. Various governmental and non governmental organizations, institution and universities are involved to organize the education and awareness program in space science and technology in Nepal . Besides these, Nepalese students get higher education in the different universities and institution of the developed/ developing nations of the world in the field of space science and technology. The general problem confronting space science education is the inability of students to see or experiences the phenomenon being taught, which often lead to an inability to learn basic principles and to see the relationship between the concepts and their practical relevance to problems in real life. In addition to this there are also the language problems where science is not taught in their native language and consider as the difficult subject and also there are not enough academically and professionally well trained teachers.

3. Educational courses on Space science technology

Due to increase in population there is a large pressure on the natural resources and widespread concerns about the quality of the environment, ranging from the consequences of climate change, food security, loss of biodiversity, management & mitigation of natural disaster, the occurrence of wide spread and persistent poverty, poor education & health care facilities and poor physical & communication etc, which will meet the needs of development to built a general capability in space science as a necessary support for infrastructure development of Nepal. Against these, back ground development of various educational courses on space sciences and technology is urgently needed in Nepal and thus three course related to space science have been developed on the basis of the education curricula developed by the united nation office of the outer space affairs and the courses are suitable according to the situation of the Asian countries.

The main objective of all the proposed courses is to meet the need of the country to build a general capability in space science as a necessary support for infrastructure development of Nepal. The required minimum qualification for all the courses to study these courses should have the qualification of the Physical science or Engineering Bachelor degree. The duration of the courses is of one year and the teaching method includes the lecture, Tutorials, Practical, Exercise, Seminars etc. After completion of these courses student will get the degree of post graduate diploma.

3.1 Geomatics engineering and Basic Space science

Research and education in astronomy and astrophysics was carried out in many universities and astronomical community has long shown leadership in creating international collaboration and cooperation. Basic space science course is included on the curriculum of the Bachelor of Geomatics Engineering and already implemented. (Curriculum B.E. Geomatics KU/LMTC, 2007)

3.2 Proposed courses on various subjects on space science

Space science and technology is related with the various activities and some of the course structure have been designed and proposed for the implementation. (Adhikary, K.R, ACRS 2008 Sri Lanka, Colombo). Space and atmospheric science, space science & satellite communication, and Satellite meteorology, global climate & remote sensing are the major activities to be address for the development of space science activities in any country.

3.2.1 Course structure of Space and atmospheric science

3.2.1.1 Theory

Module 1: Structure, Composition and Dynamics of planetary atmosphere (Basic concept, dynamics of earth atmosphere, solar radiation and its effect and atmosphere of planet/satellite)

Module 2: Ionosphere Physics (Structure and variability of the earth's ionosphere, ionosphere measurement techniques, plasma dynamics, airglow ionosphere of other planets/ satellites)

Module 3: Solar wind, Magnetosphere and Space weather (Elements of solar physics, magnetic field of earth and planets, magnetosphere space weather, measurement techniques)

Module 4: Astronomy and Astral physics (Introduction, instruments, observation techniques, star galaxies, high energy astronomy, radio astronomy)

Module 5: Spacecraft design, Construction and launch

3.2.2 Practical

Module 1: Ionosphere sounding, Surface monitoring of ozone

Module 2: Optical imaging of plasma depletions, Photometry of binary star

Module 3: Interferometer study of planetary, Mass of suspended particles

Module 4: Optical depth measurement, modeling experiment,

Module 5: Study of solar spectrum

3.2.3 Seminar and Project

Student should have to present one seminar in each of the five theory topics and a pilot project need to be done by the student.

3.2.4 Evaluation

Examination will be carried out regularly to evaluate each student with the allocated marks and grading will be given according to their grade points .The total marks of 1000 are allocated as:

1. Examination (written)	400
2. Class test	100
3. Experiments	200
4. Seminar	100
5. Pilot Project	200

3.3 Course structure of Space science and Satellite communication

3.3.1 Theory

Module 1: Communication system (Telecommunication ,information theory, modulation, code, microwave, optical communication, networking ,protocols, discrete & continuous time signals, z-transformation, discrete Fourier transform and computation, filter, digital signal processing)

Module 2: Satellite communication system (introduction ,Satellite orbit, Satellite configuration, lunching of satellite, space environment ,reliability satellite communication links, frequency band for communication ,Electro magnetic interference EMI, Electro magnetic compatibility EMC, Radio frequency interference RFI)

Module 3: Planning and Earth station technology (network planning, space segment, ground segmentation, control, management of operation, coordination, space law, financial aspect, network op Introduction, earth station sub system, design &fabrication, earth station standards, reliability, operation and maintenance)

Module 4: Transmission and broadcasting (analogue/ digital modulation, forward -error correction coding, spread-spectrum ,multiple access, digital television, TV, internet protocol, satellite news gathering, radio networking, multimedia, video conferencing)

Module 5: Application and operation(satellite communications services, VSAT network, data collection system, search and rescue system, mobile & personnel communication, satellite navigation, multimedia, internet, fixed satellite, mobile satellite, broadcast satellite, multimedia broadcast service, operational communicational satellite systems, international regulation)

3.3.2 Practical

Module 1: Simulation and hardware experiments, demonstration

Module 2: Link parameter calculation, orbit and foot print simulation,

Module 3: Transmit/receive terminal, TV and IP terminal

3.3.3 Seminar and Project

Student should have to present one seminar in each of the five theory topics and a pilot project need to be done by the student.

3.4 Course structure of Satellite meteorology, global climate and remote sensing

3.4.1 Theory

Module 1 Fundamental of meteorology, climatology and remote sensing (Introduction, Basic concept, meteorological satellite orbit, instrumentation and data products, satellite imagery, digital image processing, use of satellite imagery in meteorology and weather forecasting)

Module 2: Parameter retrieval and Application (Radiative transfer, and parameter retrieval, application using digital satellite data, application in oceanography, satellite data assi and numerical model, climate s environment issues, parameter retrie modeling)

Module 3: Principles of remote sensing (Intro history, evolution, electro magnetic r Spectrum, spectral characteristic o vegetation, soil and water, remote platform, sensor and ground system interpretation, photographic interpret

Module 4: Digital image processing (overview of programming language, statistical concept, ground data, preprocessing and post processing of digital image processing, radiometric, atmospheric, and geometric correction ,image enhancement, filtering, classification, image fusion ,image segmentation, transformation ,image analysis, projection)

Module 5: Numerical models and global climate (regional and global model, concept of data assimilation, satellite data assimilation, climate change ,greenhouse effect, global warming, anthropogenic effects, impact on climate change, environmental protocol, disaster management)

3.4.2 Practical

Module 1: Operational metrological satellite data handling

Module 2 Parameter retrieval modeling

Module 3 Image processing and interpretation

3.4.3 Seminar and Project

Student should have to present one seminar in each of the five theory topics and a pilot project need to be done by the student.

4. Recommendation

Curriculum of the proposed three different courses of post graduate level on the space & atmospheric science, space science & satellite communication, and satellite meteorology, global climate & remote sensing will meet the need of development to build a general capability in space science as a necessary support for infrastructure development of the developing country. The curriculum could be modified depending upon the availability of the equipment to be used for the module of practical purposes of the concerned institution or university. This proposed curriculum will be very beneficial on the effective use of space science by all the educational institution and

Nepal Curriculum B.E.
7

irs ST/SPACE/15 Satellite
ate education curriculum

irs ST/SPACE/16 Satellite communication education curriculum United Nation 2003

4. *Office of the outer space affairs ST/SPACE/17 Space and atmospheric science education curriculum United Nation 2003*
5. *Office of the outer space affairs ST/SPACE/18 Remote sensing and the Geographic information education curriculum United Nation 2003*

2008-2009 at a glance

1. Survey Goswaras dissolved

As per the decision of the Government of Nepal on 13th February 2009 the Survey Goswaras are dissolved and merged to Survey offices. Now the Survey offices are classified into five categories. Survey office lying on category "ka" and "kha" are responsible for Surveying and mapping and updating where as the Survey offices lying on categories "Ga", "Gha" and "Na" are responsible for updating only. The Survey office and the different categories are as follows.

Category "Ka"
Dillibazar, Parsa, Banke, Rupndehi, Kailali, Sarlahi, Jhapa Kaski, Biratnagar.

Category "Kha"
Lalitpur, Bhaktpur, Chabahil, Kalanki, Sunsari, Saptari, Siraha, Dhanusha, Mahottari, Rautahat, Bara, Chitawan, Makawanpur, Nawalparasi, Kapilbastu, Dang, Bardiya, Kanchanpur.

Category "Ga"
Kawashoti, Lahan, Belbari, Damak, Tikapur, Udayapur, Kavre, Surkhet, Tanahuh, Doti, Dhankuta, Shyanga, Palpa, Ilam, Dhading, Nuwakot, Sindhupalchok, Parbat.

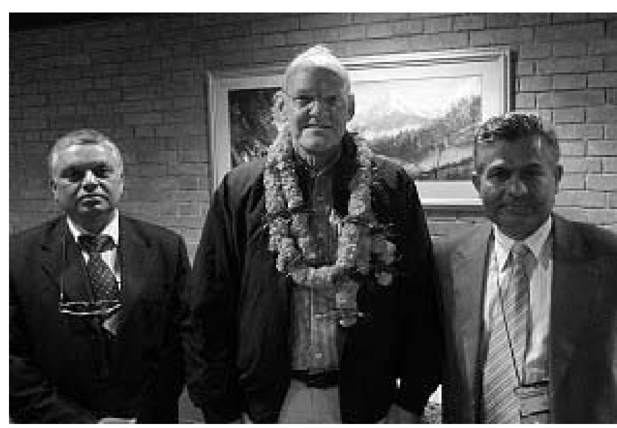
Category "Gha"
Baglung, Sindhuli, Gulmi, Arghakhanchi, Dailekh, Salyan, Pyuthan, Baitadi, Dadeldhura, Dolakha, Ramechhap, Gorkha, Lamjung.

Category "Na"
Myagdi, Bhojpur, Panchthar, Solukhumbu, Khotang, Okhaldhunga, Khandbari, Chainpur, Rukum, Rolpa, Taplejung, Tehrathum, Darchula, Bajhang, Rasuwa, Jajarkot, Achham, Mustang, Manang, Bajura, Jumla, Humla, Mugu, Dolpa, Kalikot.

2. Visit of President of FIG to Nepal

President of International Federation of Surveyors (FIG) Prof. Dr. Stig Enemark visited Survey Department on 16th February 2009 during his visit to Nepal from 14 February to 18 February 2009. the then Director General of Survey Department Mr. Raja Ram Chhatkuli highlighted the present activities run by Survey Department and future vision of the Department amidst a function. Prof Enemark presented a paper on Land Administration System. For full paper please visit
www.fig.net/news/news_2009/nepal_february_2009.htm.

*Mr. Rabin K. Sharma, Prof. Dr. Stig Enemark,
Prof. Dr. Mr. Suresh Raj Sharma and Prof. Dr. Bhola Thapa*



*Mr. Raja Ram Chhatkuli, Prof. Dr. Stig Enemark,
and Mr. Babu Ram Acharya.*

3. Change of leadership in Survey department

Government of Nepal appointted Rabin kaji Sharma , the Executive Director of Land Management Training Centre as Director General of Survey Department on 2nd March 2009. After taking the charge of Director General Mr. Sharma addressed the staffs in the meeting hall of the Department. He addressed that his prime focus will be to improve service delivery to the stake holders and the general public. He requested to all the staffs to work in team spirit and to change their behavioral attitude from traditional way to match the spirit of the present Government.

4. Interaction Program

Survey Department organized a interaction programme with the participants of short course on "Adopting Geo-ICT for Land administration" jointly organized by Kathmandu University, Land Management Training Centre and ITC the Netharlands on 17th June 2009. Director General of Survey Department, Rabin Kaji Sharma delivered the welcome speech, Chief Survey Officer Kalyan Gopal Shrestha presented the introduction and activities of Survey Department. Dr. A.M. Tuladhar from ITC. made remarkes on the presentation and discussion.

5. Workshop on SDI: Policy frame work in the Nepalese context.

National Geographic Information Infrastructure Programme, Survey Department has organize one day workshop on SDI policy framework in the Nepalese context on 18th June 2009.

6. Preparation of topographic maps for JPO-SKSKI.

As per Memorandum of Understanding between Survey Department and Joint Project Office Saptakoshi Sunkoshi Investigation , draft maps of small scale maps made by photogrammetric method are completed and large scale maps by ground survey method are prepared.

7. Survey office building under construction

Survey office building of Lalitpur, Syngja and Kanchanpur are under construction as per the annual programme of the department.
After the completion of these three buildings total 18 Survey Offices will have own building fifty Survey Offices have their own land for building construction.

Land policy in perspective

Nab Raj Subedi, Survey Officer
Survey Department, Nepal
subedi03939@itc.nl, nawraj_s@yahoo.com

Keywords
Land policy, land tenure security, land market, land taxation, land valuation, land use planning, land reform and land administration

Abstract
Fundamental entity where the existence resides is Land. Obviously being the basis of life and then source of wealth and power, land has been observed as a focal entity of social conflict and disorder. Any government willing to pay attention for good governance must give its eyes on the issues of land, otherwise, any effort made in the name of development will be like pouring water on sand. Being encapsulated by the strong but better political will for doing something to raise the people up from their plight and blight of abject poverty, it is urgently needed to formulate land policy whereby all policy implementation instruments will be systematically arranged within the skeleton of land policy framework. Land tenure security, land market, land valuation and taxation, land use planning and land reform are the main instruments envisaged in this paper ignoring which the expected gain out of the applied effort on any land issue can not meet the demand of the society. The block composed by these implementation instruments will rest on the system of land administration, acting as a tool designed to be matched with the land policy.

1. Introduction

One in five spends their life in urban slums. One in two lacks basic sanitation. Increasing numbers manage to trade rural for urban destitution (UN-HABITAT, 2004). FAO estimated that unless progress was accelerated, there could be some 680 million hungry people in the world by the year 2010, more than 250 million of whom would be in sub-Saharan Africa (World Food Summit, 1996). Until recently, majority of land surface under customary system were not recognized in Africa and therefore such area, on which rural people rely on for their livelihoods and subsistence, remained outside the realm of law. In parts of Asia, highly unequal ownership and access to asset have made it difficult to establish inclusive pattern of growth. In Eastern Europe, collective production structure have failed to contribute to rural growth (Deininger, 2003).In South America land reform is a major problem because enormous tracts of land are concentrated in very few hands with laborers no better off than serfs (Encyclopedia-Agrarian Reform). In Nepal, massive population is capturing the urban-fringe area as informal settlers. (Subedi and Paudyal, 2005).

From the discussion made above, it is seen that despite the social, economic and political importance attached to land, majority of countries seem lacking in formulating the land policy that brings the effective change. Directly or indirectly, these countries remain heavily dependent on land for the elemental needs of survival, for habitation, subsistence cropping.

To address all these issues, and more, it becomes imperative to bring in land policy. In fact, land administration strategies and process need to be structured within the broad policy framework, the shape of which will depend on the jurisdiction concerned. A common thread between the systems will be the promotion of the economic development, social justice and equity, political stability and environmentally sustainable development (Dale and McLaughlin, 2003). Land policy consists of the whole complex of legal and socio economic prescriptions that dictate how the land and the benefits from the land are to be allocated (UN Land Administration Guidelines, 1996). Deininger defines land policy as the rules governing access to and the distribution of the benefits from one of the economy's main assets.

To materialize the essence of the land policy, different implementation instruments are required for which a well designed tool (from legal, institutional and technological perspective) i.e. a well designed land administration system is indispensable, which carries out fundamental activities such as recordation and maintenance of right (legal aspect), prepares cadastral index and other spatial information (map), disseminate relevant information to the required agencies or users. The form of the land administration system itself is dependent on which implementation instrument is emphasized on the land policy. To achieve these or to materialize what is prescribed as the land policy statement, different implementation instrument have been designed. Namely, those are land tenure security, land market, land taxation, land use planning, and land reform and the relationship between is shown in Figure 1. These are dealt in the subsequent sections.

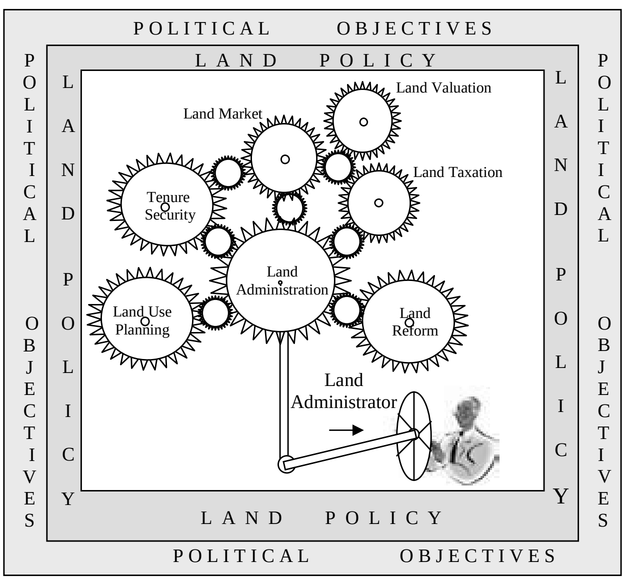


Figure 1: Showing the dependability of implementation instrument on the land administration tool and the systems encapsulated by land policy and ultimately by political objective

2. Property rights and tenure security

Land is a fundamental factor for agricultural production and is thus directly linked to food security. Without land, farmer can not grow, at least, their intended corps of production. If somebody is not assured of possession what he/she holds, then it constrains to perform development activities on that piece of land by the fear of possibility of eviction. Moreover the abiding law itself does not allow performing any economic activity (or/and use for benefit) on or with entity of non-ownership. People overwhelmed by the extreme poverty may be led to conflict and finally degrade the environment for short-term survival. Hence, from one perspective, security of land tenure implies economic development, environmental management, social stability, and can be supportive in reconstruction process following a disaster or conflict.

At the same time, it has been observed that property right assurance is not the only means of uplifting of poor. Property rights are only means of recognition by the authority and society. As long as informal occupation is not contested, user can use it for livelihood and agriculture production as it happens in the rural areas of mountain (in Nepal, the author has observed it) where people use unregistered land for horticulture or wild plantation of economic value. Another observation is that the highly complex formalities required for land titling causes the poor to enhance the hardship and make ultimately less attentive derailing them to be out of the system and making them informal settler.

Figure 2, Evicted people under the open sky, Source: http://farm3.static.flickr.com

Figure 3, Informal settlement in Kapan 3, Kathmandu, Source: www.google.com

In the other cases, property rights are related to the economic growth. Poorly defined land rights exploit the effort of the land holder just to defend their land and divert them from other income generating activities. Secure tenure rights facilitate transfer of rights at low transaction cost which stimulate formal land market and ultimately empowers the private sector (Deininger). Property rights itself should have some desirable characteristics which Land policy must hint for materialization of the expectation it states in its declaration.

- Mostly desirable one is the indefinite property rights, but if there are other rights (as described in the continuum such as lease or rental one), the accruable period must confirm the benefit from the land (or activities on it) over the investment. Hence such rights should be renewable and of long term and inheritable (so that widows or divorced can continue the economic performance).
- Property rights should be identifiable (depending up on the frequency of the transaction) and easily transferable (i.e. low transaction cost). There should also be provision of bundle of rights (stack of right sticks!) for different type of occupants.
- Since type of rights such as individual or group, is the matter of social, cultural and historical arrangement, such rights should be only ascertained based on (i) how the externalities can be managed (by group or by person), (ii) how the resources or outcome are to managed (iii) productivity (it is low if accrued by an individual effort and/or high if by the group force).This is more applicable to the agricultural land. (Figure 4 and 5)
- There must be presence or establishment of institutions for legal backings when legitimate or legal rights are to be enforced when called on by the property right holders (Deininger).

Figure 4, Showing group effort in cultivation

Figure 5, Individual effort with traditional technology may result low production.

- The land rights must be adaptable to the development i.e. it must be evolutionary that adapts the change carried by the technology. Particularly, in case of group rights which must be evolvable into the individual rights if an individual can generate the same or even more production than the group by the use of the state of art technology (Figure6).

Figure 6, Farming using technology

3. Land policy and land market

Land market is one of the formal mechanism that makes the land accessible to the poor (or rich as well). Different types of land market model such as sales market, rental market, and credit market and mortgage based on land are seen to be existing. But at the same time, land market may lead to destitution to the poor stripping them off their property, if there are speculations causing land accumulation by the so-called elites. In case of political turbulence or social unrest, people may not be able to sell their wage labor while they are compelled to sell their only piece of land by which they even lose their ultimate means of subsistence. Poor are easy to lure by money since they do not look for tomorrow.

3.1 Sales and rental land market

The other facet of economics, macroeconomics takes the land as an element of factor market. In circular flow model, land acts as a base like labor and capital for firms. In sales market, land as an asset can be sold (in fact, only in psychological perspective we feel land as sold, in fact we only transfer the use right!) and as a result money can be generated. But depending on the use of land, the land is not generally purchasable by the poor or even if they purchase, the return against investment may not accrue due to market imperfection. In such situation, the accessibility to the land may be made by the rental system which needs less transaction cost or a mere agreement between the parties. Even in such rental market, the contract duration period should be flexible depending on the return (income) made out of the investment by the poor. The output to be provided to the real owner in rental land market may be based on sharecropping as a safeguard against market shocks because fixed cost may not be met if the production is low by some reason.

3.2 Credit and Mortgage market

Secure tenure is the basis of credit market. It acts as an incentive for investment to access credit by which landowner can either improve productivity of their land or generate income by selling the surplus or start micro-enterprise which makes them less-dependent on the wage labor (Figure 4, 5). Tenure security enhances the asset base of especially vulnerable groups such as women whose land rights are often neglected and improve the welfare of the poor. Non-farm owner can also keep their land as collateral in the financial institution and access credit by which they can make investment for off-farm activities. The risk factor in the mortgage market is that if an entrepreneur suffers bankruptcy due to economical shocks and can not gain what he expects out of the investment made, the deposit i.e. land asset subjects to moratorium after the terms of duration expressed in the contract.

Figure 7

Figure 8

Example of micro-business by credit accessed from cooperatives Image source: www.idepfoundation.org/idep_microcredit.html

3.3 Land market and Valuation

Valuation is supposed as one of the pillar of land market like the land administration and financial sectors as long as land price is derived based on the land use (better say market derived) but not on the spatial extent. Land administration (LA) stimulates by providing the sense or perception of right to the actors. LA relates people and land by associating with the bundle of rights. Connection between the people and the money is done by the financial services such as bank, cooperatives but based on the rights on land. But the bridging between the land and monetary value is done by the valuation system. But the valuation must be based on the proper identification of the assets and should be carried out by one official body. Hence, land valuation has been shown as one of the cogs related connecting the land market (perception of the author of this report) in Figure 1.

Since land is an inelastic, immobile but tradable asset, it provides foundation for economic activity based on the transfer of rights (permanent or temporary). Activities on land can be more stimulated by establishing land market mechanism underpinned on the principle of tenure security. Land policy formulation process must not be oblivious of such potentiality and should be attentive for generating such market.

4. Land policy and Land Taxation

Taxation has both advantage and disadvantages from the economic, social and land use aspects. To make the people or landholder responsible and, at the same time, to generate a budgetary framework for the infrastructure development (more generally for land use) in the local level, system of land taxation is indispensably essential but at the same time it distorts the land market pushing away the people from the formal land market. Tax exemption for lower value property is legitimate but it retards the money circulation in the market. Tax based on productivity is considered better as it calls on market parties but it induces competition which causes low revenue generation and retards the development activities of local government.

High taxation causes the people to run away from the formal system. Land taxation as well as land market mechanism can effectively sustain if there exists well defined and well designed land valuation system. Land market, land taxation and land valuation are separate system but in the modern perspective they are intertwined each other (Please refer Figure 1 above). The taxation system should also incorporate appeal procedure for those who do not get content on the tax imposed on their property.

Figure 9, Town Planned area having secure land tenure in Sinamangal, Kathmandu

5. Land policy and Land use planning andpublic acquisition of land

Land use and zone planning is the only land policy implementation instrument that ties land policy with other policies those concern for land. Land use planning synoptically deals with land generally from very small maps whereas cadastre deals with large scale maps. Expansion of agricultural land at the cost of the forest or other areas degrades environment. The story of urban area is also not seen promising. Exodus from rural to urban has caused urbanization to expand to the extent affecting the agrarian land turning into jungle of building for the purpose of housing, industrial or commercial set up. Land is accelerating toward scarcity. If it is not managed based on proper land use planning, over and haphazard exploitation will firstly deplete the public lands through grabbing and encroachment and then lead to social unrest or disintegration due to demands for shelter in the urban area which ultimately create social unrest due to the pressure of over population. It should not be forgotten that the value of the private land is judged by the quality of public space.

Lack of land use planning and its implementation cause the urban areas into slums. The more the public lands (green space, road, parks and river etc. but all managed) made availed through planning, the better the environment. The necessary of land zoning can be better illustrated by comparing the following two images of part of Kathmandu area (Source: www.Google.com)

Figure 10, Unplanned area also having secure land tenure in Kapan, Kathmandu shows no road for the interior building

Access to land and Tenure security on the other hand is not the ultimate goal for better humankind. On one hand, people must be able to reap the benefit from the land they are given access to. On the other hand, in the name of accessibility to and ownership on land, they should not be authorized to generate side effect of the legitimate-use (!) in the environment (Figure 11). It means land accessibility for one should not violate the sustainability for the whole (society). It is here the concept of internalization of the externalities should be introduced just to balance the man-land relationship by maintaining sustainable usability of land and its resources, through the legitimate restrictions which must be based on legislation and general interest. Controlling over exploitation and legitimate use entails land use planning.

Land use regulation and zoning process involves creation of framework for planning, implementation and maintenance of the defined use, which by some way, always affect the owner in exercising their rights on use of the land. Therefore land use planning must be based on the standard multiple geo-spatial data of the area concerned by making use of national geospatial information infrastructure along with other socio-economic data. As mentioned above, it interferes with the private rights and therefore such measures must be based on the legal background and only for public welfare. Land policy must hint such issues so that expectation can be materialized.

acquire credit. Government must arrange such mechanism. Properly formulated land reform program watchful to the side effect can solve national problem in stead of being a mere political agenda. Conspicuous example of land reform is Nicaragua's agrarian reform under the Sandinistas which resulted in expropriation of some large holdings(1979), which after initial collectivization has been progressively redistributed to individual farmers, including returning Contras after 1989(http://www.infoplease.com /ce6/sci/ A0856508.html).

Figure 11 Using own land Clean Bhaktapur, having nasty polluters (brick kiln) surrounding and within the city, Nepal, (News source http://kantipuronline.com/kolnews.php?&nid=59560)

6. Land policy and Land Reform

Land reform is the process of examining and changing laws, regulations and customs relating to land ownership and land tenure. The purpose of land reform should be to bring about a more equitable distribution of land ownership at the same time the land suffers underutilization adding to abject poverty on the rural people. This brings about access to land on the poor and also enhances agricultural productivity. Land reform program can take into many forms such as land redistribution, land tenure reform, land restitution, land consolidation etc. For implementation of such program, preventive legislation needs to be removed and new incentive legislation should be introduced. This usually involves changes in laws and regulations and also changes in customs.

The land reform as such does not bring an automatic the change on the economic status. For this, Poor must have accessibility to non-land assets and working capital by the poor. The beneficiary of land reform program must be able to

7. Conclusion

Land policy issues are highly complex having interrelation among them. It is related to an individual's subsistence to the whole society's welfare and only one sided orientation can not meet the multifaceted demands. Institutional responsibilities regarding land is not bound to only one sector but it comprises many of them such as environment, urban planning, agriculture, land reform etc, which necessitates to be threaded by broader policy framework and needs support and cooperation among all concerned line agencies.

Land administration is not itself a goal but it is meant to serve the policy implementation instruments. The form the administration is dependent of what the land policy declares or expects.

Guarantee of land tenure security, reduction of the transaction cost and environment for institutional enforcement for enjoy of accessed right are the preliminary issues the land policy should address to. Land policy issues are not unique and depend on the social, cultural and political and geographical setting of a particular country as well.

References

1. *Bell K. C., 2007, Good Governance in Land Administration, Hong Kong*
2. *Dale P. and McLaughlin J., 1998, Land Administration, Oxford University Press, UK*
3. *Deininger K., 2003, Land Policies for Growth and Poverty Reduction, World Bank Report, USA*
4. *Encyclopedia, Agrarian Reform, Latin America and Africa, Columbia University Press, www.infoplease.com/ce6/sci/A0856508.html*
5. *EU Task Force on Land Tenure, 2004, EU Land Policy Guidelines*
6. *Holden S., Kaarhus R. and Lunduka R., 2006, Land Policy Reform: The Role of Land Markets and Women's Land Rights in Malawi*
7. *Istanbul Declaration on Human Settlements, 1996, United Nations Conference on Human Settlements (Habitat II), Istanbul*
8. *Subedi N.R. and Paudyal D.R., 2005, Identification of Informal Settlement by Integration of Cadastral Information and Remote Sensing Satellite Imagery, www.oircf.org, FIG*
9. *UN-HABITAT, 2004, Pro Poor Land Management, UNHSP*
10. *United Nations, 2007, United Nations Land Administration Guide Lines, Reader, International Institute for Geo-information Science and Earth Observation, ITC, The Netherlands*
11. *van der Molen, P., 2008, Land Policy and Land Management, Reader, International Institute for Geo-information Science and Earth Observation, ITC, The Netherlands*
12. *World Food Summit, 1996, www.fao.org/wfs/index_en.htm*

Participation in international events by the officials of Survey Department

– Raja Ram Chhatkuli , the then Director General a.i.
– Tek Bahadur Shah, Chief Survey officer
RICS Asia Pacific Conference
3-7 July, 2008
Bangkok Thailand

– Professional education
Ganesh Prasad Bhatta, Chief Survey Officer
Janak Raj Joshi, Survey Officer
Roshani Sharma, Survey Officer
1 year from September 2008, ITC the Netherlands

– Raja Ram Chhatkuli, the then Director General a.i.
Public Land Management
7-13 September, 2008
Verona, Italy

– Raja Ram Chhatkuli, the then Director General a.i.
15th Asia Pacific Regional Space Agency Forum
8-12 December, 2008
Hanoi, Vietnam

Price of Maps

S.No.	Description	Coverage	No. of sheets	Price per sheet (NRs)
1	1:25,000 Topo Maps	Terai and mid mountain region of Nepal	590	150.00
2.	1:50 000 Topo Maps	HIgh Mountain and Himalayan region of Nepal	116	150.00
3.	1:50 000 Land Utilization maps	Whole Nepal	266	40.00
4.	1:50 000 Land Capibility maps	Whole Nepal	266	40.00
5.	1:50 000 Land System maps	Whole Nepal	266	40.00
6.	1:125 000 Geological maps	Whole Nepal	82	40.00
7.	1:250 000 Climatological maps	Whole Nepal	17	40.00
8.	1:125 000 Districts maps Nepali	Whole Nepal	76	50.00
9.	1:125 000 Zonal maps (Nepali)	Whole Nepal	15	50.00
10.	1:500 000 Region maps (Nepali)	Whole Nepal	5	50.00
11.	1:500 000 Region maps (English)	Whole Nepal	5	50.00
12.	1:500 000 maps (English)	Whole Nepal	3	50.00
13.	1:1 million Nepal Map	Nepal	1	50.00
14.	1:2 million Nepal Map	Nepal	1	15.00
15.	Wall Map (mounted with wooden stick)	Nepal	1	400.00
16.	Photo Map		1	150.00
17.	Wall Map (loose sheet)	Nepal	1 set	50.00
18.	VDC/Municipality Maps	Whole Nepal	4181	40.00
19	VDC/Municipality Maps A4 Size	Whole Nepal	4181	5.00
20.	VDC/Municipality Maps A3 Size	Whole Nepal	4181	10.00
21.	Orthophoto Map	Urban Area (1: 5 000) and Semi Urban Area (1: 10 000)	-	1 000.00
22.	Administrative Map	Nepal	1	5.00

Price of co-ordinates of Control Points

Type	Control Points	Price per point
Trig. Point	First Order	Rs 3 000.00
Trig. Point	Second Order	Rs 2 500.00
Trig. Point	Third Order	Rs 1 500.00
Trig. Point	Fourth Order	Rs 250.00
Bench Mark	First & Second Order	Rs 1 000.00
Bench Mark	Third Order	Rs 250.00
Gravity Point	-	Rs 1 000.00

Land use land cover change in mountainous watersheds of middle Himalayas, Nepal

Basanta Raj Gautam[1] and **Paban Kumar Joshi[2]**

[1]Faculty of Forest Sciences, University of Joensuu, Finland (gautam@cc.joensuu.fi)
[2]Associate Professor, TERI University, New Delhi, India

Keywords

land use change, mountain, watersheds, GIS

Abstract

The study was aimed at examining land use dynamics in two typical mountain watersheds in Rasuwa district in the central development region of Nepal, namely Chileme and Bamdang. A comparative change analysis was performed for the last three decades i.e. 1976–1988, 1988–2000 and 2000–2006 using RS & GIS technology. The analysis was based on the multi-temporal Landsat and IRS images taken in December 1976, December 1988, December 2000 and January 2006. During the last three decades, forest cover has been reduced drastically with increasing population pressure and agricultural expansion. Some limiting factors such as socio-economic setup and policies have also contributed to these changes and resultant land use in the watersheds.

1. Introduction

Himalaya is the most complex and fragile ecosystem among the global mountain system. It figures a major biophysical setting of the earth (Singh 2006). The destabilization of fragile mountain slopes through deforestation, agriculture expansion and excessive grazing has increased land degradation in the mountain regions (Ives and Messerli 1989; Thapa and Weber 1995). More than 90% of the population lives in rural areas with exponential population growth and unequal land distribution forcing farmers to expand agriculture on marginal lands on high slopes (Rao and Pant 2000). The socio-economic scenario of hillside farmers in the mountain region is characterized by a simple subsistence economy, mainly for self-consumption. The agricultural expansion associated with population growth resulted in the modification of land use and land cover structure.

Different techniques have been evolved to collect, analyze and to present the natural resource data. Remote Sensing and GIS technology is accepted as an efficient and effective tool to gather the land use land cover change information, especially for the inaccessible areas (Ulbricht and Heckendorff 1998; Gautam et al. 2003, Joshi et al. 2005). Various attempts have been made to study land use land cover dynamics in the mountain regions (Joshi et al. 2004; Joshi and Gairola 2004) but only limited work describes the land use land cover change pattern. In the present paper, an attempt has been made for comparative study of the land use land cover dynamics in two watersheds situated in the same geographical area but varying resources and diverse social implication. The quantitative land use dynamics was assessed from temporal satellite images using state-of-the-art technology i.e. RS & GIS.

2. Study Area

The study area comprised of the Chileme and Bamdang watersheds in Rasuwa district. It is located in the central development region of Nepal. The study area and its location is presented in the Figure 1.

3. Materials and Methods

Landsat MSS from December 1976, Landsat TM from December 1988, Landsat ETM+ from December 2000 and IRS P6 LISS III from January 2006 were used for land use land over mapping. The satellite data were radiometrically and geometrically (rectification with UTM/WGS 84 projection) corrected. The datasets were maintained with sub pixel level accuracy.

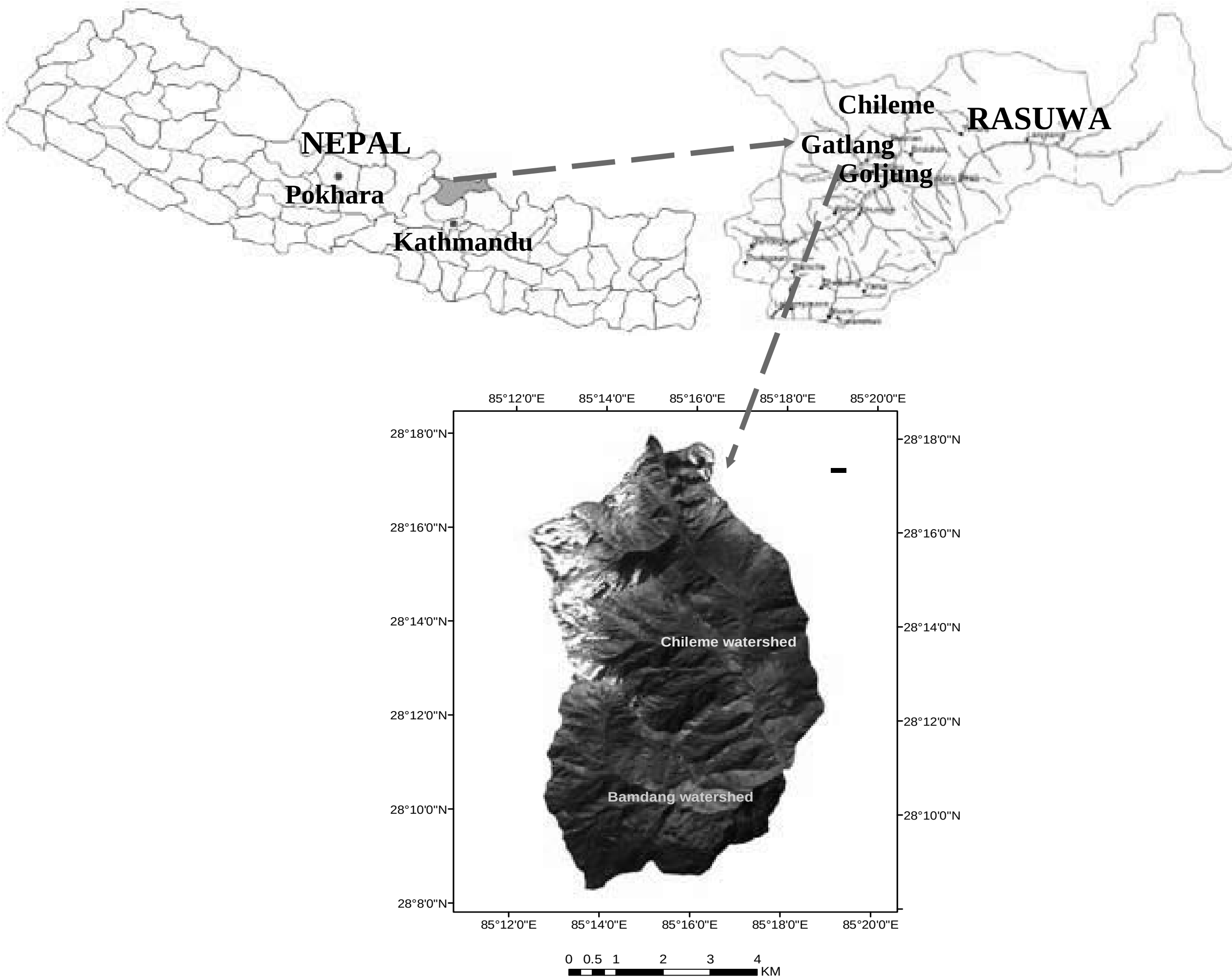


Figure 1. Study area and its location

Contour map was prepared in 40m contour intervals from 1:50000 scale topographic maps produced by the Department of Survey (Nepal). Similarly drainage and spot height map were prepared from the same topographic maps. A Digital Elevation Model (DEM) was generated in ARC/INFO software using contour, drainage and spot height map. Slope and aspect maps were derived from DEM in ERDAS software. The land use land cover maps of respective years were intersected with slope and aspect index map in ERDAS software to assess land cover distribution along the topography. Change detection was performed by intersecting thematic land use land cover map of 1976 and 1988, 1988 and 2000, and 2000 and 2006 in ERDAS. The time series land use maps were compared to locate change areas. The intersected maps were recoded into binary variables 1 and 0 representing "change" and "no change" areas. The slope and aspect maps were intersected with recoded changed/unchanged map to find out the role of topographic parameters on land use land cover change.

4. Results

On screen visual interpretation of satellite data was carried out to find out different land use land cover classes in conjugation with information from topographic maps and ground truth. The identification and delineation of land use classes with other cover types were done by following the standard visual interpretation technique. A uniform land use classification scheme was used while interpreting the land use classes. The land use map of the year 1976, 1988, 2000 and 2006 were prepared for both watersheds. Total 14 land use land cover classes were identified in Bamdang watershed whereas total 15 land use land cover classes were identified in Chileme watershed (Figure 2).

The major land use classes identified were forest and non-forest. Forest was further subdivided into pine mixed forest, mixed forest, conifer forest other than pine, degraded forest, shrubs/bushes, grassland, pasture, and scrub. Non-forest was further classified into tree-farm land, agriculture, water body and snow. Distribution of land use land cover in Bamdang and Chileme watersheds is shown in the Table 1 and 2 respectively.

The results of land use land cover change analysis showed, out of 8617.06 ha. geographical area 1702.74 ha. (19.76% area) was under change category in Chileme watershed and out of 4163.75 ha. geographical area 1292.28 ha. (31.03% area) was under change category in Bamdang watershed during 1976 and 1988. The analysis revealed a huge change in open pine mixed forest in Chileme and in open mixed forest in Bamdang watershed. A total 613.13 ha of open pine mixed forest was converted into other land use types, majority comprised of agriculture (216.63 ha) in Chileme watershed. Similarly, 248.25 ha open mixed forest was converted into other land use types, majority comprised of agriculture (60.63 ha) in Bamdang watershed.

During 1988 and 2000, 1390.44 ha area was assessed under change category in Chileme and 1089.31 ha in Bamdang watershed. During this time, the major changes were in open mixed forest in both watersheds. Total 538.63 ha open mixed forest was converted into other land uses especially degraded forest (466.81 ha) in Chileme and total 709.19 ha open mixed forest was converted into other land uses especially degraded forest (584.06 ha) in Bamdang watersheds. During 2000 and 2006, 282.94 and 239.19 ha area was assessed under change category in Chileme and Bamdang watersheds respectively. During 2000 and 2006, the major changes were in open mixed forest in Bamdang whereas the major changes assessed in shrubs and bushes in Chileme watershed. 49.25 ha open mixed forest was converted into other land use classes especially agriculture (22.75 ha) followed by degraded forest (21.25 ha) in Bamdang watershed whereas total 59.63 ha area converted into alpine pasture in Chileme watershed. The annual rate of change was assessed as 8.34%, 8.33% and 16.66 % in Bamdang and 5.61%, 10.90% and 16.67% in Chileme watershed during 1976 – 1988, 1988 – 2000 and 2000 – 2006 respectively. The present result demonstrated the effect of topography on land use land cover change. Slope and aspect maps were taken into consideration while analyzing change along topography. Change analysis revealed that there were very less changes up to 6 degree slope in both watersheds. As

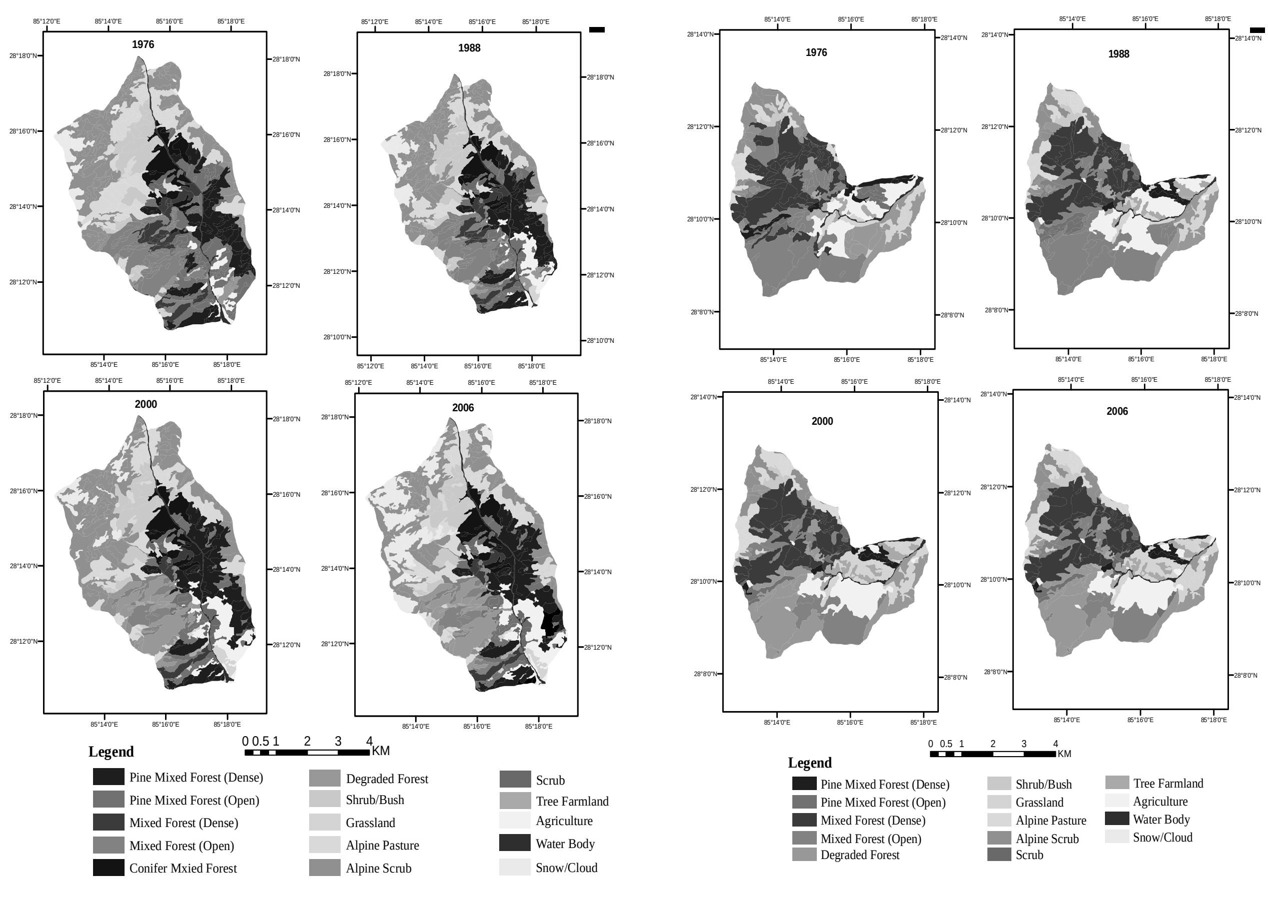


Figure 2: Land Use Land Cover map of Chileme and Bamdang watershed from 1976 to 2006

the slope increased the change areas were also increased. The change process was gradual between 6 to 25 degree slopes. However, very prominent changes were assessed between 25 and 55 degree in both watersheds. This process of change coupled with collected socioeconomic information revealed that people are shifting towards inaccessible areas for resource extraction. This might be because of the fact that resource in the gentle slope was already reached beyond the threshold of optimum utilization.

Table 1: Area statistics of different forest/land use land cover in Bamdang watershed

S.N.	Land Use Class	1976		1988		2000		2006	
		Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
A.	Forest								
1	Pine Mixed Forest (Dense)	147.69	3.55	114.63	2.75	117.38	2.82	113.81	2.73
2	Pine Mixed Forest (Open)	130.88	3.14	126.69	3.04	92.31	2.22	89.81	2.16
3	Mixed Forest (Dense)	988.31	23.74	948.44	22.78	943.50	22.66	959.81	23.05
4	Mixed Forest (Open)	1205.69	28.96	1242.19	29.83	561.94	13.50	540.44	12.98
5	Degraded Forest	459.19	11.03	295.38	7.09	923.81	22.19	891.06	21.40
6	Shrub/Bush	46.25	1.11	51.19	1.23	51.00	1.22	52.38	1.26
7	Grassland	195.56	4.70	164.25	3.94	341.00	8.19	348.56	8.37
8	Alpine Pasture	193.88	4.66	286.75	6.89	310.69	7.46	277.06	6.65
9	Alpine Scrub	294.25	7.07	241.06	5.79	216.56	5.20	206.19	4.95
10	Scrub	17.38	0.42	21.44	0.51	41.81	1.00	40.81	0.98
	Sub Total	3679.06	88.36	3492.00	83.87	3600.00	86.46	3519.94	84.54
B	Non-Forest								
11	Tree Farmland	85.69	2.06	139.69	3.35	162.31	3.90	196.75	4.73
12	Agriculture	355.44	8.54	499.25	11.99	365.38	8.78	405.94	9.75
13	Water body	43.56	1.05	32.81	0.79	36.06	0.87	33.00	0.79
14	Snow							8.13	0.20
	Sub Total	484.69	11.64	671.75	16.13	563.75	13.54	643.81	15.46
	Grand Total	4163.75	100	4163.75	100	4163.75	100	4163.75	100

Table 2: Area statistics of different forest/ land use land cover in Chileme watershed

S.N.	Land Use Class	1976		1988		2000		2006	
		Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
A.	Forest								
1	Pine Mixed Forest (Dense)	1156.44	13.42	1318.75	15.30	1310.25	15.21	1305.38	15.15
2	Pine Mixed Forest (Open)	1081.56	12.55	549.00	6.37	436.81	5.07	425.75	4.94
3	Mixed Forest (Dense)	391.38	4.54	327.63	3.80	197.13	2.29	193.63	2.25
4	Mixed Forest (Open)	924.50	10.73	924.75	10.73	386.75	4.49	382.94	4.44
5	Coniferous Forest	469.25	5.45	449.94	5.22	449.19	5.21	447.13	5.19
6	Degraded Forest	67.56	0.78	83.38	0.97	702.19	8.15	681.38	7.91
7	Shrub/Bush	653.94	7.59	696.31	8.08	658.38	7.64	602.31	6.99
8	Grassland	28.38	0.33	112.88	1.31	108.00	1.25	94.25	1.09
9	Alpine Pasture	1342.88	15.58	1049.38	12.18	1090.19	12.65	1047.50	12.16
10	Alpine Scrub	1859.88	21.58	2080.94	24.15	2216.00	25.72	1652.38	19.18
11	Scrub	98.25	1.14	234.19	2.72	208.44	2.42	199.56	2.32
	Sub Total	8074.00	93.70	7827.13	90.83	7763.31	90.09	7032.19	81.61
B.	Non-Forest								
12	Tree Farmland	0.00	0.00	7.06	0.08	24.00	0.28	28.88	0.34
13	Agriculture	181.69	2.11	342.88	3.98	452.50	5.25	522.00	6.06
14	Water body	95.06	1.10	90.38	1.05	96.31	1.12	88.32	1.02
15	Snow	266.31	3.09	349.62	4.06	280.938	3.26	945.67	10.97
	Sub Total	543.06	6.30	789.93	9.17	853.75	9.91	1584.87	18.39
	Grand Total	8617.06	100	8617.06	100	8617.06	100	8617.06	100

Aspect generally refers to the direction to which a mountain slope faces. It is also an important topographic characteristic, which affects the distribution and productivity of various forest types.

In both the watersheds, higher changes were assessed in south-east, south and south-west aspects. These slopes are highly illuminated for greater time period and consequently have high productivity accompanied with the changes. However, north, north-east and north-west aspects have relatively low productivity due to less solar illumination and resulting less human pressure.

5. Discussion

The present analysis identified three main driving forces responsible for land use land cover change in the study area. These are socio-economic driver, biophysical driver and management practices. Forest being the dominant natural resource, it covers an area of 63.42% in Bamdang and 46.88% in Chileme watershed. Annually 15.22 ha of land under forest and grassland in Chileme watershed and 11.23 ha in Bamdang watershed were converted into agriculture fields. The change analysis revealed three important changes namely increase in degraded forest, decrease in dense forest, and agricultural expansion. A similar trend was reported by Joshi et al. (2004) and Joshi and Gairola (2004) while working in Garhwal Himalaya, India.

It is generally accepted that the land use change may be prominent in gentle slope areas (Zeleke and Hurni 2001; Chen et al. 2001 and Semwal et al. 2004). But the present study showed a steeper slopes were also affected by land use change. This result supports the findings of Wakeel et al. 2005 while working with mid elevation zone of Central Himalaya in India. They found increasing amount of forest loss on steeper slopes. As presented earlier, it might be because of the resources in the lower slope were already used by the villagers and now they concentrate their activities in the higher slopes areas where resource are plenty.

Assessment of land use change has been a key to plan and implement sustainable land use planning to cope with global climate change. Global initiative and local action is of urgent need. The Bali Conference on Climate Change has agreed to consider a new initiative to help Emission Reduction from Deforestation and forest Degradation (REDD). Developing countries are facing challenges to make economic and policy incentives to reduce emissions from land use change (Santilli et al. 2005). It is possible to measure temporal forest carbon stocks by using remote sensing data with ground verification (Rosenqvist et al. 2003, Drake et al. 2003). Assessment of spatiotemporal land use change using remote sensing and GIS is starting points to begin REDD implementation (Herold and Johns 2007) at local level.

References

1. *Chen, L.,Wang, J., Fu, B. and Qui, Y. 2001. Land-use change in a small catchment of northern Loess Plateau, China. Agric. Ecosyst. Environ. 86: 163–172. Collier, G.A., Mountjoy, D.*
2. *Drake, J.B. 2003. Above-ground biomass estimation in closed-canopy neotropical forests using lidar remote sensing: factors affecting the generality of relationships Glob. Ecol. Biogeogr.* ***12****: 147–59.*
3. *Gautam, A.P., Webb, E.L., Shivakoti, G.P. and Zoebisch, M.A. 2003. Land use dynamics and landscape change pattern in a mountain watershed in Nepal. Agriculture, Ecosystems and Environment.* ***99****: 83–96.*
4. *Herold, M. and Johns, T. 2007. Linking requirements with capabilities for deforestation monitoring in the context of the UNFCCC-REDD process. Environ. Res. Lett. 2: 045025, 7pp.*
5. *Ives , J.D. and Messerli, B. 1989. The Himalayan Dilemma: Reconciling Development and Conservation. Routledge, London, U.K.*
6. *Joshi, P.K. and Gairola, S. 2004. Understanding land cover dynamics in Garhwal Himalayas using geospatial tools - a case study of Balkhila Sub-Watershed. Journal of the Indian Society of Remote Sensing* ***32****(2): 199–208.*
7. *Joshi, P.K., Das, K.K., Jamwal, A.K. and Hemlata 2004. Analyzing land cover dynamics vis-a-vis topography in Huinyal watershed (Garhwal Himalayas) using geospatial tools. Indian Journal of Forestry* ***27****(1): 1–10.*
8. *Joshi, P.K., Li, Q., Lele, N. and Yang, X. 2005. Land Use Land Cover Change analysis and its impact on Soil erosion. Indian Journal of Soil Conservation* ***33****(3): 200–203.*
9. *Rao, K.S. and Pant, R. 2000. Land use dynamics and landscape change pattern in a typical micro watershed in the mid elevation zone of central Himalaya, India. Agriculture, Ecosystems and Environment* ***86****: 113–123.*
10. *Rosenqvist, A., Milne, A., Lucas, R., Imhoff,*

M. and Dobson, C. 2003. A review of remote sensing technology in support of the Kyoto Protocol. Environ. Sci. Policy 6: 441–55.

11. *Santilli, M., Mouthino, P., Schwartzman, S., Nepstad, D., Curran, L. and Nobre, C. 2005 Tropical deforestation and the Kyoto protocol. Clim. Change 71: 267–76.*
12. *Semwal, R.L., Nautiyal, S., Sen, K.K., Rana, U., Maikhuri, R.K., Rao, K.S. and Saxena, K.G., 2004. Patterns and ecological implications of agricultural land-use changes: a case study from Central Himalaya,India.Agric.Ecosyst.Environ.102:81–92.*
13. *Singh, J.S. 2006. Sustainable development of the Indian Himalayan region: Linking ecological and economic concerns. Current Science,* ***90****(6): 784–788.*
14. *Thapa, G.B. and Weber, K.E. 1995. Status and Management of watershed in the Upper Pokhara Valley, Nepal. Environment Management.* ***19****: 497–513.*
15. *Ulbricht, K.A. and Heckendorff, W.D. 1998. Satellite images for recognition of landscape and landuse changes. ISPRS Journal of Photogrammetry and Remote Sensing,* ***53****: 235–243.*
16. *Wakeel, A., Rao, K.S., Maikhuri, R.K. and Saxena, K.G. 2005. Forest Managementand land use/ cover changes in a typical micro watershed in the mid elevation zone of Central Himalaya. Forest Ecology and Management.* ***213****: 229–242.*
17. *Zeleke, G. and Hurni, H. 2001. Implications of land use and land cover dynamics for mountain resource degradation in the northwestern Ethiopian highlands. Mountain Research and Development* ***21****: 184–191.*

Obituary

All the officials of Survey Department pray to the Almighty for eternal peace to the departed soul of the following officials of the department and remembered them for their contribution towards the achievement of the goal of the department.

1. Late Mr. Rajaram Shrestha - Survey Officer
2. Late Mr. Laxmeshwor Pandit - Survey Inspector
3. Late Mr. Lalit Narayan Misra - Survey Inspector
4. Late Mr. Dhirendra Lal Karna - Survey Inspector
5. Late Mr. Toya Nath Bhattrai - Office Helper
6. Late Mr. Durgadevi Shrestha - Office Helper
7. Late Mr. Bhakta Bahadur Magar - Office Helper

Price of some of the publications of Survey Department

1. List of Geographical Names volume I to V - NRs 600/- for each volume.
2. Nepalese Journal on Geoinformatics - NRs 100/-
3. The Population and Socio-economic Atlas of Nepal (Hard Copy) NRs. 2,500 (In Nepal), € 200 (Out side Nepal)
4. The Population and Socio-economic Atlas of Nepal (CD Version) NRs. 250/-

Call for papers

The Editorial Board requests for Papers / articles related with Geoinformatics for the publication in the ninth issue of the Nepalese Journal on Geoinformatics. Last date for the submission of the article is March 31, 2010.

For more information, please contact
Jagat Raj Paudel, Editor-in-Chief
or
Deepak Sharma Dahal, Member, Editorial Bord
Topographical Survey Branch
Survey Department
P.O.Box 9435, Kathmandu, Nepal
Tel: +977-1-44 78 723, +977-1-44 66 463
Fax: +977-1-44 82 957, +977-1-44 96 216
Email: topo@ngiip.gov.np
Website: www.dos.gov.np

Need of professionalism in geomatics profession for the development of sustainable system

Umesh Kumar[1] and **Rabin K. Sharma**[2]

1. Instructor, Land Management Training Centre
e-mail: lmtc@ntc.net.np

2. Director General, Survey Department
e-mail: sharma19434@alumni.itc.nl

1. Introduction

Government of Nepal visualized for building new Nepal by development of sustainable system for good governance. The basic elements of good governance are: sustainable economic growth, incremental agricultural productivity, preservation of environment, reduction of poverty, easy access to proper education and health, etc. Accurate, reliable and operable spatial and attribute data are the fundamental input to address these issues. The data can be made available through the profession of Geomatics and professionals from this discipline are the one who create the data and this data set could be at the level of expectations for the user communities for the development of sustainable system when the professionals bear their professionalism. So it is felt that there is a need of professionalism in Geomatics profession for the development of sustainable system.

Development of professionalism for a professional from Geomatics profession is not an easy task. The professionals must have adequate education background and should affiliate with different institutions such as national and international organizations and its own working place for enhancing its capabilities and updating the knowledge necessary for the profession. Because, the government is responsible to uplift the entire society by facilitating social, economical and environmental issues which is depend upon the sustainable system of the government which in turn to be rely on the input data that are generated by the professionals from Geomatics profession. So they must feel high responsible for their job which is possible only when (s)he bears a good professionalism. This indicates that there is a relation between profession, professional and professionalism for development of sustainable system. This paper tries to identify the inter-relation between these elements by analyzing the related components

2. Definition of a Surveyor

Surveyor is one of the key persons of a country for the national development. It is a well known fact that every activities of national development need data and information related to land, sea and the Universe. The Surveyors are the one who collect, process and present data which are based on the actual field work or the information gathered through remotely sensed techniques. So as per the Land (Survey & Measurement) Regulations 2058, the works of surveyor are defined as follows:

- To conduct cadastral mapping which includes preparation of land records related to land owner and the tenant, preparation of cadastral plan, finding out area of the parcel, classification of land, preparation of field book.
- To operate aerial photography mission
- To establish control points
- To prepare topographical maps of various scales

Government of Nepal has made a provision to issue license to a qualified surveyor as mentioned in the article 11e of Land (Survey and Measurement) Act 2019 (Eight Amendment 2056). In this context "Licentiate Surveyor" is defined as surveyor who have obtained license under the Article 26 of Land (Survey and Measurement) Regulations 2058 and the license should be considered as a letter of permission for conducting survey and mapping in accordance with this Article.

International Federation of Surveyors (FIG) is a well known and recognized international organization for the surveyors and the definition of surveyor laid out by this organization is accepted globally and it defines as:

"A Surveyor is a professional person with the academic qualifications and technical experiences to practice the science of measurement, to assemble and assess land and geographic related information; to use that information for the purpose of planning and implementing the efficient administration of the land, the sea and structures thereon; and to investigate the advancement and development of such practices."

So each individual surveyor must confine her/his responsibilities and duties within the limit set by the local and global definition of Surveyors for establishing her/his profession.

3. Need of Professionalism

Geomatics profession has direct link with the property mapping of each individual holding even a piece of land as well as with the activities related to national development such as land development, hydro power projects, road construction projects, irrigation projects, atlas preparation, etcetera. Because, all of these projects need accurate, reliable, standard and up-to-date spatial as well as attribute data for planning, designing and implementation. Establishment of such data needs to design a system for acquiring, processing and presenting the data. Human resources involved in this entire system belong to the Geomatics profession and they should possess the characteristics related to professionalism which are dedicated, qualified, competent and honest for its profession. So it is obvious that for development of sustainable system, Geomatics professionals must have professionalism otherwise there could be a high chance for the failure of the project. On the other hand, sustainable system is required for the government to exercise the power in managing social, economic and natural resources for attaining good governance. It can be achievable only when it fulfills the norms identified in the UN Habitat Global Campaign on Urban Governance; adopted from FAO 2007. They are as follows:

- Sustainable and locally responsible
- Legitimate and equitable
- Efficient, effective and competent
- Transparent, accountable and predictable
- Participatory and providing security and stability
- Dedicated and integrity

So, the professionals should work hard to develop sustainable system and to support for establishing good governance, however, professionals bearing professionalism could stand to develop sustainable system because such professionals could establish good relation between political and bureaucratic system and without their understanding no project can succeed to achieve goals of the project.

4. Basic Entities of Professionalism

When an individual received a certain degree of training or studied some level of academic course in the field of Surveys or Geomatics, (s)he is qualified to become a surveyor. But to be recognize as a professional surveyor, (s)he must possess some basic entities of the professional and they are specified as academic qualification and/or training and the elements of professionalism.

4.1. Education of Surveyor

In Nepalese context, an individual is named as a surveyor when (s)he has acquired one of the following training courses or academic degree:

a) Training course

i. Basic Surveyor course of 12 months duration
ii. Junior Surveyor course of 12 months duration
iii. Senior Surveyor course of at least 12 months duration
iv. Survey Graduates or equivalent course from a recognized institution

4.2. Elements of Professionalism

The elements of Survey Professionalism are as follows:

- Role of an Employee: Most of the surveyors will attach with either public or private organization as an employee. So (s)he must play the role to achieve the goal of the organization as defined in the works, duties of responsibilities of her/his job description.
- Role of Professional Practitioner: Surveyor can practice his profession as a professional practitioner.
- Role of a Member of Professional Organization: It is obvious that professional organizations and the profession are inter-linked terms because the professional organization could evaluate as a good organization only when the professionals of the organization are active and bears good professionalism. So to maintain the sustainability of this inter-relationship the surveyors must affiliate with the professional organization and should contribute her/his services in the activities to foster the organization as well as professionalism of the sector.

5. Organization

Organization also guides professionals for achieving professionalism in their profession. The organization could be educational institution, national professional organization, international organization and the working organization. Each influences the professionals in different ways for developing their professionalism.

5.1. Educational Institution

Educational institutions for the production of Geomatics professionals are training and academic institutions. At present, the following private training institutions impart training course for basic surveyors under the approval from Council for Technical, Educational and Vocational Training (CTEVT):

1. School of Geomatics, Kathmandu
2. S.K. Institute of Technology, Mahendranagar
3. Kailali Polytechnical Institute, Dhangadhi
4. Narayani Training Centre, Bharatpur
5. Baglamukhi Technical Institute, Itahari
6. Nepal Technical Institute, Janakpur

Furthermore, School of Geomatics also conducts Diploma in Surveying. One more private institution: Geomatics Information Technology, Kathmandu; affiliated with Purbanchal University conducts Graduate course in Geomatics and Land Management Training Centre, Dhulikhel: the only Government Institution of Nepal for Geomatics profession imparts training for Basic, Junior and Senior Surveyor courses and also conducts Bachelor of Engineering in Geomatics Engineering in collaboration with Kathmandu University. Educational institutions have greater responsibilities to produce good quality professionals and they are:

- Designing standard curriculum for the courses
- Selecting enthusiastic students for learning
- Managing motivated resource persons for teaching
- Organizing effective class routines for the course
- Ensuring adequate infrastructure for teaching and for extra curricular activities
- Ensuring sufficient financial resources
- Attempting to establish good relation between the class and the teacher for maintaining the spirit of teaching and learning

5.2. National Professional Organization

Geomatics encompasses several disciplines and each discipline associated with its own organizations and furthermore the group of professionals of a particular discipline established their own professional organization. The common objectives of these professional organizations are mainly to secure and promote the profession, to facilitate regular dissemination of new ideas and technology, and to play an advisory role in formulating policies and programmes in their corresponding domain. Some of the professional organizations involved for developing professionalism in the field of Geomatics are as follows:

1. Nepal Geographical Society (NGS)
2. Nepal Engineering Association (NEA)
3. Nepal Geological Society (NGS)
4. Nepal Surveyor's Association (NESA)
5. Nepal Geographical Information System Society (NEGISS)
6. Nepal Remote Sensing and Photogrammetric Society (NRSPS)
7. Nepal Institution of Chartered Surveyors (NICS)

So the professionals should join at least one related professional organization as a member and should actively involve in the activities for achieving the goals of the organization and consequently, helps in development of professionalism.

5.3. International Organization

In Agenda 21 of the Earth Summit 1992 of Rio de Janeiro, it states that *"No nation can achieve sustainable development of its own, so global partnership is being sought for the cause"*. So guided by this philosophy, Government of Nepal supported Survey Department of Nepal for joining the International Organizations and for participating the events of those institutions. The main objectives are to give exposure of the Department in international forum, to update knowledge on recent developments in the field of Geomatics, to exchange views and experiences for solving the common technical problems with the experts from different parts of the world, to cooperate mutually for the development of technological advancement etc. The following are the organizations where Survey Department has acquired membership:

1. SAARC Networking Arrangement on Cartography (SNAC)
2. Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)

3. International Steering Committee for Global Mapping (ISCGM)
4. Asian Association on Remote Sensing (AARS)
5. Asia Pacific Regional Space Agency Forum (APRSAF)
6. Group on Earth Observations (GEO)
7. International Federation of Surveyors (FIG)
8. Global Spatial Development Infrastructure Association (GSDIA)
9. Sentinel Asia Joint Project Team (SA JPT)

Land Management Training Centre (LMTC) also started foot stepping the same principle of Survey Department by joining the international organizations to enhance its training programmes for producing better professionals in the field of Geomatics. So far, LMTC received membership of FIG in 2006 as Educational Member and applied for the membership of Sentinel Asia Joint Project Team in 2009.

Professionals are advised to involve or participate in the activities of such international organizations because one of their objectives is to emphasize on strengthening professional institutions promoting professional development; and encouraging professionals to acquire new skills and techniques. These objectives are set so that the professionals are properly equipped to meet the needs of society and the environment for facilitating economy, social and environmental sustainability.

5.4. Working Organization

A professional, in general, will attach to one organization: public or private, where her/his role will be to fulfill partially the objectives of the organization and in return (s)he will get her/his salary. At the same time (s)he will get opportunities to enhance her/his capabilities through sharing the issues, problems, solutions and technologies with the colleagues, clients, experts, etc. and also the same can be achieved by participating national and international meetings, seminars, conferences, etc. This will lead the professionals for development of its professionalism.

6. Profession, Professional and Professionalism

Inter-relation between profession, professional and professionalism can be illustrated with the diagram below:

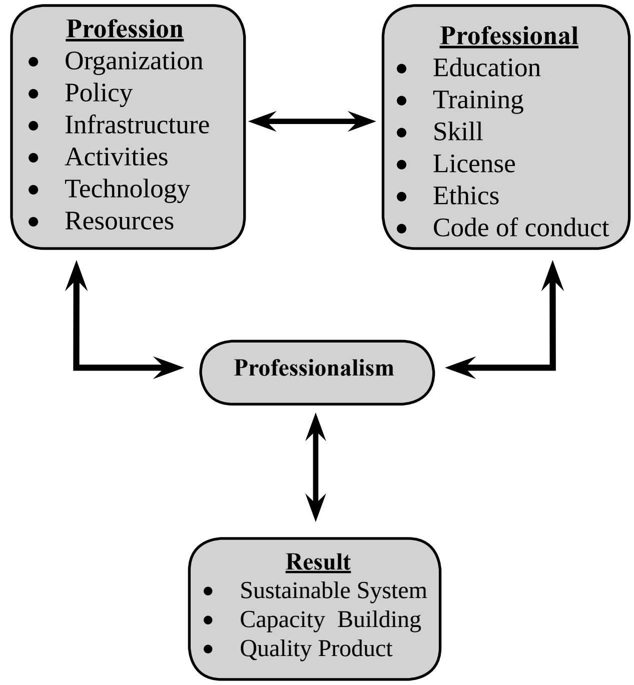


Figure: Inter-relation between Profession, Professional & Professionalism

Profession in an organization is always guided by governmental policies and activities supported by infrastructure, human and financial resources and technology in a particular field. A professional is distinguished by certain characteristics having a specified education and training, and having command and skill on a particular field, and enforcing them for following ethics and code of conduct of the profession resulting to development of professionalism. The end results in the environment of profession with such professional will be quality products, capacity building and sustainable system.

7. Conclusion

It is clear that there is a strong relation between profession, professional and professionalism. Geomatics professional must have specified qualification and/or training. S(he) could get a survey license issued by the related organization. Finally, (s)he must obey the ethics and code of conduct specified by the related organization. Some of the ways to develop her/his professionalism are to practice in a related organization, involve in professional organization and participate in the event of national and international organizations related to Geomatics profession. Such professionals could develop sustainable system and hence it is felt that professionalism is necessary in Geomatics profession for the development of sustainable system for achieving good governance in the country.

Reference

1. *Buddhi Narayan Shrestha; Licentiate Surveyor System in Nepal; Nepalese Journal on Geoinformatics, Number 7; 2008*
2. *Buddhi Narayan Shrestha; Need of Licensing in Surveying Profession; Nepalese Journal on Geoinformatics, Number 1; 2002*
3. *Earth Summit : Agenda 21; The United Nations Programme of Action from Rio; Rio de Janerio, Brazil; 3-14 June 1992*
4. *Land (Survey and Measurement) Act, 2056*
5. *Land (Survey and Measurement) Regulations 2058*
6. *Nab Raj Subedi; Surveying Profession and Professionalism; Nepalese Journal on Geoinformatics, Number 6; 2007*
7. *Rabin K. Sharma; Profession and Professional Organizations in Nepalese Context; paper presented in XXIth ISPRS Congress 2008, Beijing China; July 3-11, 2008*
8. *Rabin K. Sharma; Professional Organizations of Geoinformatics in Nepal; Nepalese Journal on Geoinformatics, Number 7; 2008*
9. *Rabin K. Sharma; Survey Department in the Forum of International Activities: an Overview; Nepalese Journal on Geoinformatics, Number 3; 2004*
10. *www.fig.net*

Price of Aerial Photograph and Map Transparency

Prduct	***Price per sheet***
a) Contact Print (25cmx25cm)	*Rs 150.00*
b) Dia-Positive Print (25cmx25cm)	*Rs 500.00*
c) Enlargements (2x)	*Rs 600.00*
d) Enlargements (3x)	*Rs 1200.00*
e) Enlargements (4x)	*Rs 2000.00*
Map Transparency	
*a) 25cm * 25cm*	*Rs 310.00*
*b) 50cm * 50cm*	*Rs 550.00*
*c) 75cm * 75cm*	*Rs 800.00*
*d) 100cm * 100cm*	*Rs 1250.00*
Diazo/Blue Prints	*Rs 40.00*
Photo copy	*Rs 50.00*
Photo lab facilities	*US$ 200/day*

In case the materials provided by the clients, the office will charge only 40% of the marked price as service charge.

Price of Digital Topographic Data Layers

LAYER	***Rs/Sheet***
Administrative	*100.00*
Transportation	*200.00*
Building	*60.00*
Landcover	*300.00*
Hydrographic	*240.00*
Contour	*240.00*
Utility	*20.00*
Designated Area	*20.00*
Full Sheet	*1000.00*

Image Data:

Digital orthophoto image data of sub urban and core urban areas mintained in tiles conforming to map layout at scales 1:10 000 and 1:5 000, produced using aerial potography of 1:50 000 and 1:15 000 scales respectively are also available. Each orthophoto image data at scale 1:5 000 (couering 6.25 Km^2 of core urban areas) costs Rs. 3,125. 00 . Similarly, each orthophoto image data at scale 1:10 000 (covering 25 Km^2 of sub urban areas costs Rs 5,000.00.

Price of SOTER Data	*Whole Nepal*	*NRs : 2000.00*

Role of geo-potential models in gravity field determination

Niraj Manandhar[1] and **Rene Forsberg**[2]

1 Chief Survey Officer, Survey Department, Geodetic Survey Branch
M.Eng. Geodesy(University of New South Wales,Sydney Australia)
manandhar_niraj@hotmail.com

2. Geodynamics Department
Danish National Space Center, rf@space.dtu.dk

Keywords

EGM (Earth gravity model), GEM (Goddard Earth Model).

Abstract

This paper sets out to describe the developments of geopotential models and its role in gravity field determination. The paper also focuses in different geopotential models those are available and in use from 1980 onwards till at present with major emphasis placed on WGS84 EGM96 geopotential model.

1. Introduction:

High degree spherical harmonic expansions can provide valuable information on the earth's gravity field. Such field can be used to determine geoid undulations as well as signals to be expected from a satellite tracking mission. In the past few years the description of the earth's gravity potential in terms of spherical harmonic coefficients has been extended to degree and order n_{max}=360. These high degree expansions can be used to evaluate quantities such as geoid heights, gravity anomalies, gravity disturbances and deflection of vertical with respect to geocentric ellipsoid. The theory of spherical harmonics used to determine the potential of the earth is given in Heiskanen and Moritz (1967) and Torge (1991).

The coefficients C_{nm} and S_{nm} up to degree (n) and order (m) for high order geopotential model are determined by a combination of data from analysis of orbit perturbation of satellites, mean terrestrial gravity values from different sized blocks and N values at cross over points in ocean areas measured by satellite altimetry. The long wavelength geoidal feature determined from satellite analysis are found in the low order terms of the model whilst the short wavelength, higher frequency information found from the satellite altimetry and terrestrial gravity is reflected in the higher order terms.Geopotential models to degree 180 are capable of detecting geoidal features with a half wavelength of 1^0, or 110 km to an accuracy of 0.5m in Canada and 0.2m in Austrlia.

2. Gravity Anomaly and Geopotential Coefficients

The satellite determination of the gravity field has been long wavelength where the maximum degrees in the spherical harmonic expansion has reached to degree 360 at present. In order to obtain high frequency information, methods were developed to combine satellite-derived potential coefficient information with surface gravity data. Many new techniques had been applied to combine data to achieve more accurate and representative expansions of the Earth’s gravitational potential and besides its many uses in physical geodesy it can define the reference surface for geodetic calculations involving geoid determination using the surface gravity data of the particular region or country. The geopotential models may be used for simulation studies for space missions (Schutz et al. 1989) and the models may be used to study the spectrum of earth’s gravitational field.

The spherical harmonic representation of the earth’s gravitational potential V is defined as

$$V(r,\theta,\lambda) = \frac{GM}{r}\left[1+\sum_{n=2}^{\infty}\left(\frac{a}{r}\right)^n \sum_{m=-n}^{n} c_{nm} Y_{nm}\left(\bar{\theta},\lambda\right)\right]$$

Where r is the geocentric distance, θ geocentric colatitude, and λ is the longitude, GM is the geocentric gravitational constant, while a (usually the equatorial radius of an adopted mean- earth ellipsoid) is the scaling factor associated with the fully normalized spherical geopotential coefficients, C_{nm}. In addition

$$Y_{nm}(\theta,\lambda)=P_{nm}(Cos\theta)Cosm\lambda$$

$$Y_{nm}(\theta,\lambda)=P_{nm}(Cos\theta)Sinm\lambda$$

$P_{nm}(Cos\theta)$ are the fully normalized associated Legendre functions of the first kind (Heiskanen and Moritz, 1967)

3. The Commonly used Geopotential models

The most commonly used higher order geopotential models and the input data used to determine them is given in Table-1.

Model	Degree	Origin	Date	Input Data
OSU81	180	Rapp	1981	GEOS 3data + 1 ^{0} Surface gravity + SEeASAT altimetry
GRIM 3	36	Reigher	1983	Satellite tracking data
GEM-L2	20	Lerch	1984	SLR+GEM9 data
GEM2	200	Wenzel	1985	GEM-L2+1 ^{O} surface gravity + altimeter data
GEM-T3S	50	Lerch et al.	1992	Satellite tracking data
GEM-T3	50	Lerch et al.	1992	Satellite tracking data,altimeter data & surface gravity observation
OSU 91A	360	Rapp, Wang, & Pavlis	1991	Satellite tracking data(GEM-T2)+sea surface topography
EGM 96	360	GSFC/DMA/ Rapp	1996	Satellite tracking data+ surface gravity etc.

Table 1

4. The World Geodetic System 1984 Earth ravity Model (WGS84 EGM 96)

The WGS84 EGM is a spherical harmonic expansion of the geopotential. It consists of 32,755 geopotential coefficients and is complete through degree(n) and order(m) 180. These coefficients are determined in two separate solutions.

5. Determination of Gravitation Coefficients

The WGS84 coefficients through n = m = 41 were obtained from a weighted least square solution of a normal equation matrix developed by combining individual normal equation matrices formed from:

- Doppler tracking of seven satellite with different inclinations
- Satellite laser ranging to LAGEOS (i=110 degree) and satellite (i=49.8 degree)
- Surface gravity data which consisted of 11, 688,136 gravity values referenced to IGSN or the WGS84 ellipsoid.
- Oceanic geoid heights deduced from a set of approximately 4.2 million along track point geoid heights derived from SEASAT-1.
- NAVSTAR GPS data which consisted of simultaneous tracking data from GPS satellites.
- Lumped coefficients, “ which are values of certain linear combination of gravity coefficients for rather large orbital perturbations on particular satellites.” (Defence Mapping Agency, 1987)

After the n=m= 41 portion of the WGS84 EGM had been solved from the weighted least square solution, the effect or contribution of the n=m= 41 coefficients were removed from the 1 degree X 1 degree mean free air gravity anomaly field. The WGS84 EGM coefficients from n= 42 m=0 through n=m= 180 were then determined independently via spherical harmonic analysis using residual field.

The total coefficients set n=m= 0 through n=m= 180 forms the WGS84 EGM, which can be used to calculate WGS 84 geoid heights, WGS 84 Δg or deflection of vertical and 1degreeX 1degree mean gravity anomalies.

6. Applications of WGS84 EGM

The EGM through n=m= 41 is appropriate for satellite orbit calculation and prediction purposes. The use of higher order terms is not recommended. The expansions from n=m= 41 to n=m= 180 degree and order are needed to accurately model geoid heights (N), and gravity disturbance components (or deflection of vertical) and mean gravity anomalies.

The EGM validation tests rather than coefficient accuracy test were performed. This was because these comparisons would not be independent since the data being used to validate the EGM is for the most part very similar to the information used in its development. The validation test did however indicate that the data sets were integrated correctly into the EGM development process in a relative sense.

The WGS 84 is significant improvement on it existing geopotential models because of the better physical modeling, through a selection of a larger gravitational potential parameter sets secondly improved equation development, including the statistical treatment of unmodelled effects and lastly the use of newer and more accurate supporting data. Therefore EGM 96 is now globally used reference height datum.

7. The WGS 84 Geoid

The geoid is defined as that particular equipotential surface of the earth that coincides with the mean sea level over the oceans and extend hypothetically beneath all land surfaces. In a mathematical sense, the geoid is also defined as so many meters (+N) or below (-N) the ellipsoid.
The WGS 84 geoid can be defined by superimposing "N" values, determined by a spherical harmonic expansion, on the WGS 84 ellipsoid. WGS 84 geoid heights (N) are calculated using a spherical harmonic expansion and the WGS EGM through n=m=180. These geoid heights when combined with WGS 84 ellipsoid define the WGS 84 geoid.

The principle function of the WGS 84 geoid (Decker, 1986) are to serve as a reference surface for WGS 84 related heights above mean sea level (h) values in those parts of the world where geodetic vertical datum are not available from tide guage data. (Enabling H = h(WGS 84) – N (WGS 84). Secondly its principle function is to provide WGS 84 positional data in oceanic regions where WGS 84 geoid heights are equivalent to WGS 84 geodetic heights that is H (WGS 84) = h (WGS 84) and lastly to provide the measure of how accurately the WGS 84 ellipsoid approximates the mean sea level surface.

The RMS of a WGS 84 geoid height taken on the basis of world wide 1 degree X 1 degree grid, is 30.5 meter. This RMS value is an indication of how accurately the WGS 84 ellipsoid taken as a mathematical figure of the earth, fits the earth's mean sea level surface. WGS 84 geoid heights determined using spherical harmonic expansion based on the WGS 84 EGM are accurate to +/- 2 to 3 meters over approximately 70% of the earth, while 93% of the earth has WGS 84 geoid heights that are accurate to better than +/- 4 meters.

For the application in geophysics, lower order surveys and the mapping control, N (WGS 84) may well be sufficient. However, for geodetic and oceanographic purposes, higher resolution geoids will be required to improve relative accuracy to the order of 1 to 2 ppm.

8. GEM-T3 and GEM-T3S Models

The improved models of the earth's gravitational field have been developed from conventional satellite tracking data (GEM-T3S) and from the combination of satellite tracking, satellite altimeter and surface gravity data (GEM-T3). This combination model represents a significant improvement in the modeling of the gravity field at half wavelength of 350 km and longer. Both models are complete to degree and order 50. The GEM-T3 model provides for more accurate computation of satellite orbital effect as well as giving a superior geoidal representation from that achieved in any previous Goddard Earth Model (GEM). A description of the model, their development and an assessment of their accuracy has been given by Lerch et al.(1992).

9. The Ohio State University (OSU) Series

The series of models of high order models for use in geoid studies and were developed by Professor Richard Rapp and other fellow researchers. The degree of the model has increased with time, and bases of the models has similarly become more sophisticated. The OSU models had been used widely throughout the world as a reference model for precise local geoid determination.

The OSU 91A model is again the result of the work carried out by Rapp et al.(1991) and it is computed to degree 360. Besides incorporating new anomaly and altimeter data, it also includes a sea surface topography model to degree 10/15, and adjusted GEOSAT orbits for the first year of the exact repeat mission (ERM). It was started from the GEM-T2 potential coefficient model and its error covariance matrix and GEOSAT orbits computed by Haines et al. (1990) using GEM – T2 Model. This model has also been tested through orbit predictions and data fitting, through comparisons with geoid undulations computed from Doppler and GPS located stations, and with comparisons to geoid undulations implied by GEOSAT altimeter data.

10. Conclusion

Geopotential models definitely play a very important role in modeling the gravity field of the earth. Without the use of the geopotential models it would be very difficult to accurately support terrestrial extraterrestrial endeavors. In this paper various model have been mentioned with major emphasis on WGS 84 EGM, GEM-T series and OSU series. Apart from that for a long period the OSU91A remained as a most accurate reference model for many application in geodesy and geosciences but it is now replaced by EGM96 geopotential model. The growing accuracy of the satellite borne data, satellite altimeter data, airborne gravity data, surface gravity data definitely calls for more accurate geopotential models.

Referances

1. *Decker, B.L (1986). World Geodetic System 1984, Fourth International Geodetic Symposium on Satellite Positioning (Austin, Texas, 28 April -2 May 1986)*
2. *Denker, H. and Rapp,R. (1990). Geodetic and Oceanographic Results from the Analysis of 1 year of Geosat Data, J. Geoshys. Res.,95,C8 pp.13151-13168, 1990.*
3. *Groten, I.E. (1979). Geodesy and the Earth's Gravity Field (Vol. 1: Principles and Conventional Methods). Fred Dummler Verlag: Bonn, 1979.*
4. *Heiskanen, W. and Moritz, H. (1967) Physical Geodesy, Freeman: San Francisco, 1967.*
5. *Kearsley, A.H.W.(1988), The determination of geoid-ellipsoid separation for GPS leveling. The Australian Surveyor Vol.34 No.1 March1988.*
6. *Lerch, F.J.,R.S. Nerem, B.H. Putney, T.L. Felsentreger, B.V.Sanchez, S.M. Klosko,G.B. Patel, R.G. Williamson, D.S. Chinn, J.C. Chan, K.E. Rachlin, N.L. Chandler, J.J. McCarthy, J.A. Marshall, S.B. Luthcke, D.W. Palvis, J.W. Rpbbins, S. Kapoor and E.C. Palvis (1992), Geopotential Models of the Earth From Satellite Tracking, Altimeter and Surface Gravity Observations: GEM – T3 and GEM –T3S, NASA Technical Memorandum 104555, Goddard Space Flight Center: Greenbelt, MD. January 1992.*
7. *Rapp, R.H and Pavlis, N.K. (1990). The development and analysis of geopotential models to spherical harmonic degree 360. Journal of Geophysical Research, Vol. 95 No. B13, pp. 21885-21911, Dec. 10, 1990.*
8. *Rap, R.H., Wang, Y.M. and Pavlis, N.K. (1991). The Ohio State 1991Geopotential and Sea Surface Topography Harmonic Coefficient Models Report No. 410, Department of Geodetic Science and Surveying. The Ohio State University: Colombus, Ohio. August 1991.*
9. *The Defense Mapping Agency (1987). DMA Technical Report (Supplement to Department of Defence World Geodetic System 1984 Technical Report) Part 1: Methods, Techniques, and Data Used in WGS84 Development, DMA TR, 8350. 2 –A, Washington DC. 1 Dec. 1987.*
10. *Torge, W. (1991) Geodesy. 2nd Edition. Walter de Gruyter: Berlin , 1991.*

Nepal Remote Sensing and Photogrammetric Society

New NRSPS Executive Committee

The new executive committee was formed on January 17th 2009 by the NRSPS General Assembly. Mr. Rabin Kaji Sharma, Executive Director of LMTC was re-elected as the president. Mr.Durgendra Man Kayastha, Project In-charge, NGIIP was elected as the Vice President. Mr. Anish Joshi, Executive Director of GENESIS Consultancy (P) Ltd. was elected as the Secretary and Mr. Him Lal Shrestha, Kathmandu Forestry College was elected as the Assistant Secretary. Similarly, Mr. Jagat Raj Poudel, Survey Dept. was re-elected as the Treasurer. Among the members, Mr. Raj Kumar Thapa, Nepal Army; Mr. Hari Prasad Pokhrel, School of Geomatics; Mr. Krishna Raj B.C., Survey Dept.; and Mr. Anil Marasini, Department of Survey were elected by the General Assembly.

Awareness Program in Institute of Engioneering , Western Regional College, Pokhara

An awareness programme was conducted on Remote Sensing in Institute of Engineering, Western Regional Campus, Pokhara on 26th January, 2009. The theme of the program was "Seminar on Application of Remote Sensing and GIS" organized by the Tribhuvan University Institute of Engineering, Western Regional Campus.

NRSPS President, Mr. Rabin Kaji Sharma was the chief guest of the program; NRSPS Secretary Mr. Anish Joshi and members Mr. Govinda Baral and Mr. Giri Raj Khanal attended the programme as the guests. President Mr. Sharma inaugurated the program and presented the overview of the international affiliations of NRSPS.

Secretary Mr. Anish Joshi presented the introduction of NRSPS and conducted interactive discussion session with the WRC faculty members and engineering students. NRSPS member Mr. Giri Raj Khanal presented the concept of Spatial Data Infrastructure (SDI) and Mr. Govinda Baral presented the introduction on Remote Sensing and Photogrammetry.

The program was very successful as the engineering students and faculty members actively participated in the seminar and showed a very positive attitude towards learning Remote Sensing and Space Technology.

Upcoming Programs/Activities in 2009

NRSPS has planned to organize several programs and has formulated a work plan for the year 2009. The upcoming activities are

- Annual Anniversary Program on April 11, 2009
- Dissemination of Information through various programs including publication of “Earth Observation” Newsletter, talk program on Remote Sensing and Space Technology, awareness program in different institutions, workshop and publication of book on Applications in Photogrammetry and Remote Sensing
- Networking with related agencies and institutions through interaction program with professional organizations/societies and courtesy visit to related agencies and institutions
- Fund raising program
- Amendment of NRSPS statute
- Membership program

Publication of Proceeding/Book on Applications in Remote Sensing and Photogrammetry

NRSPS has envisaged to publish a conference proceeding/book on applications in Remote Sensing and Photogrammetry with an aim to disseminate information of remote sensing and space technology science and its applications in various sectors in the country. This publication aims to contain country papers, best practices and use cases and conference proceedings from the seminar to be held.

NRSPS, therefore call for papers and articles related to the theme “Applications in Remote Sensing and Photogrammetry” to all the interested individuals/ organizations.

Executive Members

President
Rabin Kaji Sharma
Survey Department
Min Bhawan, Kathmandu
rabinksharma@hotmail.com

Vice President
Durgendra Man Kayastha
Survey Department
Min Bhawan, Kathmandu
durgendra.kayastha@gmail.com

Secretary
Anish Joshi
Genesis Consultancy (P) Ltd.
New Baneshwore, Kathmandu
anish@genesis.wlink.com.np

Assistant Secretary
Him Lal Shrestha
Kathmandu Forestry College
Koteswor, Kathmandu
hlshrestha@gmail.com

Treasurer
Jagat Raj Paudel
Survey Department
Min Bhawan, Kathmandu
Jagatrajpoudel@hotmail.com

Members
Raj Kumar Thapa
Nepal Army
Krishna Raj B.C.
Survey Department
Hari Prasad Pokhrel
School of Geomatics
Anil Marasini
Survey Department

Nepal GIS Society

Advisory Committee Members

Prof. Dr. Mangal Siddhi Manandhar
Dr. Binayak Bhadra
Mr. Buddhi Narayan Shrestha
Director General Department of Survey
HoD Central Department of Geography, TU
HoD MENRIS, ICIMOD
President Nepal Engineering Association
President Nepal Geographical Society
President Nepal Geological Society
President Computer Association of Nepal
Mr. Pramod S. Pradhan Former President

Executive Committee 2007-2010

President	-	Dr. Krishna Poudel
Vice President	-	Manohar K. Bhattarai
General Secretary	-	Govinda Joshi
Secretary	-	Karuna Bhakta Shrestha
Treasure	-	Madhav Adhikari
Member	-	Shova Kanta Dev
Member	-	Sushila Rajbhandari
Member	-	Milan Dahal
Member	-	Bhola Nath Dhakal
Member	-	Santosh Kokh Shrestha
Member	-	Kumud Raj Kafle

Nepal Geographical Information System Society (NEGISS) was formally registered in the Government of Nepal on 22 July 1995 with clear objectives of furthering the use and application of GIS and spatial data analysis technologies in the country as an aid to our mainstream endeavors in ensuring sustainable human development through effective management and mobilization of resources base, and networking among the organizations.

Since its establishment the Society has been working for the development of GIS awareness activities and its application in the country. The Society has regularly published annual news bulletin ***'GIS Nepal'***, organizing talk progamme, workshop, training, seminars and product exhibition.

Activities of Fiscal Year 2064/65 (2008)

International GIS Day and GIS Awareness Week November 2008 Celebration
The week was celebrated by organizing basic GIS training for the individuals, teachers and students of various subjects and organization and a workshop on 'application of GIS in Nepal'.

Training Course for the Higher Secondary School Teachers 01st to 05th September 2008.
Nepal GIS Society in close collaboration with International Centre for Integrated Mountain Development (ICIMOD) and European Space Agency (ESA) had organized a Geographic Information System (GIS) and Remote Sensing (Earth Observation from Space) Training for Higher Secondary School Teachers at Jawlakhel Lalitpur.

Workshop on GIS for School Education August 2008
A half day GIS workshop for the Higher Secondary School Students and Teachers was organized by the Society. Over 70 participants were participated the workshop.

Celebration of 13th Anniversary of the Nepal GIS Society 6th Shrawan 2064 (July 22, 2008).
The 13th anniversary of the Society was celebrated by presenting the 'Application of GIS in Nepal.

Professional Level GIS training 06 January to February 08, 2008
Professional level GIS training was conducted by Nepal GIS Society in close collaboration with Department of Humanities and Social Sciences, Institute of Engineering Pulchwok Campus and Nepasoft Solutions. Eighteen participants from various organizations

Nepal Surveyors' Association (NESA)

NESA CEC
Secretariat

Mr. Madhusudan Adhikari
President
Mr. Ambadatta Bhatta
Chief Vice President
Mr. Saroj Chalise
General Secretary
Mr. Prakash Dulal
Secretary
Mr. Durga Phuyal
Secretary
Mr. Sahadev Ghimire
Treasurer
Mr. Dadhiram Bhattarai
Co-treasurer
Mr Hari Prasad Parajuli
Member
Ms. Jyoti Dhakal
Member

NESA CEC
Other members

Mr. Ram Sworup Sinha
Vice President
Eastern Development Region
Mr. Tanka Prasad Dahal
Vice President
Central Development Region
Mr. Gopinath Dayalu
Vice President
Western Development Region
Mr. Ramkrishna jaisi
Vice President
Midwestern Development Region
Mr. Karansingh Rawal
Vice President
Farwestern Development Region
Mr. Premgopal Shrestha
Member
Ms. Geeta Neupane
Member
Mr. Laxmi Chaudhari
Member
Mr. Kamal Bdr. Khatri
Member
Mr. Bijubhakta Shrestha
Member
Mr. Sahadev Subedi
Member
Mr. Balam Kumar Basnet
Member
Mr. Nawal kishor Raya
Member
Mr. Santosh Kumar Jha
Member

Background

Utilizing the opportunity opened for establishing social and professional organizations in the country with the restoration of democracy in Nepal as a result of peoples movement in 1990, Survey professionals working in different sectors decided to launch a common platform named Nepal Surveyors' Association (NESA) in 1991, as the first government registered Surveyors' Organization in Nepal.

Objectives

The foremost objective of the association is to institutionalize itself as a full fledged operational common platform of the survey professionals in Nepal and the rest go as follows

- *To make the people and the government aware of handling the survey profession with better care and to protect adverse effects from it's mishandling.*
- *To upgrade the quality of service to the people suggesting the government line agencies to use modern technical tools developed in the field of surveying.*
- *To upgrade the quality of survey professionals by informing and providing them the opportunity of participation in different trainings, seminars, workshops and interaction with experts in the field of surveying and mapping within and outside the country*
- *To upgrade the quality of life of survey professionals seeking proper job opportunities and the job security in governmental and non governmental organizations*
- *To work for protecting the professional rights of surveyors in order to give and get equal opportunity to all professionals with out discrimination so that one could promote his/her knowledge skill and quality of services.*
- *To advocate for the betterment of the quality of education and trainings in the field of surveying and mapping via seminars, interactions, workshops etc*
- *To wipe out the misconceptions and ill image of survey profession and to uplift the professional prestige in society by conducting awareness programs among the professionals and stakeholders*
- *To persuade the professional practitioners to obey professional ethics and code of conduct and to maintain high moral and integrity*
- *To advocate for the ratification of Survey Council Act and Integrated Land Act for the better regulation of the profession and surveying and mapping activities in the country.*

Organizational Structure

The Organization is nationwide expanded and it has the following structure
14 Zonal Assemblies ZA, 14 Zonal Executive Committees ZEC
5 Regional Assemblies ZA, 5 Regional Executive Committees ZEC
Central General Assembly CGA, Central Executive committee CEC

Membership Criteria

Any survey professional obeying professional ethics and code of conduct, with at least one year survey training can be the member of the Association. There are three types of members namely Life Member, General Member and Honorary Member. At present there are 2031 members in total.

Activities

In Shrawan of 2065 (July 2008)the 3rd National Convention was completed in an enthusiastic environment electing a new central executive committee
In Bhadra 18th of 2065(3rd Sept. 2008) the Surveyors' day was celebrated with different programs like: Blood Donation, Survey Quiz and Volleyball competition among members.
The association is regularly publishing Journals and Calendars
The association conducted different social activities like felicitation programs with great honor to the prominent professionals, financial support for the treatment of some of its members

Theory of error and least square adjustment: Application in coordinate transformation

Madhusudan Adhikari
President NESA

Abstract
After detection and elimination of blunders, determination and correction of systematic errors the remaining random errors are adjusted by the method of least square. It is very useful technique in survey adjustments; as an example of its application, adjustment of conformal transformation of coordinate has been presented in this paper.

1. Basic concept of Errors

Geomatics engineers are usually faced with the problem of estimating some unknown quantities (parameters). This is done through collecting several measurements of some kind known as observations- and then adopting some appropriate mathematical model relating both observations and unknowns [Naser EL-Sheimy]

Observations generally require some form of instrumentation that is operated by some observer under certain environmental condition. Therefore, in every observation these three things- instrument, observer and environment have an influence on the accuracy of the measured quantity. Due to this influence, all observations contain error - the difference between an observation of a quantity and it true value.

The true value of a quantity is never known and hence the true error too. However, both quantities can be estimated.

$$e = l - t$$

e : *true error*

l : *observed value*

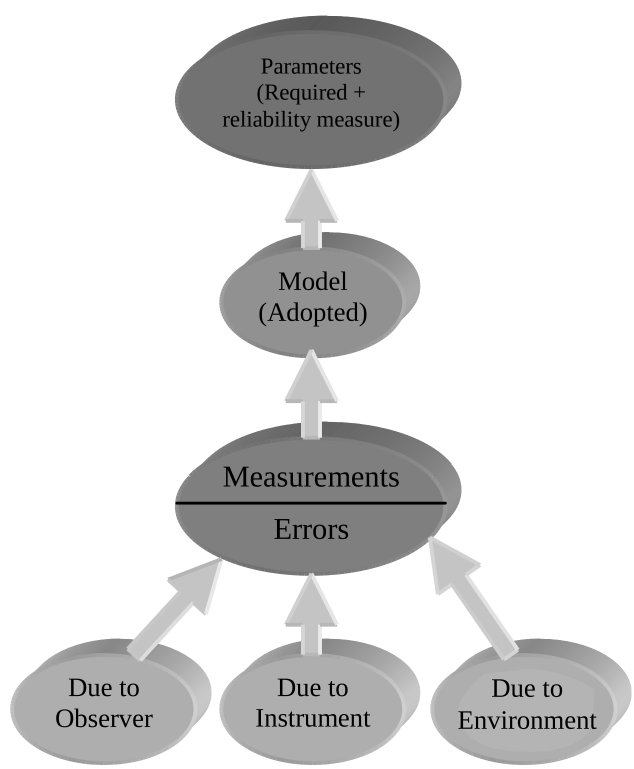
t : *true value*

$$n = l - \hat{x}$$

n : *estimated error*

l : *observed value*

$\hat{x}$: *estimated value*



1.1 There are three sources of error

Personal: due to limitations in human perception power, carelessness, fatigue etc.

Instrumental: due to imperfect construction, improper and incomplete adjustment, precision limits (least count) etc.

Natural: due to changing environmental conditions, structure of the earth, gravity and gravitational forces, earth's rotation etc

	Gross errors, mistakes, or blunders:	**Systematic errors**	**Random errors**
Characteristics	These are the largest of the errors likely to arise/ abnormal observations	These can be constant or variable through out the observation and are generally attributable to a known circumstance. These can be expressed by some functional relationships.	These are those variants, which remain after all other errors have been removed. they have no functional relationship based up on a deterministic system usually modeled by probability theory
Source	Personal sources carelessness of the observer	All instrumental personal and natural sources can cause systematic error	All instrumental personal and natural sources can cause random error
Effect/ nature	Inhomogeneous observables	It is cumulative in nature. It shifts all the observations in a certain direction.	It is compensating in nature. Cannot generally be eliminated.
Treatment	Must be detected by careful checking and independent check measurements and eliminated by filtering out	Must be detected and corrected by proper calibration of the instrument before use. Use appropriate procedure during measurement, like reciprocal observations two face reading. Apply corrections.	Can be minimized by taking redundant observations and adjusting by method of least square. the process is referred to as the "Adjustment of observation" or "Adjustment computation"

Three types of errors

2. Principle of Least Square

As the true value and true error by the measurements of a quantity is never known, what do we do is we estimate the most probable value (MPV) which is supposed to be the nearest to the true value among or within the range of the large no of observations. The basic theorem in this subject is referred to as Gauss-Markov theorem, which states, "in the case of independent observations of equal weight the least square estimates are the linear unbiased estimates with minimum variance." In surveying literature the principle of least square is shown derived for the observations of normal distribution and is usually expressed as- "the most probable value or the best linear unbiased estimate of a set of observations is one for which the sum of weighted squared residuals is a minimum." [w. Schofield]

The expression for the normal distribution curve, the probability curve is given by $y = \frac{h}{\sqrt{\pi}} e^{-h^2 \varepsilon^2}$

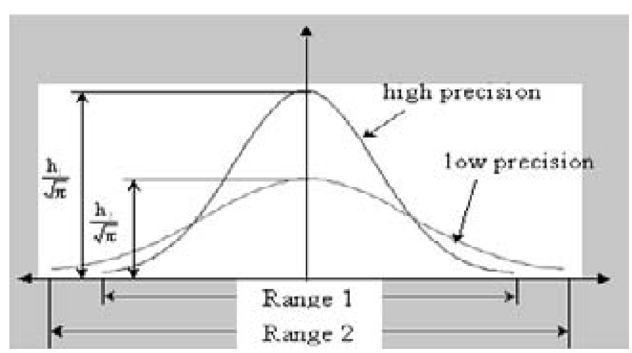


Figure 2: Probability Curve

Where

y -is the probability of occurrence of the error ε

h -is an index of precision

e -is the exponential function 2.71828

Differentiating with respect to *h* we will get

$$\frac{dy}{dh} = \frac{e^{-h^2\varepsilon^2}}{\sqrt{\pi}}\left(1 - 2h^2\varepsilon^2\right)$$

For a maximum *y*, $\frac{dy}{dh} = 0$

$$\text{i.e.} 1 - 2h^2\varepsilon^2 = 0$$

$$\text{or } \varepsilon^2 = \frac{1}{2h^2}$$

Thus, the error will be decreased and the accuracy will be increased as the precision *h* increases the maximum accuracy will be achieved when

$$\sum_{i=1}^{n} e_i^2 = \sum_{i=1}^{n} \frac{1}{2h_i^2} = \text{a minimum}$$

For weighted observations

$$\sum_{i=1}^{n} w_i e_i^2 = \text{a minimum}$$

ε_i = MPV (M) - ith observed value (M_i)
w_i = weight of i^{th} observed value
Then,

$$\sum_{i=1}^{n} w_i e_i^2 = \sum_{i=1}^{n} w_i (M - M_i)^2 = \text{a minimum}$$

or $$\frac{d}{dM}\left(\sum_{i=1}^{n} w_i (M - M_i)^2\right) = 0$$

or $$\sum_{i=1}^{n} w_i (M - M_i) = 0$$

or $$\sum_{i=1}^{n} w_i (M - M_i) = 0$$

or $$M\sum_{i=1}^{n} w_i - \sum_{i=1}^{n} w_i M_i = 0$$

or $$M = \frac{\sum_{i=1}^{n} w_i M_i}{\sum_{i=1}^{n} w_i}$$

thus the most probable value is the weighted arithmetic mean of the observed values. if the observed values are of equal weight i.e. $w_1 = w_2 = w_3 = ... = w_n = w$,

$$\sum_{i=1}^{n} w_i = nw$$

and

$$\sum_{i=1}^{n} w_i M_i = w\sum_{i=1}^{n} M_i,$$

Then $$M = \frac{\sum_{i=1}^{n} M_i}{n}$$

Thus for the observations with equal weight the most probable value is the simple arithmetic mean. There are two basic methods for adjustment of the observations by this technique, namely The Indirect Method or Method of Observation Equations, and Direct Method or The Method of Condition Equations.

In the Indirect Method, we will have following four steps:

Step 1: Assume the values for required quantities (the assumed value may be the observed quantity or any other arbitrarily assumed quantity)

Step 2: Formulate the observation equations by applying corrections (*v*s) to the assumed values to obtain MPV.

Step 3: Determine the residuals by subtracting observed values from MPV

Step 4: formulate the normal equations by applying least square conditions.

3. Adjustment of Conformal Transformation of Coordinates by Least Square Method

3.1. Conformal Transformation of Coordinates

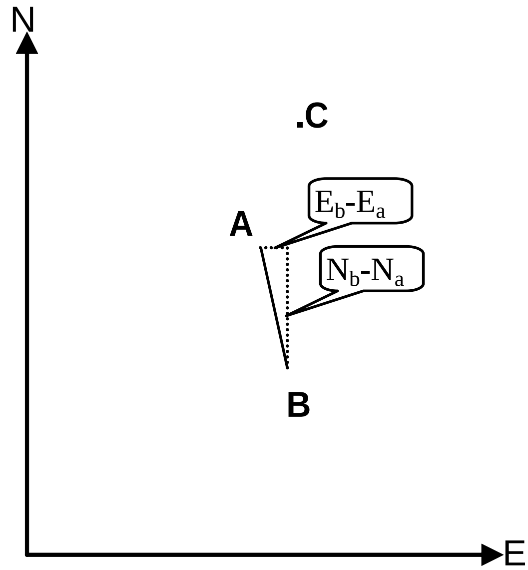
Let us first derive the equations for the conformal transformation. A two Dimensional Conformal Transformation consists of three basic steps:

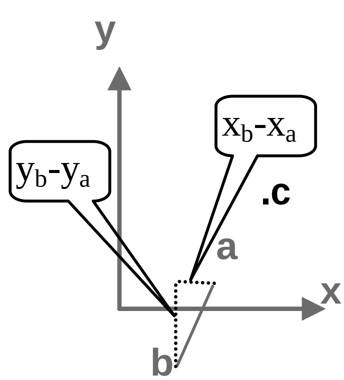
- Scale Change
- Rotation
- Translation

3.1.1 Scale Change

Let us say we have coordinate systems XY and EN as shown in figure locating the points a (X_a , Y_a) and b (X_b , Y_b) in XY system and their corresponding positions a (E_a , N_a) and b (E_b , N_b) in EN system, then the scale factor is given as

$$S = AB/ab = \sqrt{\frac{(E_b - E_a)^2 + (N_b - N_a)^2}{(X_b - X_a)^2 + (Y_b - Y_a)^2}}$$

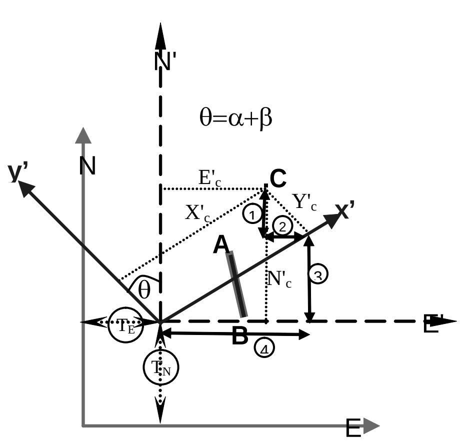




First, we will change the scale of XY system making equal to that of EN system by multiplying each x,y by the scale factor S . The scaled coordinates are x',y'.

3.1.2 Rotation

Here we super impose the scaled x' y' coordinate system over EN system, so that AB and ab of both the system coincide as shown in the figure below and construct an auxiliary axis system E'N' coinciding the origin with the origin (shifted during rotation) of x'y' system.



① $y'_c Cos\theta$ ③ $x'_c Sin\theta$

② $y'_c Sin\theta$ ④ $x'_c Cos\theta$

$$\alpha = Tan^{-1}\left(\frac{x_b - x_a}{y_b - y_a}\right)$$

$$\beta = Tan^{-1}\left(\frac{E_B - E_A}{N_B - N_A}\right)$$

$$E' = x' Cos\theta - y' Sin\theta$$

$$N' = x' Sin\theta + y' Cos\theta$$

3.1.3 Translation

It is the Translation from E'N' coordinate system to EN system

$$T_E = E_A - E'_A = E_B - E'_B$$
$$T_N = N_A - N'_A = N_B - N'_B$$

Finally we determine the coordinates in EN system as

$$E_c = T_E + E'_c = T_E + x' Cos\theta - y' Sin\theta$$
$$= T_E + S \times xCos\theta - S \times ySin\theta$$

$$N_c = T_N + N'_c = T_N + x' Sin\theta + y' Cos\theta$$
$$= T_N + S \times xSin\theta + S \times yCos\theta$$

if we suppose S*Sin*θ = *b* and S*Cos*θ = *a* we will have the general transformation equations as

$$E = T_E + ax - by$$
$$N = T_N + bx + ay$$

4. Transformation with Least Square Adjustment

If more than two control points are available, redundancy exists and the transformation can be computed using least square solution.

Let A, B and C are three control points known in both the XY and EN systems of coordinate.

As derived above, there will be 6 observation equations, two for each A, B and C, as follows: (which are with added residuals to make the redundant equations consistent.)

$$aX_A - bY_A + T_E = E_A + v_{E_A}$$
$$aY_A + bX_A + T_N = N_A + v_{N_A}$$
$$aX_B - bY_B + T_E = E_B + v_{E_B}$$
$$aY_B + bX_B + T_N = N_B + v_{N_B}$$
$$aX_C - bY_C + T_E = E_C + v_{E_C}$$
$$aY_C + bX_C + T_N = N_C + v_{N_C}$$

For least square adjustment, let us square and add the residuals

$$\sum v^2 = (aX_A - bY_A + T_E - E_A)^2 + (aY_A + bX_A + T_N - N_A)^2 + (aX_B - bY_B + T_E - E_B)^2 + (aY_B + bX_B + T_N - N_B)^2 + (aX_C - bY_C + T_E - E_C)^2 + (aY_C + bX_C + T_N - N_C)^2$$

If we take the partial derivative of the Σv^2 with respect to a, b, T_E and T_N and compare each with zero to fulfill the condition of minima we will get four equations that can be represented by the following matrix equation.

$$\frac{\partial}{\partial a}\sum v^2 = 0, \qquad \frac{\partial}{\partial b}\sum v^2 = 0,$$
$$\frac{\partial}{\partial T_E}\sum v^2 = 0, \text{ and } \frac{\partial}{\partial T_N}\sum v^2 = 0$$

$$A^T AX = A^T L$$

Where,

$$A = \begin{pmatrix} X_A & -Y_A & 1 & 0 \\ Y_A & X_A & 0 & 1 \\ X_B & -Y_B & 1 & 0 \\ Y_B & X_B & 0 & 1 \\ X_C & -Y_C & 1 & 0 \\ Y_C & X_C & 0 & 1 \end{pmatrix},$$

$$X = \begin{pmatrix} a \\ b \\ T_E \\ T_N \end{pmatrix}, L = \begin{pmatrix} E_A \\ N_A \\ E_B \\ N_B \\ E_C \\ N_C \end{pmatrix}$$

The solution of the equation $A^T AX = A^T L$ is

$$X = \left(A^T A\right)^{-1} A^T L$$

We can get $A^T A$ from A as

$$\left(A^T A\right) = \begin{pmatrix} \sum(X_i^2 + Y_i^2) & 0 & \sum X_i & \sum Y_i \\ 0 & \sum(X_i^2 + Y_i^2) & -\sum Y_i & \sum X_i \\ \sum X_i & -\sum Y_i & 3 & 0 \\ \sum Y_i & \sum X_i & 0 & 3 \end{pmatrix}$$

$$i = A, B, C$$

If we assume $\alpha = \sum(X_i^2 + Y_i^2)$, $\beta = \sum X_i$ and $\gamma = \sum Y_i$

the matrix will be formed as

$$\left(A^T A\right) = \begin{pmatrix} \alpha & 0 & \beta & \gamma \\ 0 & \alpha & -\gamma & \beta \\ \beta & -\gamma & 3 & 0 \\ \gamma & \beta & 0 & 3 \end{pmatrix}$$

Calculating determinant of the matrix we will get

$$Det\left(A^T A\right) = \psi^2,$$
$$where, \psi = (3\alpha - \beta^2 - \gamma^2)$$

Again determining the inverse matrix we will get

$$\left(A^T A\right)^{-1} = \frac{1}{\psi^2}\begin{pmatrix} 3\psi & 0 & -\beta\psi & -\gamma\psi \\ 0 & 3\psi & \gamma\psi & -\beta\psi \\ -\beta\psi & \gamma\psi & \alpha\psi & 0 \\ -\gamma\psi & -\beta\psi & 0 & \alpha\psi \end{pmatrix}$$

If we assume

$3/\psi = p, -\beta/\psi = q, -\gamma/\psi = r$

and $\alpha/\psi = s$ we will have

$$\left(A^T A\right)^{-1} = \begin{pmatrix} p & 0 & q & r \\ 0 & p & -r & q \\ q & -r & s & 0 \\ r & q & 0 & s \end{pmatrix}$$

Again, we can get $A^T L$ from A and L as follows

$$A^T L = \begin{pmatrix} \sum(X_i E_i + Y_i N_i) \\ \sum(X_i N_i - Y_i E_i) \\ \sum E_i \\ \sum N_i \end{pmatrix} = \begin{pmatrix} e \\ f \\ g \\ h \end{pmatrix} (say)$$

$$i = A, B, C$$

If we operate $A^T L$ with $(A^T A)^{-1}$ we will get X

$$X = \begin{pmatrix} a \\ b \\ T_E \\ T_N \end{pmatrix} = \left(A^T A\right)^{-1} A^T L = \begin{pmatrix} p & 0 & q & r \\ 0 & p & -r & q \\ q & -r & s & 0 \\ r & q & 0 & s \end{pmatrix} \times \begin{pmatrix} e \\ f \\ g \\ h \end{pmatrix}$$

Finally, we will get the adjusted transformation parameters as

$$\begin{pmatrix} a \\ b \\ T_E \\ T_N \end{pmatrix} = \begin{pmatrix} pe + qg + rh \\ pf - rg + qh \\ qe - rf + sg \\ re + qf + sh \end{pmatrix}$$

Getting these parameters, we can transform any point D in XY coordinate system to EN coordinate system as

$$E_D = aX_D - bY_D + T_E$$
$$N_D = aY_D + bX_D + T_N$$

5. Conclusion and Recommendations

The theory of error and the method of Least Square adjustment has been presented in brief in this paper, the mathematical computation for the Least Square adjustment seems to be rather cumbersome if we proceed manually, it is recommended to use computer program to make its execution easier and faster. During the adjustment of survey observations or computations, one should first detect the blunders. Those observations which are larger than 3σ i.e. E99.9 are assumed to be blunders, first they should be detected filtered out. After that the corrections to the systematic errors and biases should be applied. And finally, only the remaining random errors should be adjusted by applying the method of Least Square Adjustment.

References

1. *Adhikari, M S,* **आधारभुत सर्भेक्षण**
2. *Arora, K R, Surveying vol. 2*
3. *Dr. Naser EL-Sheimy, Introduction to adjustment of observation*
4. *Schofield, W., Engineering Surveying*
5. *Wollf, Paul R. Elements of Photogrammetry*

Calendar of International Workshop/Seminar/Conference

FIG Working Week and XXXII General Assembly
Eilat Israel
3-8 May 2009
E: fig@fig.net
W: www.fignet/fig/2009/

Joint Urban Remote Sensing Event
Shanghai, China
20-22 May 2009
W: www.urban-remote-sensing-2009.org.cn/

Global Spatial Data Infrastructure (GSDI 11)
International Conference
Rotterdam, The Netherlands
15-19 June 2009
W: www.gsdi.org

Cambridge Conference: The Exchange
Southampton, U.K.
12-15 July 2009
E : sallie. white@ordnancesurvey.co.uk
W : ordnancesurey.co.uk

2nd Joint Project Team
Sentinel Asia Meeting
Bali, Indonesia
15-17 July 2009
E: ogsptm@restec.or.jp
W: www.drss.tksc.jaxa.jp/sentinel

10th South East Asian Survey Congress
(SEASC)
Bali, Indonesia
4-7 August 2009
E: info@seasc2009.org
W: www.seasc2009.org/

Map Asia 2009
18-20 August 2009
Singapore
E: info@mapasia.org
W: www.mapasia.org

XXII ISPRS Congress 2012
Melbrone Australia
24 August - 3 September 2012
E: info@isprs2012.melbrone.org
W: www.isprs2012melbrone.com

Geomap 2009
Banglore, India
28-29 August 2009
W: www.igeomap.org/

52nd Photogrammetric Week 2009
Stuttgart, Germany
7-11 September 2009
E: phowo@ifp.uni.stuttgart.de
W: www.ifp.uni.stuttgart.de/phowo/

30th Asian Conference on Remote Sensing (ACRS)
Beijing China
18-23 October 2009
E:30acrs2009@ceode.ac.cn
W: www.ceode.ac.cn/en/

16th International Steering committee for Global
Mapping (ISCGM)
25th October 2009
Bangkok, Thailand
E: sec@iscgm.org
W: www.iscgm.org

15th Permanent Committee on GIS Infrastructure for
Asia and the pacific (PCGIAP)
Bangkok Thailand
26-30 October 2009
E: sec@pcgiap.org
W: www.pcgiap.org/

Group on Earth Observation GEO VI
Washington D.C., USA
17 - 18 Nov. 2009
W: www.usgeo.gov.

16th APRSAF
Phuket, Thailand
26-29 Jan 2010
E: secretariat@aprsaf.org
W: www.aprsaf.org/

An Overview of the 29th Asian Conference on Remote Sensing

Rabin K. Sharma
Executive Director
Land Management Training Centre, Nepal

1. Background

The first Asian Conference on Remote Sensing (ACRS) was held in Bangkok, Thailand in 1980 AD and the Asian Association on Remote Sensing (AARS) was formed in the 2nd ACRS in Beijing, China in 1981 AD. Since then AARS is organizing ACRS every year in one of the Asian countries for promoting remote sensing technology through the exchange of information, mutual cooperation, international understanding and goodwill amongst the members. The 29th ACRS was held to fulfill the aim of AARS in Colombo, Sri Lanka from November 10 -14, 2008.

The 29th ACRS was attended by 494 participants from 30 countries. Out of which 220 participants were from Sri Lanka and 274 from other parts of the globe. There were 6 participants from Nepal. (Two from Ministry of Land Reform and Management and one each from Land Management Training Centre, National Planning Commission, Ministry of Finance and Institute of Engineering of Pokhara) .

2. Opening Ceremony

The conference was jointly inaugurated by lighting the traditional oil lamp by Mr. J.R.W. Dissanayake, Secretary, Ministry of Land and Land Development; Emeritus Prof. Shunji Murai, General Secretary, AARS; Prof. Orhan Altan, President, ISPRS and Ms. Jorien Terloum, ITC Alumni Coordinator, The Netherlands. The opening ceremony was chaired by the Chairman of the Local Organizing Committee Mr. B.J.P. Mendis, Surveyor General, Survey Department, Sri Lanka. Most of the messages delivered by the speakers are available in the Programme Book of the Conference.

2.1. Keynote Speech

The following two papers were presented as keynote speeches:

i. 3D Mapping from Space – Fact or Fiction by Prof. Armin Gruen
ii. Monitoring of Terrestrial Scene from Space-Environmental Changes and Disaster by Prof. Haruo Sawada.

2.2. Exhibition:

There were 12 exhibition stalls from different organizations related with Remote Sensing, Space Technology and Geographical Information System. The exhibitors displayed their recent products and publications and demonstrated the strengths, functions and provisions of their hardware and software.

2.3. Technical Session:

In total 2 plenary sessions and 37 parallel sessions were conducted to present 8 and 189 technical papers respectively. Out of which the following papers were presented from Nepal:

i. Space Science and Geomatics Education in Nepal by Krishna Raj Adhikary
ii. Preparation of Land Use Data for Municipality using Remote Sensing and Geographical Information System Technology by Rabin K. Sharma.

Furthermore, in one of the technical sessions, the Local Organizing Committees gave opportunity to Mr. Rabin K. Sharma from Nepal to chair a session on Image Classification Innovation Problem to Solving Methodologies.

2.4. Poster Session:

In total 60 technical papers were presented in three poster sessions and Mr. Krishna Bhandary from Nepal presented a poster on Application of GIS Japanese Encephalitis Risk Zone Mapping Based on Socio-Cultural and Environmental Factors - A case study of Kailali, Bardiya and Banke Districts of Nepal.

3. National Delegates Meeting

National delegates meetings were one of the major events of AARS. The meetings were conducted on November 11 and 13, 2008. The meetings were chaired by Mr. B.J.P. Mendis, Chairman of the Local Organizing Committee. Some of the outcomes of the meeting were as follows:

- European Space Agency was awarded to be Associate Member of AARS
- In order to celebrate 30th ACRS in 2009, AARS is going to publish Geo-referenced Satellite Image of Capitals in Asia. So AARS requested member countries to provide the Geo- referenced Satellite Image of the Capital.
- The new Editor-in-Chief of Asian Journal of Geo-informatics shall be Dr. Ngugen Dinh Duong from Vietnam as the term of Prof. Bruce Froster, from Australia as an Editor-in-Chief has been terminated. This journal is one of the publications of the AARS
- Dr. Gorbachoiv from Russia presented a technical paper on Rice-sat Issue.
- In order to commemorate 1000 years of establishment of the city Hanoi of Vietnam, the 31st ACRS shall be organized in Vietnam in 2010 AD.
- The 30th ACRS shall be organized in Beijing, China from October 19- 23, 2009.

4. Reception

In honour of the participants, the Local Organizing Committee offered a welcome reception on November 10, 2008 at Hotel Galadari of Colombo. Before commencement of the dinner, a cultural programme was organized in two phases. The professional artists from Sri Lanka performed various Sri Lankan dances in the first phase of the programme which was followed by the second phase of song and dances performed by the delegates of the countries from Sri Lanka, China, China Taipei, Japan, Thailand and Nepal.

5. Additional Events

In conjunction with the conference the following additional events were also conducted:

i. **AIT Workshop:** Some selected participants were invited to participate on AIT workshop to discuss on web mapping

ii. **ERDAS Workshop:** ERDAS Workshop was conducted to provide information on the product of the ERDAS Software.

iii. **ITC Event:** ITC, The Netherlands organized two events. The first event was ITC workshop which was organized to provide information on the various courses of ITC, The Netherlands. The second event was an interaction programme among the ITC Alumnus in presence of the Ambassador of the Netherlands to Sri Lanka followed by a reception dinner.

iv. **White Elephant Session:** This Session was focused for the students to teach them how to write a better technical proposal and the thesis and the effective way of presenting the paper. The power point of the presentations of these techniques is given in the official web site of AARS (www. aars-acrs.org.)

v. **Student Session:** This session was organized to promote Post Graduate, M. Sc and Ph. D. Students of Asian countries for promoting activities of ACRS in relation to Remote Sensing and Geographical Information System.

vi. **ISPRS Meeting:** Prof. Orhan Altan, President, ISPRS organized a special meeting to prepare a document on the concept of the activities of Remote Sensing which is to present from the Asian side in the coming Congress of ISPRS. The participants in this meeting were the representatives from the member organization of ISPRS who were present in the Conference. Mr. Rabin K. Sharma President, Nepal Remote Sensing and Photogrammetric Society (NRSPS) of Nepal also participated in the meeting as this Society is one of the member organizations of ISPRS.

6. Closing Ceremony

The Closing Ceremony of the 29th ACRS was held under the Chairman of Prof. Kohei Cho from Japan. Emeritus Prof. Shunji Murai, General Secretary of AARS presented the summary report of the National Delegates Meeting. He also awarded Japanese Society for Photogrammetry and Remote Sensing (JSPRS) Award to Young Scientists whose technical paper were among the best. Accordingly, the Chairman of JSPRS Award committee, Prof. Ryutaro Tatieshi, Japan announced the 5 names from the best oral presenter and 2 from the best poster presenter.

The Coordinator of the Local Organizing Committee, Mr. D.N.D. Hettiarachchi, Deputy Surveyor General, Survey Department, Sri Lanka presented the statistics of the conference and also offered Vote of Thanks. Then the representative from China, Prof. Tong Qingxi invited all the participants to join the 30th ACRS to be held in Beijing, China in 2009. Finally, the Chairman of the Session, Prof. Kohei Cho summarized the conference and thanked all the participants and the Local Organizing Committee Members for their active roles to conclude the conference successfully and announced the completion of the conference.

7. Conclusion

The conference completed with a grand success and the Secretary General, of AARS expressed his great satisfaction for the participation from more Asian Countries than the previous conferences. This is an appropriate forum for acquiring knowledge on the recent technological developments in the field of Remote Sensing and Geographical Information System. So the Geomatics professionals from Nepal should try to participate in such events for improving the present technological systems in his/her working place and for introducing the feasible technology for the betterment of Society in Nepal.

Reference

1. Programme Book of the 29th Asian Conference on Remote Sensing 2008.
2. Rabin K. Sharma: An overview of the 26th Asian Conference on Remote Sensing; Nepalese Journal on Geoinformation, 5, 2006.
3. Report of General Secretary of the 29th Asian Conference on Remote Sensing 2008.
4. Report of the 29th Asian Conference on Remote Sensing, 2008.
5. Statutes of the Asian Association on Remote Sensing 2007.
6. Web Site: www.aars-acrs.org

Instruction and guidelines for authors regarding manuscript preparation

- Editorial board reserves the right to accept, reject or edit the article in order to conform to the journal format.

- The contents and ideas of the article are solely of authors.

- the article must be submitted in A4 size paper with one side typed in Times New Roman "10" font size or in digital form on a floopy diskette or on CD in Microsoft Word or compatible format or by email.

- Editorial board has no obligation to print chart / figure / table in multi colour, in JPEG/TIFF format, the figure / picture should be scanned in a high resolution.

- Authors are also requested to send us a written intimation that the same articles is not sent for publication in other magazine / journal.

Format: Single line spacing with two columns. With upper 26mm, lower 22mm, left 24mm, right 22mm.

Length of manuscript: Manuscript should be limited to 6 pages.
Title should be centrally justified appearing near top of 1st page in SueVemeer5 20 Point (Normal)

Authors name: Authors name should be at after two line spacing after title in Arial "10" with Upper and lower casing, centrally centered with all possible addresses.

Keywords: Four to five keywords on paper theme in Times New Roman "10", with two spacing under the Authors name and adddress.

Abstract: Single line spacing after keywords, limited to around 300 words in Italic Times New Roman.

References: Should be listed alphabetical order at the end of paper in following sequence and punctuation. Author's last name, Author's initials, Year of publication, title of reference article, name of book of journal, volume number, country or city, name of publisher etc.

Headings: Major heading should be flushed with the left margin in Times New Roman "10" Bold font and with Upper casings.
Minor headings should be flushed with the left margin in Times New Roman "10" Bold font and with Upper and lower casings.

Bullet points: Use only dash (-)

Placement: Photographs or tables should be pasted in place of manuscript pages with captions in their positions in Times New Roman "10" with Upper and lower casing.

Updating of topographic maps in Nepal

Kalyan Gopal Shrestha
Chief Survey Officer

Abstract

The latest Topographical maps in Nepal are over a decade old. The "ideal" mapping product is one which is produced in real time from an updated spatial database. There is an urgent need to update existing ones. A complete and renewed process of updating databases, in traditional and conventional methods, is expensive, time-consuming and demands a great deal of human and capital resources. Therefore, it is impossible to update maps quickly by traditional and conventional methods. The Topographical Survey Branch of Survey Department is updating topographical maps using satellite imagery. It is preferable to focus on the continuous updating of the spatial database, with well defined specifications. In this paper, the updating of topographical maps in Nepal using satellite imagery is discussed.

1. Introduction

The Survey Department of Nepal has prepared the topographic maps of Nepal. Depending upon the terrains of the country there are two kinds of national topographic map series. These are 1:25,000 maps of middle mountains and Tarai and 1:50,000 maps of high mountainous and Himalayan region.

The Topographic map gives idea about surface features including relief, vegetation cover, water bodies or topography by means of contour lines, shading, hatching, or other graphic devices. A large-scale topographic map even includes the locations of haats (market-places), petrol-pumps, education institutes, rural narrow roads, etc. Meanwhile, the modern world is very dynamic: cities are growing, new settlements appear, new roads, communications networks and engineering facilities are being constructed, new areas of natural resources are being developed, forests are cut, and land use structure is changing. Therefore, topographic maps are always subject to updating. The Survey Department of Nepal, being the national surveying & mapping organization, has the sole authority to survey, prepare and update the topographic maps of Nepal.

2. Background

Some decades before Topographical maps of Nepal at the scale of one inch to one mile or 1: 63,360 maps, popularly known as One inch map series, made by Survey of India during the period 1960s-1970s were in use. The second series of Topographical maps of Nepal were prepared by Survey Department of Nepal. In 1991, with the technical and financial assistance of Japanese Government, Survey Department prepared 81 sheets of topographical maps at the scale of 1:25,000 for Lumbini Zone using aerial photographs of 1989. And later on Topographical maps series for the rest of 13 zones have also been prepared using photogrammetric method with the technical and financial assistance of Finland Government during the period of 1992-2001 at the Scale of 1:25,000 (509 sheets) for Tarai and middle mountainous area and 1:50,000 (116 sheets) for high mountainous and Himalayan area. Thus, the total number of Topographical maps covering whole the country is 706 sheets.

3. Need For Updating Topographic Maps

Since land is the foundation for any development activities all the planners and decision-makers naturally expect for the updated mapping, hence the importance of an updated map or topographical database can be easily realized. Therefore, regular updating of Topographical map is most essential to the future development planning of a nation. If updated base map data is either absent or inaccessible, map-users may rely upon outdated (paper) maps. These deficiencies can adversely impact the planning and implementation of development projects.

Up-to-date topographic maps are the basic tool for environmental analyses, rural and urban development, land use policy, warning and mitigation of natural disasters, infrastructure development etc. According to international studies topographical maps may, if they are effectively used and depending on the sector, improve the effectiveness of the investment and reduce implementing costs of development works.

The usual update rate for the topographic maps ranges from ten to twenty years. As the existing base maps of Lumbini Zone and Eastern Zones have been over a decade, the Survey Department has initiated a program for total updating of the base maps 1:25,000 of Lumbini Zone since a couple of years. The Survey Department, as a national surveying and mapping agency, bears responsibility to give the updated geo-information of the country to support multi-sector development activities.

Many changes have occurred since the first edition in 1992. Hence, need for updating of map series is an essential task. The updating will include more accurate topographic data collected with advanced technologies, information on the changing land cover, the improved transportation network, the expanding built-up areas and other land uses. Also in some other cases there are mistakes in the topographic maps that have to be located and corrected. The ideal case is to update areas with a high rate of change more frequently. The updated material should be presented in any new series of maps.

Consequently, it is crucial to change the updating process to one that is faster, more efficient, modern, and will take all map series into consideration. Updating will be very easy once we already have digital database. Modern and efficient geo-information can be obtained from the remote sensing technology. In the present context it is realized that the integration of GIS and RS (remote sensing) technology is important and appropriate for updating maps.

4. Approaches for Updating

Map updating was achieved, at first, by graphical, manual techniques only; then computerised methods were developed, aided by peripheral equipment such as scanners and digitizers. These interactive methods involve intensive manpower. Today, in the digital and computerised era, updating of digital databases, in theory and in practice, is evolving for a wide range of applications, in addition to mapping purposes. Several methods are in use: establishing a new national GIS database, by re-mapping rather than digitising existing maps; producing huge, unique and unified databases in large scale; working on large-scale updating and maintenance. The main approach lately, involves automatic change detection and incremental updating of periodic changes which occurred on the earth surface. Aerial photos and satellite imagery are both used in the interpretation of different features and automatic change detection,

There are two major approaches for updating spatial databases:

- remapping the entire area, establishing a new, alternate, and updated database, which will replace the old one,
- remapping limited areas, incorporating the new data into the available database.

Many subjects are discussed in dealing with maintenance and updating spatial data. For example:

- enhancement of linear features to update transportation networks,
- automatic extraction of geographical objects (roads and buildings) and their integration into an existing Information System ,
- utilisation of the image processing techniques for identification, interpretation, segmentation and matching among objects in known built areas,
- automatic interpretation and extraction of visible, spatial topographic objects from imagery .

5. Selection of Methods

Nowadays, several countries in the world face problems in relation to outdated topographic maps. As a consequence there is the necessity to apply methodologies which allow map updating in a faster and more efficient fashion. Aerial photos have been traditionally used as the primary source for the topographic maps making and updating. Aerial photography is season dependent and not reasonably carried out for small area.

After the digital revolution and the beginning of computer-assisted map processing, geographic information entered a new era a few years ago: with the arrival on the public market of very-high-resolution digital satellite images, which in theory allows large-scale maps of everywhere to be made while remaining seated in one's office. This revolution in geographic information is in fact a combination of many factors such as increasing powerful computers at a cheaper price, more and more efficient processing software, and the availability of very-high-resolution satellite images. Satellite-based digital images open new horizons: cheaper imagery, increased territory coverage and decreased relief distortions. Besides, generalization on the small-scale maps becomes simpler: instead of time-consuming simplification of large-scale maps, it is possible to use space images directly. Therefore, satellite-based imagery is used increasingly wider and may soon become the principle method of topographic maps updating. New satellite images with higher resolution give new possibilities for using the technology as a source for updating topographic maps.

One of the great advantages of satellite imagery is the ease of access to areas which have previously been too remote or too dangerous to reach using conventional aerial photography. Owing to this fact satellite images have been considered as an information source which presents several advantages:

1) speed in the process of obtaining updated information: Remotely sensed images of a specific site can be collected with very short revisit time.
2) relatively precise and consistent spatial information: Possibility to apply faster updating methodologies than the traditional photogrammetric process; and Data integration is easier.
3) high temporal resolution and multiple use: With few exceptions (e.g., EROS-B), satellite data are multispectral, so value-added products can also be used for thematic mapping purposes.
4) fairly low costs:

A single satellite scene covers a large area (from less than 65 km^2 for OrbView-3 to more than 270 km^2 for QuickBird). Availability of higher resolution imagery at reasonable price has heightened the possibility of application of Remote sensing imagery.

In Nepal too, Remote sensing technology is highly relevant. Large areas of Nepal are not easily accessible for ground survey. New aerial photography for whole the country costs relatively expensive to Satellite Imagery. Making aerial flight for a particular required area is virtually impossible. But in case of satellite imagery, the latest image can be procured for just the required area.

6. The Present Situation

Survey Department has already National Geographic Information Infrastructure (NGII) and completed the production of digital topographical database based on the latest available topographic maps. Survey Department has started to provide digital topographical data base to governmental and non-governmental map user agencies. These data are available in both hard copy and soft copy format.

Topographical Survey Branch of Survey Department has initiated the Remote Sensing Technology in digital data generation. The Branch has softwares like Photogrammetric Suit, PC Arc/INFO (USA), ArcView (USA) and ERDAS Imagine Professional software version 9.2 and is doing updating Topographical maps of Lumbini Zone since a couple of years with the resources in hand. The main objectives of updating works are focused on updating National Topographical Database and publishing latest printed maps.

Images used so far are IKONOS, IRS and ALOS at different periods of time. There are in total 81 sheets to be updated in Lumbini Zone. Because of limited budget and limited skilled human resources the pace of progress is very slow. So far 36 sheets have been updated, out of which field verifications of 15 sheets have been completed recently. Due to the political conflict existed field verification program was halted for some years. These verified sheets are yet to be finally edited for the final printing. 10 sheets are in progression this year. The present updating works should be extensively expedited to satisfy the real meaning of updating 706 sheets of topographical maps of the entire country and needs of the map users.

6.1 Issues

The Survey Department is facing some problems of resources : –

- Human Resources: Since the most of staffs working in digital mapping are just confined to GIS, many staffs are left to be trained for RS. Some of those have trained abroad and some others were trained on-the-job from few weeks to a month. Since the procedures involve mathematical calculations, programming and other unpredictable jobs highly skilled manpower should be allocated for this work. Existing working environment lacks general specification, working manual and time frame for the job. Motivations to employed staff are also to be taken into account.
- Computers and software: The quantities of computers are not sufficient to expedite the pace of work. Map updating job by remote sensing generally associated with mainly two types of software: Image

processing software and GIS software. The powerful GIS software packages are not fully exploited and presently limited to Cartographic Digital Database. Further, the Remote Sensing section needs to keep pace with the technical advancement and adapt to changes in terms of hardware and application software.

- Image: Lower resolution image are not so effective for quality updating. High resolution image are expensive. Currently, the branch is using image of 2.5m resolution, efficient for the standard scale of 1:50 000 and 1:25 000.

7. The Methodology

The latest satellite imagery of required area of required spectral and spatial resolution is purchased. Then these imageries will be rectified geometrically. The job begins with the Automatic Aerial Triangulation, stereo restitution, and digitization of satellite images. As draft prints are prepared, Field Verification will be performed before the finalization of updating. Missed information will be collected during field verification and thus collected information are incorporated in the updated work. After the completion of updating work, hard copy maps will be printed for public use as per the designed national specification with appropriate symbols.

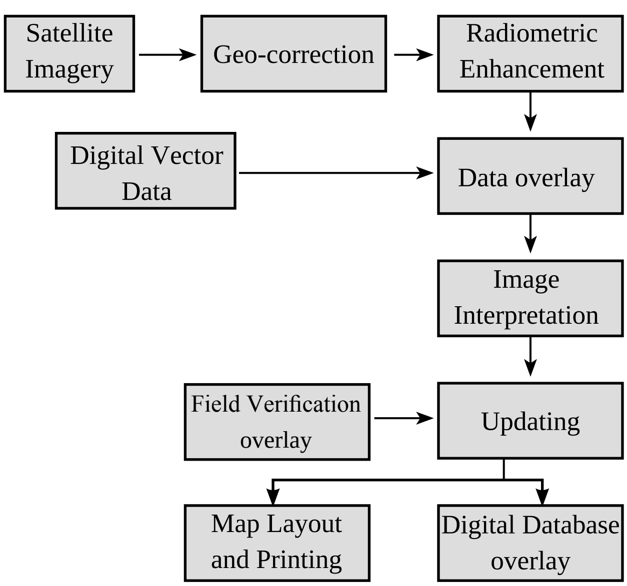


Figure: 1 Flow chart for map updating

8. Solutions

Importance of up-to-date topographical digital data is realized by every concerned people now a day. But the present pace of progress seems far lagging behind to meet the real sense of updating national topographical map series. The updating process should be framed with the aim of completing updating maps of whole country in five years. The process is planned to be implemented in three phases.

During the first phase, System and Infrastructure Development works will be performed. Management of Hardwares, Image processing Softwares and Humanwares are accomplished. Procurement of high-resolution satellite imagery for the entire country will be followed by collection of ancillary data. A huge investment will be incurred at this phase.

The second phase will cover updating works, field verifications and incorporation of thus verified information. The final phase will conclude with editing and final printing of maps. Ultimately the updated geo-information will help greatly in effective planning, decision making, managing limited natural resources, etc.

Apart from updating of existing topographical maps of the entire nation we expect some other benefits from this work. As we acquire high-resolution satellite imagery for the entire country, these data subsequently can also be used for other possible products. Consequently the updating works will also support indirectly to fulfill some of our additional objectives as follows:-

- Prepare various kinds of thematic maps.
- Prepare new land resource maps.
- Help establishment of Standards and Specifications.
- Help improve technical capacity building of Survey Department..
- Help create DEMs and orthoimages for many analysis applications.
- Help reduce investment cost in development works in a long run.

9. Conclusion

The significance of updated map can not be overlooked in the present context when the nation is striving hard for framing a new Nepal. Only with the received budget at hand the objective of updating topographical maps of the entire country in five years seems hardly to be fulfilled. At a time, when Nepal is facing financial hardship due to post political conflict, the country will not be in position to allocate sufficient budget to expedite this mission. The most part of the budget at present is being invested in reestablishment of the development infrastructures. The effective, smooth and successful implementation of this mission requires technical and financial assistance from the international donor agency.

References

1. *David Holland (corresponding author), Paul Marshall, Updating Maps in a Well-mapped country Using High Resolution Satellite Imagery, Ordnance Survey, Romsey Road, Southampton, SO16 4GU UK*

2. *Jagat Raj Poudel and Nab Raj Subedi, Remote Sensing and Space Technology Application in Topographic Mapping and Maps Updating, Colloquium on the Role and Functions of Survey Department in the Context of Broader Technological Development, Kathmandu, March 4-5, 2005*

3. *Kumar, M. and Castro, O., 2001, Practical Aspects of Ikonos Imagery for Mapping, article published on the 22nd Asian Conference on remote sensing*

4. *Michael Tonon, SPOT 5 data for line map updating: New perspectives in mapping, GIS Development*

5. *Prof. Gottfried Koneeny, Mapping from Space, University of Hanover, Germany, 2002, article published on the 23rd ACRS Proceedings, Kathmandu, Nepal.*

6. *Tirtha B. Pradhanang, Topographical Survey Branch with Remote sensing, article published on the 23rd ACRS Proceedings, Kathmandu, Nepal*

Relationships among Spatial Objects Embedded in a Plane

Durgendra M. Kayastha
Survey Department

Data modelling for spatial data is the process of representing phenomena of the real world in a spatial database. There are different approaches of modelling. Basically in all approaches the phenomena of the real world to be modelled is identified as entities or objects and then the relationships between them are established. Common method of data modelling is using entity relationship approach. In this approach the real world entities are abstracted and the relationships among them are identified.

Because of limitations in entity relational approach in modelling relationships with complex semantics present in the entities, other modelling techniques have evolved such as semantic data modelling, and more recently the object oriented approach. The object oriented approach has the advantage of abstracting entities more closely to the reality than any of the previous modelling techniques. Further it has a powerful mechanism of inheritance and encapsulation, which provides transparency to user as well as designer of the database by providing modular support in evolving database systems.

1. Spatial object

A spatial object can be modelled as object having spatial and aspatial attributes. The aspatial attribute although is also related with the spatial attribute of the objects we do not consider that aspect in this paper. The spatial aspect of the object is the subject in consideration.

The spatial attribute of an object may be represented in either vector or raster system. In raster system, the object will be described by a group of contiguous raster cells at proper location which is implicit as the raster space is the regular tessellation of the domain space and each cell with specific location will describe the object by the cell attribute value. Different objects will have different groups of raster cells representing respective objects.

In vector system, the object to be modelled will be represented using geometric primitives like point, lines and areas. A point is described by a coordinate pair (x,y) and is designated as a node. A line (arc) by a series of coordinate pairs $\{(x_1,y_1),.....(x_n,y_n)\}$. Each coordinate pair describes the vertices, the starting and the ending vertices will be explicitly designated as nodes. A polygon is an area enclosed by the arc(s). In case of a polygon described by one arc the begin_node and the end_node will be the same. The relations are not explicit hence we need an approach to describe relations between spatial objects.

Another approach of modelling spatial objects is by using simplicial or cell complexes. Simplicial complexes are the collection of simplices of different dimensions to suit a particular application. When dealing with objects in the plane we have to consider three simplices viz. 0-, 1-, and 2-dimensional simplices. 0-dimensional simplices are points which do not have extent, 1-dimensional simplices are lines which do not posses lateral extent and the 2-dimensional simplices are triangles which are bounded by three 1-dimensional and three 0-dimensional simplices.

With this approach the entire domain space can be partitioned. The characteristics of simplicial complexes are that any two simplices can meet at the common face only, no overlap of simplices are allowed. Also any simplex will be bounded by its faces except in case of 0-dim. simplex. The faces of a k-dimensional simplex are simplices of dimension less than k, this implies that 0- and 1- dim. simplices are the faces of 2-simplex, for example a 2-simplex (triangle) has three 1-simplices and three 0- simplices as its faces. Similarly a 1-simplex has two 0-simplices as its faces. Cell complex is more general in modelling compared to simplicial complex [Kainz 95].

2. Spatial relations

Spatial relations between any two objects can be described in three ways, they are: metric relations, topological relations, and order relations.

In describing relations in terms of metric usually distances, directions and location of spatial objects in the underlying metric space are considered.

Topological relationships among spatial objects represented as one dimensional interval in a one dimensional topological space is dealt in [Pullar and Egenhofer 88], this paper will cover relations among the spatial objects in two dimensions only.

In analyzing the relations between objects in the topological space we do not measure distance, the concept of neighbourhood is employed, but it should be remembered that every metric space is a topological space. Hence this approach of topology can also be employed in metric spaces.

Certain relations between spatial objects can also be analyzed using order theory of mathematics. This approach is based on the fact that any group of spatial objects can be put to a partial order by certain order relation such as containment or subset relations. Further, every partially ordered sets (Poset) can be transformed into a lattice by processes like normal completion.

3. Topological spatial relationships in continuous space R^2

Spatial data is distinguished from non-spatial data by specific properties, such as spatial operators, relationships among spatial objects, and their graphical representation. The relationships go beyond the comparison like equal, not_ equal, contains or contained_in. Topological relationships can provide answers efficiently to queries like - what is the spatial relation between object A and B? or get all the objects having specified relations with an object X [Pullar and Egenhofer 88].

Topological relations among spatial objects are the relations which remain unchanged (invariant) under certain topological transformations such as rotation, scale change, translation and skews. The transformations are homeomorphic. Topological relations are based on connectedness or neighbourhood and do not consider distance hence topology is a non-metric domain.

In the pure set theoretic approach the topological relation between any two point set can be determined by evaluating set operations e.g. the set operators =, ≠, ⊆ and ∩ can be used as follows:

$$\text{point(x)} = \text{points(y)} \Rightarrow x = y$$

$$\text{point(x)} \neq \text{points(y)} \Rightarrow x \neq y$$

$$\text{points(x)} \subseteq \text{points (y)} \Rightarrow \text{x inside y}$$

$$\text{points(x)} \cap \text{points(y)} = \varnothing \Rightarrow \text{x outside y}$$

$$\text{points(x)} \cap \text{points(y)} = \neg\varnothing \Rightarrow \text{x intersects y}$$

This formalism is not complete. Further it does not distinguish the parts of the point sets such as the boundary and interior hence complete topological relations can not be distinguished. [Pullar 88] augmented the point set approach with the additional concept of boundary and interior and hence made it possible to distinguish overlap and neighbour.

Even by evaluating empty/nonemptiness of intersections between boundaries and interiors, we can distinguish four relations viz. neighbourhood, separations, strict inclusion and intersection. Still we cannot make any distinction between equality and intersection, covers and coveredBy, inside and outside. This limitation has been removed by evaluating interior-boundary and boundary-interior intersections in addition to boundary-boundary and interior-interior intersections.

So the relation function becomes a four-tuple between the two point-sets.

$\boldsymbol{R} = \{ \delta \cap \delta, \delta \cap^\circ, {}^\circ \cap \delta, {}^\circ \cap^\circ, \}$, where δ denotes boundary, and $^\circ$ denotes interior, or

alternately $\boldsymbol{R} = \begin{bmatrix} \delta \cap \delta & \delta \cap^\circ \\ {}^\circ \cap \delta & {}^\circ \cap^\circ \end{bmatrix}$

The relations among the objects can now be described based on the value of the 4-tuple consisting of binary values as such there will be altogether sixteen relations. As our interest is to model spatial relations that occur between polygonal areas we restrict the topological space and the sets under consideration. We consider that the topological space **T** is connected and the spatial region i.e. the sets of our interest are bounded and connected. All sixteen relations can occur in case of point-set embedded in a plane.

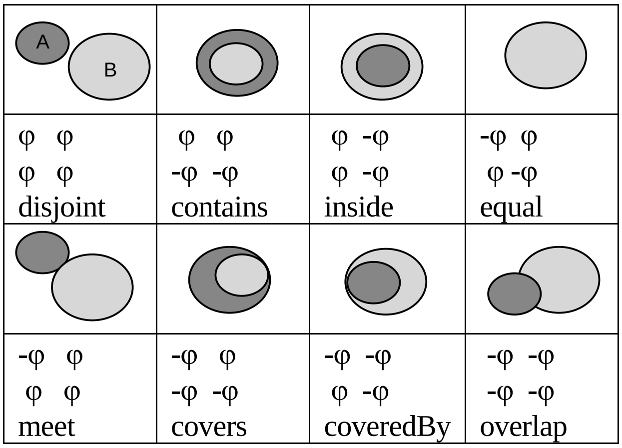


Figure 1 : Spatial relations between two regions in $\mathbf{R}^2$

A spatial region **A** on a topological space **T** is a non-empty proper subset **A** of **T** where $\mathbf{A}^o$ is connected and $\mathbf{A} = \mathbf{A}^o$. This implies that **δA** is non-empty i.e. a spatial region in $\mathbf{R}^2$ is a 2-dimensional point set that is homeomorphic to 2-disk. With these constraints on the point-set defined as a spatial region the total number of meaningful relations reduces to eight without considering the regions with holes. The relations that can be realized are shown in figure 1.

The eight relations are namely disjoint, meet, covers, covered by, contains, contained-in, equal and overlap. But the relation between the two sets depends also on the underlying topological space as the same two sets could have different evaluation of the relation.

Employing the concept of boundary and interior, many queries can be evaluated with minimum of computations. This will definitely enhance the query processing in overlay operations. For instance if we want to know - if the parcel A is suitable for crop type X, then evaluate the 4-tuple i.e. 4-intersections by using the parcel object and the crop X object in different layer. The result will be assessed to provide the semantic meaning of the relation that means we can answer some of the above queries straight away without resorting to extensive mathematical computations.

This 4-intersections approach of evaluating the topological relationship can be extended to 9-intersections by adding exterior part of the object as well. The latter approach has the advantage in higher order space; however the result in the two-dimension is exactly eight relations.

Topological relations vary depending upon the underlying space and the definition of the spatial objects. Same two objects in different domain space yields different results. For instance, a line defined as a closed interval in $\mathbf{R}^1$ and a line embedded in a plane. Some relations may be realizable in one domain but not in another [Kainz 93]. Further, relations that are described so far did not consider the content of the intersections; we only used the concept of empty/non-emptiness of the 4-, or 9-intersections. If we consider the contents as well many relations could be identified such as if the two regions touch at one point or have a set of noncontiguous common boundary segments etc.

4. Topological spatial relations in discrete space $\mathbf{Z}^2$

A finite proper subset of $\mathbf{Z}^2$ is called an extended spatial object. Any two point A and B that belongs to an extended object **E** are connected if a connected path exists between them in **E**. The connected path means a sequence of adjacent points from A to B all lying in **E**.

Corresponding to the definition of neighbours, **E** can be 4-connected or 8-connected. If there exists a 4-path of finite length between any two points in **E** then **E** is 4-connected. Similarly **E** is 8-connected if an 8-path of finite length exists between any two points A and B in **E**.

The objects in raster space are raster regions, i.e., extended objects that are bounded. The boundary separates the background into two components and every point in the boundary is adjacent to both the components. Unlike in vector model where there is no lateral extension of the boundary, in raster boundary has definite extent i.e. one pixel.

Raster regions, therefore, posses following properties:

- Boundary and interior are non-empty,
- The boundary is 4-connected such that each boundary point has exactly two 4-neighbours.
- The exterior of raster regions is 4-connected such that each exterior point has at least three 8-neighbours.

Furthermore, extra conditions are added to exclude degenerate cases of having very small and very large raster regions as follows:

- each point in the interior of a raster region must have at least three 8-neighbours
- the union of any pair of the raster region cannot occupy Z^2 completely.

As per above properties the topological relation between any two raster regions can now be investigated using 9-intersections of boundary, interior and exterior of each region. The binary value of each of the 9-intersections yields $2^9 = 512$ different relations. Enumerating all 512 relations is not useful as all the relations may not be valid for the raster regions with restrictions as we have imposed. In order to enumerate valid relations an approach of elimination [Egenhofer and Sharma 93] is more practical. The process requires creating templates with consistency constraints and then pattern matching can be employed to checkout relations which do not carry any meaning.

Raster regions considered here are 2-dimensional and embedded in $\mathbf{Z}^2$, therefore, any one part among interior, exterior and boundary of a spatial raster region constraints the location of other two parts. Accordingly [Egenhofer and Sharma 93] gave list of conditions to be imposed and arrived at sixteen meaningful relations. There is a close matching between the relations in vector and raster. The extra eight relations in raster is due to the reason that in raster the boundary occupies a distinct extent whereas in vector the boundary does not have extent. The extra relations in raster can be further reduced by considering the boundary as a mere line between the interior and the exterior of the region. This can be realized by two extra constraints in addition to the previous constraints. The conditions are:

(i) if $\mathbf{A}^o \cap \delta\mathbf{B} = \neg\emptyset$ then $\mathbf{A}^o \cap \mathbf{B}^- = \neg\emptyset$ and vice versa,

(ii) if $\mathbf{A}^o \cap \mathbf{B}^o = \emptyset$ then $\delta\mathbf{A} \cap \mathbf{B}^o = \emptyset$ and vice versa.

These extended relations are valid for vector regions but not for the raster regions by our definition of the raster region, however it helps to compare the situations in two domains in terms of similarity or correspondence of the relations.

The topological relation in terms of topologically invariant properties is fairly simple and the relations between any two point-sets may be determined with little computational effort. Also the eight relations are more complete in the sense that any new relation may be a derivative of these eight relations considering the $\mathbf{R}^2$ space and not considering the spatial regions with holes.

5. Partially ordered sets and lattices.

Another approach of looking into the relation is by using the theory of ordered sets. The philosophy behind the approach is that any sets of spatial objects can be put to partial order with the order relations such as containment. The investigation of containment of sets leads to posets and lattices. The total order may not be possible straightaway, but with the process of normal completion they can be ordered to form a lattice. Once the lattice is created certain type of relations can be evaluated easily by just checking if there is a link between the two sets in question. Posets and lattices overcomes some of the limitations in hierarchical subdivision of spatial regions and also the operation on multi-layered data such as crop zones and the fields lying in different crop zones as exhibited in [Kainz 93], however the problem with this approach is to create a lattice out of posets, because in reality there are enormous number of sets to be put into order, in any GIS environment. [Kainz 93] and [Kainz 88] can be referred for details on mathematical aspects, here we will try to explore the elegance of this approach in abstracting spatial relations by a simple example.

Consider that there is a parcel map consisting of four parcels (Figure 2a) and a land suitability map (Figure 2b) showing suitability/unsuitability for a particular purpose. The poset and lattice generated after normal completion is shown in the figure 3 and 4 for the overlay respectively.

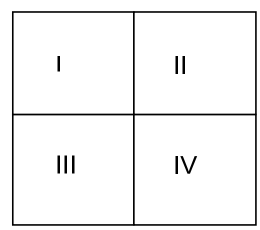


Figure 2 a. Parcel map

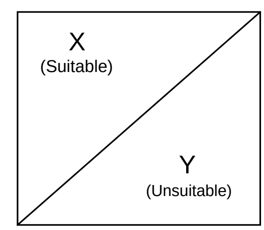


Figure 2 b. Suitability map

Using this lattice we would be able to answer queries like whether a particular parcel is suitable or unsuitable by checking the link between the corresponding objects, however the lattice in figure does not give indications of certain topological relations. But if we define the data model using simplices in 2-dimension we can derive topological relations as order relations in the poset.

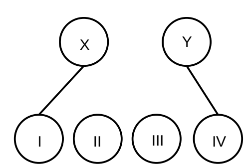


Figure 3: Poset

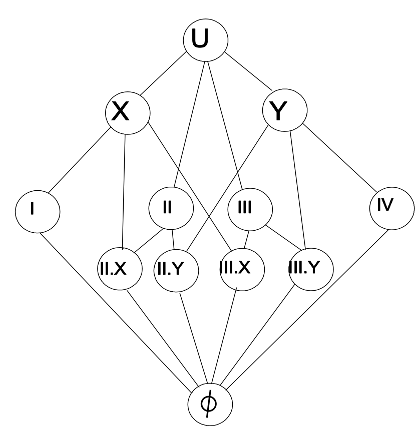


Figure 4: Lattice for the overlaying of suitability map on parcelmap.

So with the previous example as the basis, we now partition the entire domain space into simplicial complex and identify 0-, 1-, and 2-simplices as follows. Let 0-simplices are denoted by numbers, 1-simplices by small case alphabets and 2-simplices by uppercase alphabets. The elements of the partition form the building blocks out of which the higher level objects are built. Using this model we can now define order relations between elements of simplicial complex such that if the point p is an end point of the segment s then p<=s and if the segment s is an edge of the triangle t then s<=t. The points, the edges and the triangles form a poset as shown which then can be completed into a lattice by a normal completion process.

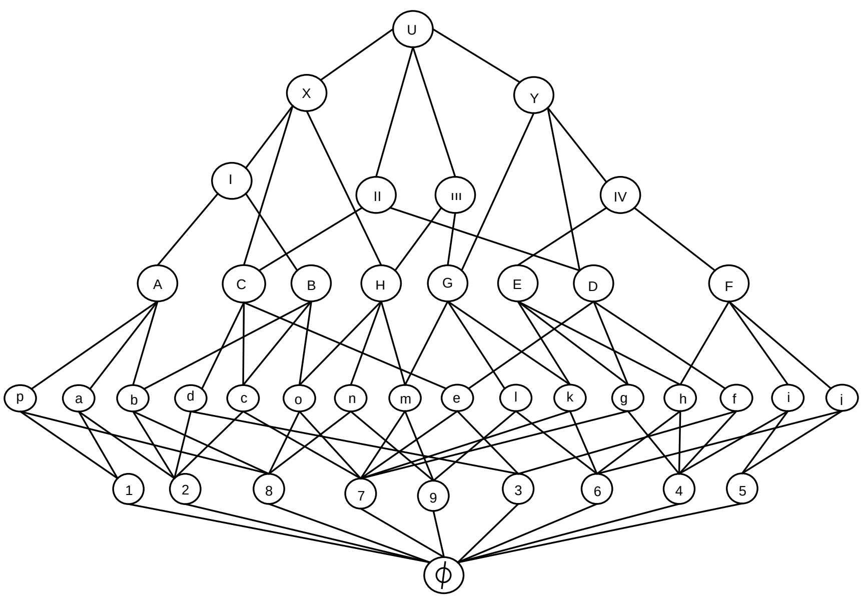


Figure 5: Lattice for the overlaying of suitability map on parcel map defining data model using simplices in the 2D.

As any two objects in the lattice will have greatest lower bound and least upper bound whereas a poset may not have them hence further processes of normal completion is an important step in generating a lattice out of a poset by adding elements. Once a lattice is created then it can be used to determine topological relationships by expressing as order relations in the poset as follows:

(i) Two points p1 and p2 can share only one segment which is $p1 \vee p2$, i.e lub.

(ii) Two segments s1and s2 can share only one point which is $s1 \wedge s2$ i.e. glb.

(iii) Two segments s1 and s2 can share only one triangle t which is $s1 \vee s2$, i.e. lub.

(iv) Two triangles can share only one segment or one point both of which is $t1 \wedge t2$ i.e. glb of t1 and t2.

Intersection is calculated as the greatest lower bound (glb), e.g. glb of X and II is C. Similarly the boundary of an area can be determined by calculating the symmetric difference of the elements that are covered by all triangles of the area, e.g. the boundary of area II can be determined by calculating the symmetric difference of the elements of triangles C and D. The segments of C and D are respectively {d,c,e} and {e,g,f}. So the boundary of II is the symmetric difference of the two sets i.e.{d,c,g,f}.

Neighbourhood relation can also be evaluated easily with the help of lattice. We can distinguish point neighbourhood and segment neighbourhood. Point neighbourhood implies all the triangles sharing point with the area and segment neighbourhood is the set of all triangles that have common segments with the triangle or the area in concern.

Similarly touch or meet relation can also be calculated using glb. If **glb** is a triangle or a set of triangles, then the two areas intersect. If **glb** is a segment then the two areas meet along that segment and if **glb** is a point then they meet at a point.

6. Considering contents of intersections

So far we have not considered the content of the intersections. When we consider the content we can further elaborate on the type of overlap and touch relations between any two spatial objects. Using the same data model based on simplicial complexes, let us investigate on one particular topological relation touch or meet.

The evaluation can be made based on the **glb** of the two areas and if needed evaluation of the **glb** of the **glb**s can be made as follows:

- if glb of the two areas is a single point then the areas meet at that point.

- if glb is one segment then they meet along that segment.
- if glb is two segments and the glb of those two segments is a point then the two areas meet along two connected segments.
- if glb is a set of two segments and glb of the this set is empty then the areas meet along two disjoint segments.
- if glb of the two areas is a set of points and the glb of that set is empty then the two areas meet at those distinct points only.

By analogy we can see that given the two areas meet, by analyzing the content of the **glb** of the two areas we can infer about the nature of meet relation. If the **glb** of the two areas which meet are n segments and **glb** of theses n segments is empty then they meet at n distinct segments. If **glb** of these segments is a set of n-1 points then they meet along n continuous segments. If **glb** of the two areas comprises of segments as well as points, then we have to evaluate the **glb** of the segments only. Then the nature of the situation will be determined accordingly considering segments only, this forms part of the situation in which we have to add number of additional meeting point equal to number of points in the **glb**.

7. Conclusion

Spatial relations between objects are the subject of much concern and in order to maintain the consistency and integrity of spatial database, interrelations needs to be constantly maintained on editing activities such as delete, insert, update operations. In addition efficiency in query processing needs to be addressed. In order to develop suitable algorithms all possible relations needs to be analyzed. When visualized graphically, it seems that all these relations look simple but working with the database in the computer environment all sorts of relations needs to be explicitly described hence a mathematical formalism is required to address this problem. [Kufoniyi et al. 93] employed the 4-intersection formalism to develop necessary algorithms for maintaining consistency in editing single valued vector map.

Description of spatial relations using an order theoretic approach based on a simplicial complex seems to be versatile and more complete despite the fact that creation of a lattice out of a poset comprising of many elements needs developing a practical approach, however we note that the partitioning of the domain space into triangular facets have already been used in DTM representation. But with overwhelming data on a spatial database such an approach of partitioning needs practical consideration as regards efficiency and maintenance.

References:

1. *Cassettari,S., 93, Introduction to Integrated Geo-information Management, ISBN 0-412-48900 7, 252 p.*
2. *Egenhofer,M.J. and Franzosa,R.D. 91,Pointset Topological Relations, International Journal of GIS, 5(2), pp. 161-174.*
3. *Egenhofer,M.J. and Sharma,J., 93, Topological Relations between regions in R^2 and $\mathbf{Z}^2$, Advances in Spatial Databases, Proceedings of the third International Symposium, Singapore, eds. Abel,D. and Ooi,B.C., pp 316-336.*
4. *Kainz,W. et al. 93, Modelling of spatial relations with partially ordered sets,International*
5. *Journal of GIS, vol 7(3), pp 215-229.*
6. *Kainz,W., 95, Logical Consistency, Elements of spatial data quality, ICA, to be published.*
7. *Kufoniyi,O. et al., 93, Topologic editing of relationally structured single valued vector maps, ITC Journal, 1993-4, pp*
8. *Pullar,D.V. and Egenhofer,M.J., 88, Toward formal definitions of topological relations among spatial objects, Proceedings of third International Symposium on Spatial Data Handling, Sydney, Australia, pp. 225-241.*
9. *Smith,T.R. and Park,K.R.,92, Algebraic Approach to Spatial Reasoning, International Journal of GIS, vol 6(3), pp 177-192.*