Editorial 4

On December 2, 2004, Mr. Toya Nath Baral took charge as a new Director General of Survey Department, so the Advisory Council and the Editorial Board has been reconstituted. The Editorial Board expects the appropriate directions from the newly formed Advisory Council and the Editor in Chief expects to receive cooperation from the current board members. However, I highly appreciate the contribution and cooperation that we received from the outgoing Members of both Editorial Board as well as Advisory Council. I would like to express my sincere gratitude to all of them for the same.

We have given a new look for indexing of the contents of this journal by grouping the similar nature items to facilitate the readers for the identification of their topics of interest. We hope the readers will appreciate this.

We are very much encouraged to receive a few new articles in this issue but we are still expecting more and more from the readers. So, the editorial board members are trying to motivate to write relevant articles for the Journal from the staffs of Survey Department and also request to other readers to send articles for this journal.

Thanks to the readers for their affirmative responses about the publication of the articles and papers in the journal, which were presented in different national and international events because, the access to all the staffs for the proceedings of the events and the Internet facility is not yet simplified in our context.

We would like to inform you that from this issue onwards, the readers could find one article specially contributed by one of the members of Editorial Board or Advisory Council of this Journal. To begin with the Editor in Chief himself has contributed on the topic **"Change of Leadership in Survey Department".**

Hope the readers will enjoy reading this issue of the Journal.

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COMPARISION OF TIN AND GRID METHOD
OF CONTOUR GENERATION FROM SPOT HEIGHT

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Abstract

In this paper the study of two digital terrain model are carried out and to some extent the comparison are made in between them. In the past few years TIN has become increasingly popular perhaps due to the increasing popularity of the Geographic information system, that can handle the TIN structure and the increasing interest in the visualization of three dimensional objects, but in the contrary there are few investigations carried out in the selection of vertices for Tin from irregularly spaced data such as contours; due to the lack of study in this field the fruitful comparison cannot be achieved. Therefore several trail and error experiments have to be carried out in order to predict the best result.

Introduction:

Digital elevation model (DEM) has a wide applications for different purposes. It is one that efficiently represent the surface of the earth and it is the major component as well as fundamental basis of the Geographic Information processing which helps to model, analyze and display the information stored in the computer to represent the topography of the surface. Digital elevation model (DEM) is the mathematical process of representation of the terrain with the aid of electronic medium therefore it is not an exact representation of the surface where it becomes necessary to make some generalization, manipulation, for the visualization of the terrain model due to the complexity of the natural phenomena. Digital terrain model (DTM) have been used in the geosciences applications since 1950's (Miller and Laflamme1958). Since then it have become a major constituent of Geographic In formation System. It provides a basis for a great number of applications in the earth and the engineering science. In GIS, DTM provide an opportunity to model, analyze and display phenomena related to topography of the surface (R. Weibel and M. Heller). The term DEM has been tended to replace the term Digital terrain model (DTM) because it is more specific term to information being collected i.e. elevation (J. Trinder). These methods cab be considered as a representative of the contours in the digital form.
At present context there are two most commonly used data structure to construct the elevation model. They are

- Regular rectangular grid (Altitude Matrix)
- Triangulated Irregular Network (TIN)

Regular rectangular grid:

Regular grid is one of the most widely used form of data structure in DEM. This regular rectangular grid method is also called altitude matrices. Altitude matrices are useful for calculating the contours, slope angles and aspects, hill shading and automated basin delineation (P. A. Barrough). Grids represent the matrix structure that records topological relations between the data point, this structure of data manifest the storage of digital contours, in other words the grid can be stored as a two-dimentional array of elevations, therefore handling of elevation matrices is simple, and the grid based terrain modeling is straight forward (R. Weibel and M. Heller). Because of the straight forwardness this method has become most commonly available source of DEM.

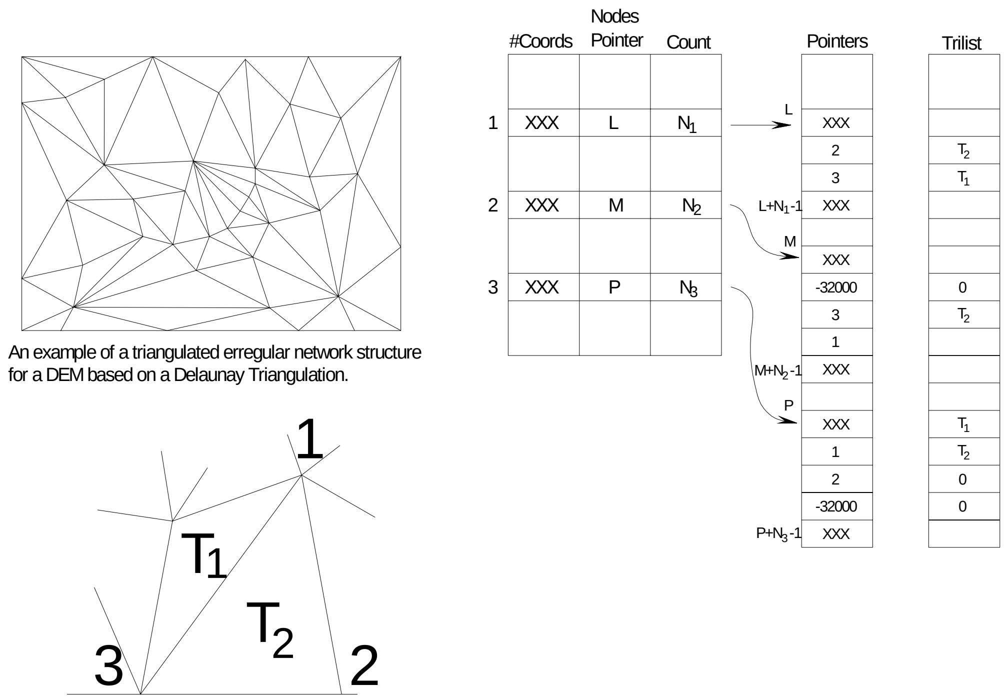
Britain and the United States of America are completely covered by coarse matrices (grid cell sides of 63.5m for USA) derived from 1: 250 000 scale topographic maps and higher order resolution matrices are based on 1: 50 000 or 1: 25 000 maps and aerial photography are increasingly available for these and other countries (P. A. Barrough). Although the regular grid method is useful for the representation of the terrain of less complexity and is particularly useful for the representation of the big areas however it still have some disadvantages as enormous data is needed to represent the terrain to a required level of accuracy.

Triangulated Irregular Network (TIN)

Triangulated irregular network is an alternative method introduced by Peuker and his co-workers (Peuker et at 1976, 78) to other widely used regular digital elevation model. TIN consists of a set of irregularly spaced points that are connected into a triangular network for representing the continuous surface of the earth. Since the TIN structure is based on the triangular elements therefore data structure is able to reflect the variable density of the points and rapidly changing surface as well as rugged terrain of the nature.

In the other hand it avoids the redundancies of the altitude matrix. This method is suitable for preparing the DEM for the country like Nepal which consist some of the most difficult terrain of the world.

The figure 1 shows a part of the network data structure used to define a Triangulated irregular network. The TIN model takes the nodes of the network as primary entities in the data base. The topological relations are built into the database by constructing pointers from each node to each of its neighboring nodes. The neighbor list is sorted clockwise around each node starting at north.



An example of a triangulated erregular network structure for a DEM based on a Delaunay Triangulation.

Data structure of a TIN (detail).

figure:1

The outside area modeled by the TIN is represented by a dummy node on the ‘reverse side’ of the topological sphere on to which the TIN is projected. This dummy node assists with describing the topology of the border points and simplifies their processing. In the above figure we find three nodes and two triangles at the edge of the area. The database consists of three sets of records which are called nodelist, a pointer list and trilist which is also called triangle list. The node list consists of three sets of records identifying each node nad containing its co-ordinates, the number of neighbouring nodes and the start location of the identifier of these neighbouring node in the pointer list. As demonstrated in the figure 1 the triangle T2 is associated with three directed edges held in the pointer list, namely from node 1 to 2 from node 2 to 3 and from 3 to 1.
The data either collected by manual digitizing or from automated point selection and triangulation of dense raster data gathered by automated orthophoto machine and be used to built up TIN structure. It was demonstrated by Peuker et al (1978). It was also demonstrated that this TIN structure is used to generate contour maps, slope maps, profiles, block diagrams, and the map showing the shaded reliefs.

<u>Sources of Data for DEM</u>

For the qualitative result of Digital elevation model the important aspect is the selection of suitable data source and the terrain data sampling technique. At the mean time there are three sources of alternative data for the DEM. They are

- Ground survey method
- Photogrammetric data source, Cartographic data source

- Radar or laser altimetry

The ground survey data is very accurate but is time consuming and cannot be applied for the large areas. Therefore it is applied to specific project areas. From the economic point of view this is very costly method of data collection.

Photogrammetric data capturing technique is commonly used and it is based on the interpretation of the aerial photograph and satellite imagery using photogrammetric instruments. The remote sensing method is also applied in order to overcome the data collection effort consequently large areas can be handled in relatively short amount of time period. Photogrammetric method of data capturing technique is often applied for nation wide data collection and this method is also used in large project areas. It is also an accurate method of data collection.

Cartographic data is an another means of the data source. The cartographic documents i.e. the contour maps, profiles, also serves as a source of data for DEM. Therefore in order to change into the digital form we have to digitize analogue data either by manual digitization or by means of automatic raster scanning and vectorization. The collection of the terrain data as well as the photogrammetric method of data collection is relatively more costly in comparison to converting the analogue data into the digital format. The existing cartographic documents are of least cost and already existing valuable source of information for generating the DEM.

Contour generation

Contours represent line of equal elevation and are the traditional form of relief depiction used in the map to represent and interpret the elevation of the terrain. In the digital elevation model generation of the contour is one of the important method which generally involves the interpolation. There are various methods of data structure that can be applied in the contour generation in order to represent the DEM such as

- Patch structure
- Line structure
- Point structure

Patch structure

It is the mathematical structure that is used to depict the surface and it rely on the polynomial functions which are valid for the terrain, therefore these mathematical functions are able to represent the complex forms with high degree of smoothness. This method is advantageous for modeling the complex surfaces with computer aided design. It split the complete cell into a irregularly shaped patches approximately of the same dimension and then the surface are fitted to the point observation with the patch, consequently the piecewise approximation can be used for interpolating the surface. With the aid of this method contours can be obtained by solving the equations for given z-values and then tracking the contour by following the z-solution (T. K. Peuker).

Line structure

The most common line model of the terrain is given by the set of contour lines that describe the hypsometric curve. The line structure as well as the point structure are similar because both of them are defined by the series of points but the decisive factor here is the order in which the point are stored has as well as a geometric as well as topological significance. The line structures have in common that subsequent points and they are linked by the straight line which can be linearly interpolated in arbitrary interval and then the straight line segment is smoothened during the display stage.

Generally contours are the output of the photogrammetric digitizing. This system of contours has the advantage that the density of the contour changes with the dynamics of the relief consequently which keeps the volume of the redundant data low, although the density of the points along the contour is very high (Goltschalk and Neubauer 1974) and this search is time consuming. Therefore it was found that the comparision of the regular grid of points with contour system that the former are more efficient for the data manipulation where as the second needs the data storage (Boehm, 1976). He explained this by comparing the line of sight test.

We also know that contours are on most existing maps. They are the ready structure of data for the DEM and many efforts have been made to capture them automatically using scanners. But there is a argument that digitizing the existing contours are poor quality DEM than direct photogrammetric measurement (Yoeli 1982). Unfortunately in the computation of the slopes as well as making shaded relief model the contour that are digitized are not suitable, therefore they have to be converted into the point model. Ceruti(1980) and Yoeli(1984) developed algorithms for interpolating contour lines to altitude matrix. Oswald and Raetzsch(1984) described a system for generating discrete matrices from the sets of polygons representing contours that have been digitized either manually or by raster scanning. The system is known as Graz terrain model.

Point structure:

There are two methods of contour generation. They are regular rectangular grid and irregular grid(TIN). These methods have already been described in the beginning. Regular grid method of contour generation is most frequently used because of its implicit definition of topologic relation. In this method the computation of the contour is relatively simple to program.

Once the the grid is constructed the contours have to be drawn. The mathematical algorithm of contouring is Delunay triangulation also there are number of other names that have been ascribed to the two structures for instance, Vorodnoi network, Drichlet tessellation and deltri analysis, all of these describe the same principle in their own field. Algorithm time for triangulation is related directly to the number of points in the data set and is virtually linear function. Compared to the fact that time is also related to the number of rows and columns of the rectangular grid. Therefore with the aid of this method automatic creation of triangulation and subsequent contouring is obtained. A number of efficient algorithms for constructing a Deluney Triangulation, Voronoi diagram is introduce3d by Guibas and Stoli 1985; Heller 1990. In terms of the contouring the interpolation procedure are based on the triangulation which is obtained by locally fitting the polynomial to triangles. Therefore triangulation plays a vital role in both the methods of terrain modeling.

The contour maps are generated from the TIN model by intersecting the horizontal planes with the network. The secondary data structure of the ridge and the channels is used as guide to the starting point of the contour envelope. The contour envelope may need secondary processing to remove artifacts from the edge of the triangles (Peuker et. al. 1978).

Comparisions:

Very few literatures are found where the comparison is made in the contour generation by regular grid and the TIN method. The study carried out by Mark P. Kumler on the "Quantitative comparison of regular and irregular Digital terrain model" was made.
In this paper investigation was carried was carried out on the accuracy for two Digital terrain models i.e. Grided digital elevation model and TIN. The research was carried out in USA on the basis of different surface characteristics and the availability of the digital elevation data. During the study TIN were constructed for each study area from the existing DEM and from the digitized contours and the spot heights in the USGS hypsography line graph. The literature make the comparative study of different TIN to each other as well as to the grided DEM.

Study area:

The study areas were selected on the basis of availability of the USGS 1: 24,000 Digital line graph (DLG) hypsography files. The files contain digital versions of all contour lines and spot heights that appear on the corresponding 7.5 minute topographic maps. Four quadrangles were selected for the study. They were west of Drinkwater Lake, CA, Tiefort Mountains, CA, Crater Lake West, New Britain CT. The DEMs and DLGs for each area were acquired directly from the National Digital Cartographic data base.

In the study the accuracy of different elevation models are compared by estimating at over 1500 test points. The models were used to estimate elevations of the test points and root mean square errors (RMSE) were computed.

Table No. 1

	No. of test points	RMSE for DEM	RMSE for (regular)DEM based TIN	RMSE for (irregular) DLG based TIN
West of Drinkwater Lake, CA	1637	2.7	2.5	1.8
Crater Lake West	1643	3.1	3.5	2.8

Tiefort Mountains, CA	1516	5.5	5.0	4.0
New Britain, CT	1705	5.5	5.7	4.0

According to the result of the table no.1 the DLG based TINs yield significantly lower RMSE than DEM based in the four study areas. The shaded relief images produced from DLG based TIN were superior to those from DEM, giving the more realistic impression of the terrain.

Conclusion:

According to the Mark P. Kumler's study the comparision that he has made in-between the regular and irregular digital terrain model triangulated irregular networks yield better estimates of the surface elevations at over 1500 test points and also the shaded relief images derived from the irregular structure very similar to the orthophotos.

It is difficult to come to the conclusion without through study. The TINs are more popular for its efficiency in the data storage and this method includes a greater number of points of the rugged terrain it also can locate the important points at their required location but on the other hand this advantage is encountered as problematic in the storage and manipulation. The location of every point in the TIN must be specified in 3D coordinates, where as in the grided structure the horizontal location is implicit tin the order of the grid. In fact there is very little works were done in this comparative study therefore in the mean time it is hard to say which method is superior.

Also because of the different terrain structure its application to these different earth surface may give different result therefore only on the basis of many experiments can come to the decisive point and can predict the best.

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Human Resource Development Policy in Space Technology Sector in Nepal

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Key Words: Social problem, Land management, Space technology, HRD policy

ABSTRACT

In Nepal, land is not only used for agriculture purposes but also used as immovable assets to overcome the instant social problems. Furthermore, land plays an important role in preserving the environment and optimum utilization of its natural resources, so it has become a subject of a constant national and international concern in recent years. Hence, land requires its effective management in order to address all of these challenges. Now a days, space technology has been the most effective tool for such management. As space technology is an emerging technology in Nepal, human resource development in this sector is inevitable. But due to lack of human resource development policy, this part is always neglected and the past trend always indicated that human resource policy is not yet oriented towards development of sustainable system, whereas it should have been given first priority.

In order to execute the space technology effectively and to sustain the system for proper land management, human resource development policies should be formulated and accordingly human resources should be developed, because, the professionals involved must have good skill and should have the appropriate knowledge of this new technology. So, this paper tries to analyze the present human resource development policies in the sector of space technology in Nepal.

Introduction

Human resource development is indispensable part for the social and economic development of the country. Human resource development is always neglected due to lack of human resource policy though it is realized that development of proper human resource is necessary to be acquainted with the technologies and to develop them to suit the local environment. The same principle is applicable to space technology sector also. So, for the effective implementation of each activity related to space technology application, proper human resources having professional, managerial and technical skills with appropriate knowledge on the subjects is necessary to sustain the system. As space technology application has a very high potential to perform activities of various sectors such as land management, surveying and mapping, land resource management, weather forecasting, environment preservation, disaster prevention, etcetera, therefore the policy should formulate to develop proper human resources in order to implement the programmes efficiently and effectively.

There exist different means to educate the human resources. So depending upon the available facilities, fund and requirements, suitable means can be selected to develop appropriate human resource.

This paper discuss about the process to develop the policy on human resource development in space technology application and the existing provisions for the production of human resources. It also explains some of the activities in the production process of human resources development both national and international level for surveying and mapping sector to use space technology technique.

Land Management and Spatial Data Infrastructure

Land management is the process to make best use of the resources of land to achieve sustainable products of food and other agricultural products. It also covers all activities concerning management of land as a resource both from an environmental and from an economic perspective. In the mean time, land is consider as an immovable property for solving instant social problems such as educating children in a better environment, conduct social rituals, etc.

In general, staffs involved in land administration and land management are from the general administration sector and they have very less knowledge and skills in this field. Due to which it takes time to feel the responsibility and accountability of the importance to maintain properly the land related records and to provide efficient services to the general public. For better land management, reliable, scientific and updated spatial and non-spatial information of land is inevitable. In the present context of development of IT based spatial data infrastructure system, which is also being applicable to land management process, proper human resource should be developed with appropriate knowledge and skills on related technology. Space technology has evolved over the years in a shifting perspective from an area of research to its varied applicability of providing services delivery in different sectors. Land management is identified as one of such sector where the technology can be applied in an integrated approach along with the concept of spatial data infrastructure. Therefore, human resource development policy should address for solving the issues of land management.

Institutions

In order to develop a certain national level policy, number of organizations has been set up and a certain mechanism has also been developed. The policy related to space technology is also one of the national levels so the formulation of space technology application policy has to follow the same mechanism.

The line ministries act as sectoral in charge. These ministries are responsible to develop policy proposals, design strategies and arrange to implement the approved policies. National Planning Commission acts as facilitator and provides philosophical, logical and professional inputs to frame the policies. Finally, the Cabinet and Parliament are the apex bodies responsible to adopt the policies *[3]*.

After realization of high potentialities of use and application of space technology, the organizations involved in this sector for their corresponding tasks are as follows:

- Survey Department
- Department of Agriculture
- Department of Mines and Geology
- Department of Forest
- Department of Hydrology and Meteorology
- Department of Irrigation
- Departments of Roads
- International Centre for Integrated Mountaineering Development (ICIMOD)
- Some other private organizations
- Etc.

These organizations implement the policy adopted by His Majesty's Government and also provide subsequent and updated information to the concerned Ministry to improve and to modify the operational policies as per the requirement.

Human Resource Development Policy

Ministry of Science and Technology is responsible to promote space technology application and to develop the policy on human resource development in this sector. Some of the general strategic policies related to Science and Technology mentioned in the current Tenth Five Year Plan of HMG are as follows *[8]*:

- Developing and adopting appropriate technology through the mobilization of private sector in the development of science and technology and import of appropriate foreign technology.
- Developing of a mechanism to conduct research and development activities in a competitive manner among individuals, communities and institutions engaged in science and technology.
- Contributing in the socio-economic development of people through the development of knowledge and skills in the science and technology sector and sustainable use of natural resources and means.
- Encouraging universities, concerned institutions and individuals in scientific researches and generating high-skill scientists by giving special priority to science and technology in the higher-level education.

Based on these policies, the Ministry is in process for drafting policy on human resource development for Science and Technology including space technology sector. In the present context of IT based technological development, human resources should have professional, managerial and technical skills and knowledge on the sector concerned. So, the policy must address to cover the development of these different skills.

Human Resource Development

Human resource development component is always neglected in every sector including land management and space technology application sectors whereas it should have given a first priority. Human resource development is well addressed in the definition of capacity building proposed by Groot / van der Moolen and is as follows *[5]*:

"Capacity Building : *The development of knowledge, skills, and attitudes in individuals and groups of people, relevant in the design, development, management and maintenance of institutional and operational infrastructures and processes that are locally meaningful"*.

Furthermore, the answers for the following key questions are necessary to develop and manage human resources for the implementation of each and every technology *[7]*. They are as follows:

1. Why do you educate?
2. What kind of officials / professionals do you educate?
3. What do you educate?
4. How many people are to be educated?
5. Where do you educate?
6. When do you educate?
7. How do you educate?

The officials in the governmental organizations can be grouped into three categories: decision makers including senior executives, gazetted officers and non-gazetted officials. The strategies or the ways to educate on the technology to be applied to these officials are quite different for each category. Meetings, briefings and workshops are the means to educate the decision makers and the senior executives. Basically, gazetted officers are trained either through academic courses or training programmes. At present, academic courses, specifically, graduate courses for surveying and mapping are not in operation within the country. So, the gazetted class level human resources should go abroad for the academic courses. While, the non-gazetted officials educated through either some formal training or a short-term special course or a refresher course or on the job training programmes. The experiences prevails that on the job training programme is the most effective procedure to educate the non-gazetted officials after having some basic knowledge and training in the subject concerned.

One of the policies of human resource development in the sector of surveying and mapping is to produce required technicians in the country itself. In this context, Land Management Training Centre previously named as Survey Training Centre was established on 1968. Primarily, the objective of the training centre was focused mainly on surveying and mapping. The scope of the centre has been broadened to include land management and some of the modern technology such as Global Positioning Systems, Remote Sensing, Geographical Information System, and Space Technology. It conducts three levels of courses namely: Basic, Junior and Senior Surveyors courses and a few special courses on some components of surveying and mapping and land management. However, with the development of computer based information technology as well as ever increasing applications of space technology, the centre has revised its curriculum to introduce subjects for such technologies.

On 1990, His Majesty's Government had adopted a new policy, to conduct academic courses and vocational trainings related to land sector by the private sectors. Accordingly, there exists now four private institutions imparting basic surveying training course and one of them has also introduced intermediate level academic course in the field of surveying and mapping *[3]*. The graduate course has not yet been started though it is very much urgent. On tenth five years plan of National Planning Commission, it has included to run graduate course in the country. Accordingly, Institute of Engineering of Tribhuvan University and some private colleges has initiated to prepare curriculum and are in the process to start the course.

Methods of Education

Education and training are very much essential to apply the technology effectively and there exist following three systems of education:

- Subject Oriented Education: It is a traditional way of teaching the students through lecturing and practical exercises, in which the students restore knowledge presented by the teacher. So, it focuses on acquisition of professional and technical skills. In this system, curriculum for each level of academic courses has to modify by deleting the irrelevant course and add the new innovation to address each new technique.

- Project Oriented Education: It is a new approach of learning and development of technological and professional skill. Learning is an active process of investigation and creation based on the learners interest, curiosity and experience and should result in expanded insights, knowledge and skills. So in this approach, the role of teacher is altered from transferring of knowledge into facilitating to learn, which means the objective of this system is "Learning by doing". By using this approach, the knowledge is established through investigation and through mutual discussion between the students in the group. This concept is very much effective when there is a demand for the modern surveyor that he/she should possesses a not only professional skills but also good management skills. Because the role of a surveyor for the present and future technology is to satisfy the clients and institutions by analyzing and managing the spatial as well as non-spatial data for their needs.

The difference between traditional subject-oriented education and the project-oriented educational model may be expressed in short by an old Chinese proverb:

"Tell me and I will forget
Show me and I will remember
Involve me and I will understand
Step back and I will act"

Skills for theoretical problem solving and skills for learning to learn can only be achieved through the process of academic courses and training at the Universities and Training Institutions while the professional and technical skills can be acquired and updated at a later stage in ones career *[7]*.

- Distance Learning Course: Gradually, the traditional system of teaching and learning is shifting towards the technique supported by virtual media. So the present trend is moving towards the distance learning technique supported by World Wide Web (www) to deliver the knowledge. However, it is yet to know how effective will be this approach.

International Organizations

The importance of use and application of space technology for various economic development of the country is well recognized internationally. Therefore, most of the international organizations related with Geo-information Science are trying to pursue and promote to adopt space technology in application of diverse field. Some of the identified fields are surveying and mapping, land resource management, weather forecasting, disaster prevention, and etcetera. Survey Department, Nepal is also shaking hands with some of the international organizations either by participating their events or by presenting its state of the art of the technology. So far, the department has been the member of the following organizations *[6]:*

- SAARC Networking Arrangements on Cartography (SNAC)
- Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)
- Asian Association on Remote Sensing (AARS)
- International Steering Committee for Global Mapping (ISCGM)
- International Federation of Surveyors (FIG)
- *Ad hoc* Group of Earth Observations (GEO)
- Asia – Pacific Regional Space Application Forum (APRSAF)

Survey Department always tries to participate as many events of these organizations as possible and also tries to fulfill the resolutions adopted by the events. Participation of the events by the officials of the department creates the opportunity to share the experiences and gain the knowledge for space applications and implementation. So this could be considered as one of the means to educate the officials of the department to keep abreast in the recent technologies available in the world.

Gender Issue

As, it is realized that sustainable and balanced development of society will not be possible without men and women having equal opportunity for their development and behavior except for the natural differences. In Nepal, women's population is more than half of the total population whereas participation of women in development activities is minimal. Similarly in surveying and mapping sector also female participation is negligible only a very few female staffs were involved in cartographic activities. The reason for less participation is that most of the surveying and mapping techniques are based on field survey, which the female candidates hesitate to carry out.

The Government has adopted a policy of quota system for women and deprived groups of family to achieve gender equality through some local development programmes such as provision for training women participation, selection of programmes that will increase women's access to services and benefits, etc. Furthermore, the situation has changed, because of development of IT based technology, there is a demand of female staffs in the sector of surveying and mapping for the establishment of National Spatial Data Infrastructure and some other areas. So, on 2003, HMG has developed a policy to conduct basic surveying training to a group of female candidates. Accordingly, Land Management Training Centre had already produced first batch of 20 female candidates of basic survey course and it is in process to conduct training for the second batch. Due to the curiosity, interest, positive response and satisfactory performance shown by the trainee during the training period, similar concept of imparting training course for female candidates has been developing for other levels of surveying courses. So this could be considered as a small step towards balancing the number of male and female survey professionals.

Space Technology Application Training Activity

Survey Department has commenced working in Remote Sensing technology for the production work after successful completion of the 23rd Asian Conference on Remote Sensing in Kathmandu on November 25-29, 2002, which was jointly organized by Asian Association on Remote Sensing and Survey Department, Nepal. Global Positioning System technology has been applying for the control point network extension, since 10 years back. In order to increase awareness to the staffs of the department in space technology applications, a six weeks training programme on Remote Sensing technology was organized on November 2003. The training package contents the various components of Remote Sensing including updating technique for topographical base maps using satellite data. The department is not in position to conduct advanced training programme, however, a concept has been developed to conduct awareness programmes on space technology and GIS to other users.

Mini-project

Survey Department, Nepal joined the Mini-project designed jointly by Japan Association Exploration Agency (JAXA), Japan and Asian Institute of Technology (AIT), Thailand. The other participating countries are Bangladesh, Cambodia, Laos, Myanmar, Pakistan, Philippine, Sri Lanka and Vietnam. The objective of the mini-project is to implement space development for promoting space technology utilization. This is one of the ways of JAXA to cooperate developing nations to encourage using space technology. The activities of the Mini-project consist of three phases, namely training component, field truth and analysis of the study and report writing. There are 15 trainee including two officials from Survey Department, Nepal. At present, the training component has been completed. In this component, the Nepalese officials has developed a methodology for the detection of urban land use changes using one of the space application techniques. In near future field truth, evaluation and report writing portion will be carried out. After the completion of the project, the department could use these two officials as resource personnel to train the other staffs, and also to design and implement a project in similar nature of subject in a national level.

Conclusion

There is an increasing trend in realization of need of proper human resources. Therefore, one can observe different approaches being implement to produce skilled human resources. However, due to lack of coordination on human resources policy and proper plan for the development of human resources, the development in this sector is not progressing as per the expectations. Finally, the following conclusions could be drawn to develop proper human resources related to space technology application:

- Give priority for realization to develop proper human resource.
- Develop capacity building tools to strengthen local education and training.
- Incorporate gender issue in human resource development policy.
- Educate senior executives and decision making through awareness programme.
- Launch education and training program jointly with international organizations wherever possible.
- Include in the policy for the promotion of space technology application for different sectors for social and economical development of the society.
- Develop policy to produce appropriate human resource for sustainable system of space technology.
- Prepare plan and to implement it to produce proper human resource.

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Registration of 3rd Dimension: the Context of Nepalese Cadastre

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Abstract

Registration of the ownership of a real estate property in Nepal is gaining its importance day by day. Before launching the Land Reform Program in 2021 by His Majesty's Government of Nepal, the descriptive system of registration system was in use. After launching the Land Reform Program, the registration of real estate property was based on the map of the land unit occupied by it on the ground, i.e. registration of two dimensions. Gradually, the trend of owning a unit of space is increasing in recent days, needing the registration of the space, i.e. the third dimension. Joint Residential Buildings are examples such need. Although some juridical measures have already been formulated for the registration of 3rd dimension, the aspect of its' visualization on a map, and some necessary measures are still lacking. The time has come to set necessary guidelines to tackle such shortcomings and face the challenges caused by the registration of third dimension. Based on this assumption, this paper highlights the existing scenarios, finds out the shortcomings and challenges in this regard, and suggests some necessary measures for solving the problems identified.

Keywords: *Registration, Real Estate Property, 3D Cadastre,*

1 Introduction

The history of land recording system in Nepal begins from the Lichchhabi Era (450- 800 B.S.). The purpose of keeping land records was to collect revenue. Administration of land got a bit wider scope after the unification of the kingdom in 1825 B.S. Historically, state ownership has been the traditional form of land tenure in Nepal. Until the year 1951 A.D., the rights of an individual over land were virtually non-existent. The landholder of occupier was considered as simply a tenant. The interim constitution promulgated in 1952 protected the citizen's full rights of using and occupying lands. Later, in the 1957 A.D. Land Act, the term "tenant" was replaced by "owner" [1]. After the enactment of the Land Act, interest of a general public on the registration of ownership over land holdings (real estate property) might have considerably grown up, which is gaining its importance day by day.

Until the year 1964, when His Majesty's Government of Nepal launched Land Reform Program, the location of the registered piece of land had been described by text. For example, the piece of land east of the *Dobato* (Junction), west of *Padhero* (water tap), North of *Thulo Bheer* (Big Cliff) and South of *Raniban* (Forest, named *Rani*) belongs to an owner. In the same way every parcel of land was used to be defined at the time of its registration. This system of registration could be termed as ***registration based on description***.

The Land Reform Programme imposed ceilings on land holding and hence the record of every parcel of land with the amount of area occupied by it was required. As a result of which Systematic Cadastral Surveying was conducted throughout the kingdom. As cadastral maps were prepared during the cadastral surveying, it was made one of the essential components for the registration of ownership over individual parcel. Since then, every parcel of land requires its plan to some scale with its dimension to be registered under the ownership of an owner. This system of registration could be termed as ***registration based on two-dimension (2D)***. In this system, a parcel is considered as the property unit. A parcel is division of a piece of land in 2D boundaries. Obviously, the right of ownership to a parcel gives the right to use the volume above and below the parcel, unless stated otherwise. As long as there is only one user on a parcel, the existing registration system is sufficient to provide insight into the property situation.

The rate of population growth is increasing day by day and the available space in the earth is fixed. The growth of population is limiting the availability of space for use. Mainly urban or semi urban areas are highly affected by the population growth. For the proper management of available space not only for the present but also for the future generation, it is inevitable to think of the optimal utilization of available space. As a result, multifunctional use of space is becoming more important in recent years. Consequently, use of space below or above a certain land parcel for different purposes is coming into practice. This has caused the possibility of more than one owners of spaces constructed above or below a land parcel. For example, distinct ownership of apartments in a building, stratified property, underground market areas and so on. Registration of distinct ownership in such cases is the challenging issue. The system of the registration of real estate property should be able to reflect the true principle of property rights: property rights always have entitled persons to volumes and not just an area, otherwise the use of land would have been impossible [7]. The existing system based on 2D registration does not reflect the true principle of property right in such cases. Registration of parcel is possible but the registration of space over it, which is represented by height above or below the parcel i.e. the third dimension, is not possible with this system. Some juridical measures have already been formulated to tackle the issues raised due to the registration of the properties, which needs the ***registration of 3rd dimension***. 3D cadastral registration starts with the possibility to establish 3D property units within the juridical framework. The next step is to provide insight into the 3D property units, e.g. by drawings included in the land registration (Public Register describing interests in land) or, even better, or by integrating the 3D information in the cadastral registration (which links the essential information from documents recorded in the land registration to geometry of real estate objects). In a final phase, regulations could be laid down, which define how to prepare and structure the 3D information that is used to maintain 3D property units in the land registration and/or the cadastral registration [7].

The existing juridical measures in Nepal are not sufficient to cope the registration of 3rd dimension of real estate property. This paper tries to provide an overview of the as is situation of the case related to the registration of 3rd dimension and suggests some guidelines to meet the challenges of Nepalese cadastre in this regard.

2 State of the Art of Registration of 3rd Dimension in Nepal

Unlike the several countries in the world, the interest of using space above or below the ground surface is increasing in the urban areas of the Kingdom of Nepal. Constructions of multistory buildings by different Housing Companies, Overhead bridges, under ground market places, etc are such examples. Fragmentation of property within a single building is the other issue that compels the use of overlapping spaces by different owners.

In fact, the need of the registration of 3rd dimension in Nepal is recognized only for multistory buildings constructed for Joint Residences and fragmentation of property within a building. Other sectors, needing the registration of third dimension, are still to be recognized. However, as per the need of time, the concept for other areas will certainly come to the front. If we look at the existing juridical framework regarding the registration of distinct ownership to more than one owners within a building, constructed for joint residences or fragmentation of inherited property within a building, some measures have been incorporated in the Land (Survey and Measurement) Act, 2019 and its' regulations, Ownership of Joint Residences Related Act, 2054 and Land Administration Directives, 2058.

3 Shortcomings of the Nepalese System

Regarding the registration of 3rd Dimension of the real estate property, one should consider the two components of 3D real property:

a) Survey of 3D component
b) Registration of 3D component

Shortcomings of the Nepalese System of registration of 3rd Dimension should be taken in to account keeping these two aspects in view. However, some other aspects also have been addressed in this section.

3.1 Survey of 3D component:

The existing system of registration of 3rd dimension does not have any provision to survey the 3rd component. Furthermore, the visualization of 3rd component is beyond the scope of existing system. However, the measurements of the dimensions of the floors are included in the Register Book and Ownership Certificate.

3.2 Registration of 3D Component

The legal framework for the registration of 3rd dimension is not sufficient. Only the case of multistory buildings is not taken into account for the registration of 3D component. Registration of 3D component is also not sufficient. Some of the shortcomings in this regard can be pointed out as follows:

- Land Revenue Act, 2034 has not incorporated the registration of 3D component yet, in spite of its major role in the registration business. Land Revenue Offices are guided by the Land Administration Directives, 2058.
- The provision for registration of 3D component in the Land Administration Directive, 2058 does not address the registration of apartments/flats in a floor. The owner of the ground floor can sell a part of his/her property but the directive does not speak any thing about the subdivision of property in the upper floor.
- Although Land (Survey and Measurement) Act, 2019 incorporates the possibility of registration of distinct ownership on the floors or apartments, the

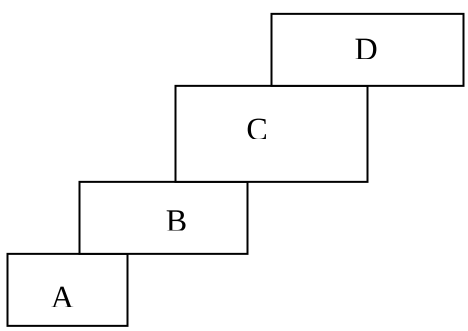
format of Register Book and Ownership Certificate does not have the provision of registering or providing ownership certificate of an apartment/flat. The existing format of Land Register Book and Ownership Certificate indicates that the ownership on the land parcel, on which the building is erected, remains with the owner of the ground floor, but not with the owner(s) of upper floor(s).

- The provisions included in the Land Administration Directive, and Land (Survey and Measurement) Act do not address the registration of distinct ownership in the housing units (apartment/flat) of Joint Residential Buildings.
- The registration system does not incorporate the registration of restriction and responsibility of the individual owner.
- The Ownership of Joint Residence Related Act and its Regulations, although a number of provisions of rights, restriction and responsibilities have been included, do not address the way of their registration.
- The visualisation of the 3rd component on the cadastral map, the system of providing unique ID's to the property unit, etc are included nowhere.

3.3 Some other aspects that are still to come into the light:

Following are some of the other aspects that are still to come into the light while performing the registration of 3rd dimension or implementing 3D Cadastre:

- Existing system does not take into account the other areas like underground parking places, underground market places, overhead bridges, etc where the 3D component plays an important role.
- Registration of ownership on the real estate property, where half of one's property is overridden by others. Such type of case is of common practice in the district of Jumla and Bajura [3].



Where,
A, B, C, and D are individual property owners. Some part of the A's Property is overridden by B, and so on.

Figure 1: Overlapping Property situation

- Registration of ownership on the buildings, where different floors have different ownership but one overlaps other in a sequential manner. Such type of case is found in the dense areas of Kathmandu Valley.

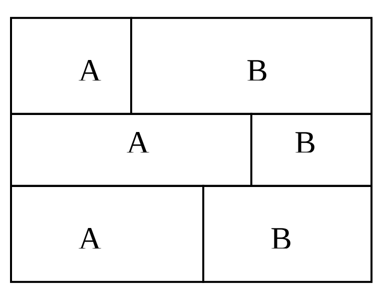


Figure 2: Owner A is overriding Owner B and subsequently Owner B is overriding Owner A

- Measurement of height is not taken into account. Adjudication of property unit is not documented in the legal framework.
- Co-ordination among the organisations involving in the registration of 3D component is lacking. For example, the Land (Survey and Measurement) Act, 2019 realised the need of registration of stratified property in its Fourth Amendment, i.e. in 2035 B.S. but the Land Revenue Act still does not have realized it. Similarly, the rights, restrictions and responsibility of an apartment/flat owner are mentioned in the Ownership of Joint Residence Related Act but their registration is not considered yet.

4 Some Suggestions Regarding the Registration of 3rd Dimension in Nepal

Some of the shortcomings of the registration system of 3rd dimension in Nepal are illustrated in the previous section. As the interest in using the space under and above the earth space is increasing and being a must in many cases, registration of the property in 3rd dimension should be made effective and the owners should be made to feel full security of their property. In this regard, some suggestion, keeping the shortcomings of the existing system in view, have been outlined as follows:

4.1 Amendment of Existing Laws

Existing legal framework for the registration of 3rd dimension does not address the registration of 3D property situation in every possible cases. Even the registration of apartment/flat is not incorporated in the existing laws. The provisions incorporated in Land (Survey and Measurement) Act, 2019 and its Regulations, and Land Administration Directive, 2058 should be amended to include the registration of every 3D property situations. Right, restriction and responsibilities of the owner of individual property unit as described in Ownership of Joint Residence Related Act, 2054 should be included in the registration of the property unit. Furthermore, following points should be considered during the amendment of existing laws to cover the registration of every possible 3D property situation:

- Identification of the sectors, where the registration of 3D situation may arise
- Smallest property unit that is transferable
- Ownership of open spaces, such as the ownership above the roof of a building
- Construction up to the height under ones ownership
- Including the lending of property in leasehold within the legal framework
- Rights, restrictions and responsibilities of the owner
- etc.

4.2 Co-ordination Among Different Agencies

Following organisations are found to have major role in the registration of 3D situation in Nepal:

- Survey Department
- Department of Land Reform and Management
- Department of Urban Development and Building Construction
- Local Authorities (Municipalities/VDCs)
- Housing Companies

At present, the coordination regarding the registration of 3rd dimension is found lacking. A number of Housing Companies are involving in the construction of Joint Residential Housings. Municipalities may have to think for the construction of underground parking places, market places, overhead bridges, etc. Similarly, other agencies may have interest in the registration of 3rd dimension.
Proper coordination among these organisations would enhance the effectiveness of the registration of 3D situation. Before formulating any laws/acts/directives, the coordination among these organisations would come up with fruitful outcomes. Hence, the coordination is strongly recommended.

4.3 Survey of 3rd Component

Survey of 3rd component is an important aspect for the registration of 3D situation. Subdivision of property has to be carried out horizontally, so accurate height information is required. Height of every property unit from the ground surface and its own height should be measured accurately.

4.4 Visualization of 3rd Dimension

Visualisation of 3rd dimension on a cadastral plan is not possible. In the digital environment, the model of 3rd dimension could be possible. Perfect solution for the visualisation of 3rd dimension in digital environment for cadastral purpose is yet to be found out. Research in this area is continued. In the context of Nepalese cadastre, this modeling is not possible at the moment as it is lacking the cadastral data in digital form. Parcel based cadastral information system would optimize the visualisation of 3rd dimension.

5 Conclusion

The trend of using overlapping spaces in Nepal is increasing considerably in the urban and semi urban areas. Many of the Housing Companies are involving in the construction of multistory building to sell the apartments. The owners of the apartments are unable to register the ownership and mortgage the properties. The general public is not assured of his property situation in the as is condition. So, appropriate measures should be immediately adopted to resolve such problems by the concerned authorities. The registration system should address the right over the 3rd dimension adequately. Furthermore, effort should be made for the visualisation of 3rd dimension.

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Spatial Data Infrastructure for Prosperous Nepal

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Key words: Metadata, Clearinghouse, Sustainable development, Good governance,

Abstract

This paper examines the current status of spatial data infrastructure development in Nepal and discuss about the components of SDI as well as expectations from SDI. Importance of metadata base and concept of electronic clearinghouse are also briefly explained. The expectations from the implementations of NSDI are identify as, it leads to envisage its rationale for development towards the prosperous Nepal, create an environment for sustainable development from local to national level and ultimately support for good governance in Nepal. Furthermore, provide a list of action plans to be taken immediately to operate NSDI efficiently and effectively.

Spatial Data Infrastructure for Prosperous Nepal

Rabin K. SHARMA, Nepal
Babu Ram ACHARYA, Nepal

1. Introduction

People living in this Earth expect shelter, food and an adequate quality of life. Development of sustainable mechanism ensures the proper maintenance of those requirements. Reliable and more valuable information, specifically, spatial information science is one of the important tools for contributing to the determination of sustainability.

In recognition to these facts, Survey Department, Nepal initiates to undertake the National Geographic Information Infrastructure Programme (NGIIP). The programme will be the development process of National Spatial Data Infrastructure (NSDI). The NSDI will encompasses the fundamental data sets, framework data sets, electronic clearinghouse, communication networks and on demand application. NSDI concept has been developed as it could play an important role in the development process to support good governance and to establish or prosperous Nepal.

2. SDI in Nepalese Context

Spatial Data Infrastructure (SDI) is being developed as a tool for national spatial data collection, storage, processing and dissemination. SDI is a basis of national information resources. Because the users can collect, revise and manage data from its own end in real time ensuring the information remains accurate and valuable. This broadens the importance of use of geo-spatial data beyond traditional users and brings them into mainstream of new technology. So, sharing of data between and within the organizations will be possible after SDI system is in operation and interoperability system will be focused in the development of NSDI. The operation System of NSDI is given in figure 1.

Poverty reduction, good governance, social justice, environmental protection, sustainable development and gender equity are some of the major national issues addressed in the current tenth five year plan (2002-2007 AD) of His Majesty's Government (HMG) Nepal. A good and reliable spatial and non-spatial data related with NSDI are the prerequisite for their effective and efficient decision making. Therefore, HMG/Nepal has commenced the NGII programme for building NSDI. It is evident that active participation and commitments from the major stakeholders could play a decisive role in building NSDI. The proposed model of operation system of NSDI seems to be one of the suitable models to support the issues mentioned above.

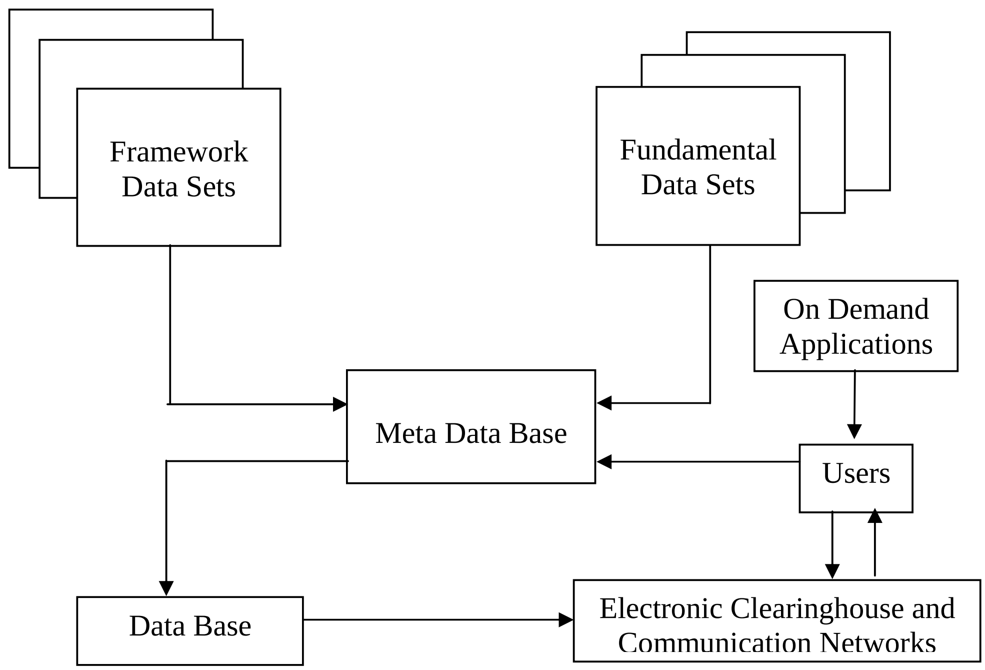

Fig 1 : Operation System of NSDI

3. Fundamental Data Sets

The fundamental data sets of Nepal is the National Topographic Data Base (NTDB) containing the different layers such as geodetic data, administrative boundaries, transportation networks, buildings, Hydrography, Topography, utilities, Land cover, Toponomy and designated areas and is organized at sheet level. The basis for NTDB is the digitization of topographic base maps of scale 1:25 000 for the Terai (Plain Areas) and the middle mountains and of scale1:50 000 for high mountains and Himalayas of Nepal. These maps were prepared and published by Survey Department of Nepal between 1989 and 2001 AD. Base data is generalized for the reduced scales and separate data layers are archived in the database. Furthermore, a large scale 1:5 000 to 1: 10 000 ortho-photo database is provided for densely populated urban and semi-urban areas.

4. Framework Data Sets

The framework data sets are the database obtained from different sources of the related disciplines such as National Data base of Population Census, Agricultural, Soil, Geological, etc. The aggregation and integration of fundamental data sets and framework data sets will solve the purpose of NSDI. This will make the works of users community more simple, efficient and effective in terms of time and resources because for most of the applications data will be available from NGII and very few data will need to be collected from primary sources.

5. Metadata

Metadata is the main key to open the door of SDI. So, the NGII project is in a state of creating metadata base. The main format of metadata presentation will be represented as thematic blocks aggregation. Each block consists of the information of some data attributes such as Information policy, data standard and norms, copyright policy, specifications, pricing policy, security and protection, etc. The users could easily access to metadata base to enable to find total information about their requirements, to evaluate the existing dataset, to understand the procedure for acquiring the dataset, etc. It also helps to maximize the data sharing and to minimize the data duplication. In our context, the users are always having problem of finding the information sources and the procedure to acquire them. So, the metadata services facility could facilitate the users to find the appropriate information.

6. Electronic Clearinghouse and Networking

In the development process of SDI, one of the services to be provided to the users is Electronic Clearinghouse service. This service will help the users to find out and access the data of its interest. One of the objectives of NGII is to support GIS users one way or other for their every study and project. So based on user's selection, data will be retrieved from the respective database and the data will be sent to the user. The user then can view, make query or download the data.

The communication network translates the concept of electronic clearinghouse to implementation level. One of the simplest ways for the connection from the users is through Internet. Data supplier will install Remote Access Server where the participating agencies can dial for their connectivity. The supplier gets connected to the Internet through dedicated Radio Link. Leased line is preferable as standby option, which will minimize the downtime.

7. On Demand Application

The creation of Spatial Data base has a certain standards and norms, format, etc. These characteristics may not suitable to some end users and some may not be able to modify as per their requirements. Such end users may apply to the supplier and submit them the data as per their interest. Therefore a provision on demand application need to be establish within the clearinghouse. The details of this application are yet to be developed.

8. The Components of SDI

The major components of SDI comprises of the following:-

- Data producer
- Other Partners
- Data Users
- Legislative Body
- Telecommunication Service Suppliers

The function of data producer is to create fundamental database and to aggregate and integrate the other framework database that are made available through other partners. For example, the population census database will be made available through concerned organizations, such as Central Bureau of Statistics in Nepalese context. Furthermore, data producer must create metadata base and to form relevant legislation and with the help of a legislative body in order to disseminate data easily to the users without disturbing the integrity of the country. The sharing of data and communication with the users is nowadays mostly carried out through Internet and e-mail. So, a better telecommunication services should be made available with the help of concerned authorities. Finally, the users should be facilitated through its electronic clearinghouse and communication network to provide efficient services to them.

9. Expectations from NSDI

At the present context of building of NSDI, establishment of NTDB has been completed and able to aggregate the population census database of Central Bureau of Statistics. The concept of NGII is develop to make participation of different stakeholders in phase basis. Accordingly, in the very first phase, Central Bureau of Statistics will join the system with their population census database. After completion of this phase, the system intends to incorporate other participating agencies such as Ministry of population and Environment, Ministry of Local Development, Ministry of Health and Ministry of Agriculture and Co-operatives. During the implementation of second phase other relevant agencies will also be encouraged to participant in the system to grow towards the development of a complete NGII.

After building of NSDI, the expectations are as follows:-

- Duplication of work goes down to a minimum level.
- Resources could be mobilize for more development activities
- Cooperation and coordination among the different disciplines will be more effective
- Implementation of development activities will be efficient
- More people will benefit with good results from the development activities.

As most of the developing programmes are related to grass root level of the population and each development programmes need spatial and attribute data for their respective activities. These data are easily accessible through NSDI applications due to which socio-economic parameters and socio-economic planning could be addressed more effectively. Therefore, NSDI will help in appropriate decision making purpose for betterment of the society; this will lead to envisage its rationale for development towards the prosperous Nepal, also it creates an environment for sustainable development from local levels to national level. Finally, it will then support for good governance in Nepal.

10. Immediate Plan of Actions

The efforts should be concentrated for the following plan of actions to implement the SDI effectively and efficiently:-

- Launch an awareness programme to educate the related persons and organizations
- Develop an appropriate working policy framework
- Establish an effective electronic clearinghouse and communication networks
- Continue development of human resources through relevant training programme and academic courses.
- Initiate capacity building to establish standard data sets and to integrate the data from several sources.

11. Beneficiaries of NSDI

The direct beneficiaries of NSDI are the Government organizations, public and private agencies and academic institutions. The Government organizations could use NSDI for evaluation of their plans, programmes and policies, preparation of development activities, etc. public and private agencies could use for their business promotion activities. Finally, the academic institutions can make use of NSDI as teaching aids as well as for research works in this sector.

12. Challenges

During the building process of NSDI, The following challenges have to be faced:

- Satisfy user demands:- User expectation is relativity high and changes in due course.
- Sustainability:- Require continued support from participating organizations for a sustainable system.
- Source of Fund:- Functioning and development of such system need a reasonable source of fund.
- Technology:- Related Technology changes very fast and is difficult to keep pace with such development.
- Human Resources:- Proper human resources development is a must which can be achieved through academic courses and local training programme.

13. Conclusions

The building of NSDI is an ambitious programme where maximum numbers of partners are expected, so the handling and management of such a massive volume of data is not an easy task or it is a very challenging work. Therefore, for the smooth operation of the NSDI, the staff involved in this work must be dedicated, honest and cooperative in nature.

At present, the development of the system is in a beginning state where the establishment of national topographic database and database of population census had been incorporated in the system. Furthermore, creation of metadata base of the existing database is in process and yet to develop the electronic clearinghouse and network communication and a system for on demand application is in a state of conceptualization. However, it is clearly visualized that quite a number of other partners will be accommodated in the system. So after the NSDI is in operation it will support in national building which will be a self sustain system and ultimately it will support for the good governance in the country and will be able to establish a prosperous Nepal.

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Study of change in Urban Landuse

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Abstract

Land use and land cover change are the result of complex interaction between socio-economic factors and other driving forces. The driving forces in land use change include population growth, technological capacity, economical development, political structures, culture and the environment. Land use and land cover change modelling has becoming an extremely common tool to understand and explore land use change. This report primarily aims to predict the change in urban land use for future scenarios. Next, it evaluates satellite imageries along with analysis techniques for feasibility in urban change detection. A post classification comparison is done to find out the land use change in Kathmandu valley from 1988 to 2001. Based on the land use maps urban land use was found to change from 11% to 19% during the study period. Adeos AVNIR 1997 image and maximum likelihood classification was found to be the best among the tested. Urban prediction was established on a rule-based model along with weightage tables to fit the local conditions. The predictions were done on the vector data of 1992 and overlaid upon the classified urban of 1997 to determine the accuracy of predictions.

Keywords: *Classification, Land use change, Urban Area prediction, Urban Land use, Urban fringe growth, Urban planning, Satellite imagery assessment, Analysis technique assessment.*

1. Introduction

Land use maps were created in the Survey Department in 1984 from aerial photographs; since then the maps have neither been updated nor re-printed. Technologically, Remote Sensing and GIS provided the best alternative for creating such maps from satellite imagery. At this juncture, the training by AIT, GAC and sponsored by JAXA, was very welcome because it provided the department with the opportunity to learn and explore different methods of analysis for creation of land use maps.

From AIT's point of view, the creation of land use maps was mere manual work requiring very little analytical techniques and adding very little to the produced land use maps. Value added work was suggested and with the joint consent of AIT and SD, the present study "Change in Urban Landuse" was undertaken. This was also within SD's objectives as urban extraction or delineation had always been problematic for topographical base map updating. A model to predict future land use would be helpful for planners. Evaluation of satellite imagery for delineation of landuse units would be extremely helpful to the department for future evaluation of alternatives.

1.2 Study Area

The study area is Kathmandu valley comprising of the Metropolis Kathmandu, the Sub – metropolis Lalitpur, and the municipalities Madhyapur Thimi, Bhaktapur and Kirtipur. For the purposes of study in urban change, the area provides a good mix of rural, urban, vegetated, cultivated, flat-land, steep land, terrace farming and bare-land. In the national topographic database (NTDB), the area covers two Topo sheets of scale 1:25000, 2785 06A and 2785 06B.

1.3 Objectives of the study

- Update land use maps
- Evaluation of satellite imagery and image analysis techniques
- Predict future urban growth scenarios

1.4 Methodology

Images of the study area were geo-corrected and enhanced. Supervised and unsupervised classifications were done on these images to obtain land use maps of chosen land use classes. Fieldwork aided ground truthing and provided input for supervised classification and accuracy assessment. Further analysis, such as PCA and NDVI were done to evaluate their feasibility in extracting urban land class and to perform a comparative analysis. Analysis was also done for assessing viability of urban extraction from imagery of different sensors. Upon extraction of urban extents for the available images of various periods, urban growth was charted mathematically and factors/variables affecting urban growth identified. After evaluation of the primary predictor model, snapshots of predicted urban were created for various baseline years like 2005, 2010 etc. An alternative method of urban prediction was proposed.

2 Satellite images

The satellite images used were TM 1988, Adeos AVNIR 1997 and ETM+ 2001. Similar corrections, classifications and analytical techniques were applied on all of them. Bands 1,2,3 & 4 were taken for all of them to obtain similarity in results.

2.1 Land use classes

The land use classes for the present study was chosen according to Level 1 of the European Corine Land-cover Nomenclature. The classes are Artificial, Agriculture, Forest and Wetland. Due to low separibility in the spectral bands, mixed land characteristics, relatively low spectral and spatial resolutions Level1 was adopted for the study.

2.2 Geo-correction & Image enhancement

Images collected from satellite sensors must be corrected geometrically before they can be used with other images that have been geometrically corrected. In our study geometric correction was done to the subset images with easily identifiable GCP tie points on both the satellite image and the vector data of the study area. Image enhancement is the process of making an image more interpretable for a particular application. Enhancement can make important features of raw, remotely sensed data more interpretable to the human eye.

3. Image Analysis

3.1 Maximum Likelihood Classification

Classification is the process of sorting pixels into a finite number of individual classes, or categories of data, based on their data file values. If a pixel satisfies a certain set of criteria, the pixel is assigned to the class that corresponds to those criteria. [Erdas Imagine Tour Guide].

Discussion: The result of this classification was satisfactory for all the images.

3.2 Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is often used as a method of data compression. It allows redundant data to be compacted into fewer bands—that is, the dimensionality of the data is reduced. The bands of PCA data are non-correlated and independent, and are often more interpretable than the source data (Jensen 1996; Faust 1989; cited in Erdas Imagine Field Guide).

Discussion: While visual interpretation provided a fair overview of the urban areas, it was considered to be inadequate for any form of extraction of information either automated or otherwise.

3.3 NDVI

Healthy green vegetation has low response in the red band and a high response in the near-infrared band of a satellite image. Subtracting the red band from the near infrared band should produce higher values for vegetated areas than for areas dominated by concrete, soil or water. This difference can then be divided by the sum of the band responses to normalize the value so that it may be less sensitive to particular lighting conditions. NDVI = (NIR – R) / (NIR + R)

Where NIR is the reflectance in the near-infrared band and R is the reflectance in red visible band.

Discussion: Classification of NDVI gave a nice picture of the urban and forests for some of the images, but it failed to fit to the general trend of growth.

3.4 IHS Merge (Pan sharpening)

IHS Merge was applied to the ETM 2001 image and the resulting image provided good visual perception for the urban areas.

Discussion: The IHS Merged image provided visually good distinction between urban areas (blue), agriculture (red), vegetation (green) and bare soil (brown) but there was no verification of numerical values to corroborate the visual impact. The classification results were unsatisfactory.

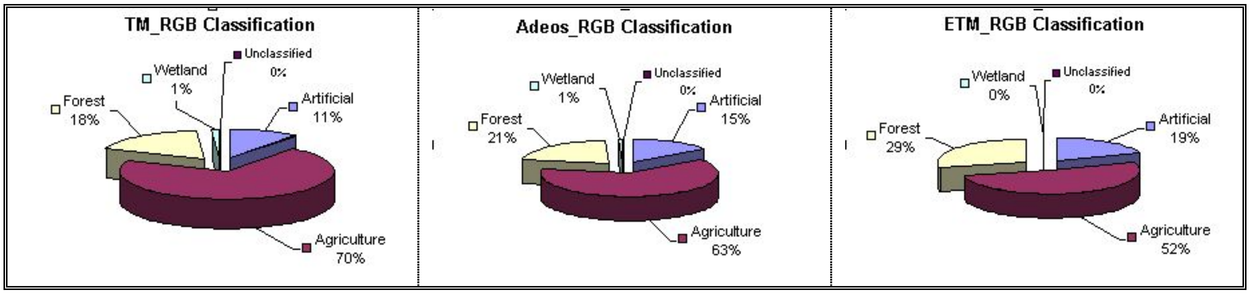
3.5 Normalisation

Sensor look angle and local topographic effects affect pixel albedo (the ratio of the radiation reflected from an object, to the total amount incident upon it, for a particular portion of the spectrum). For airborne sensors, this look angle effect can be large across a scene. It is less pronounced for satellite sensors. This calculation shifts each (pixel) spectrum to the same overall average brightness. Correctly applied, this normalization algorithm helps remove albedo variations and topographic effects. [Erdas Imagine Field Guide]

Discussion: This resulted in certain areas being highlighted in the visual inspection, but the result of the classification was very bad since 50 – 75 % of the pixels remained unclassified.

3.6 Classification accuracy

For the accuracy assessment of the maximum likelihood classification 256 random points were generated and the classification reference values assigned from the ortho-photo and IKONOS image of Kathmandu. The accuracy obtained from maximum likelihood classification for TM 1998 was 92.5%, so it was the best among the 13 analyses for the three images.



Comparison of Landuse units from Classification

__**Discussion**__: The land use maps have been derived from classification of satellite imagery of various periods. *Agriculture*: It has shown a decrease of 10.04% in the first period and 18.24% in the second period. The first period is of 11 years and the second is of 5 years only. Overall, the agriculture land use decreased from 70.7% to 52% over the whole study period.

Artificial: Urbanisation has shown a rapid increase at the cost of agricultural lands and has increased from 10.7% to 19.2% over the whole period. Phase-wise, it has increased at a rate of 36.45% in the first phase and 31.51% in the second phase.

Forest: It has increased from 17.7% in 1988 to 28.7%. The increase percentages for the two stages are 18.08% and 37.32% respectively.

4. Urban Prediction

Although urban growth is perceived as necessary for a sustainable economy, uncontrolled or sprawling urban growth causes various problems. Not only does urban sprawl rapidly consume precious rural land resources at the urban fringe, but it also results in landscape alteration, environmental pollution, traffic congestion, infrastructure pressure, rising taxes and neighbourhood conflicts. [Allen, Lu]

Urban growth prediction is a complex science. Successful dynamic model is yet to be built because urban growth commonly shows irregular spatio-temporal patterns, has many indefinable and un-quantifiable variables, and is governed by internal forces and external market pressures.

There exist a number of urban growth models. One method is the Rule-based method developed by Allen and Lu, which is considered to be highly suitable for a spatio-temporal urban growth model for this study.

4.1 Rules guiding urbanization

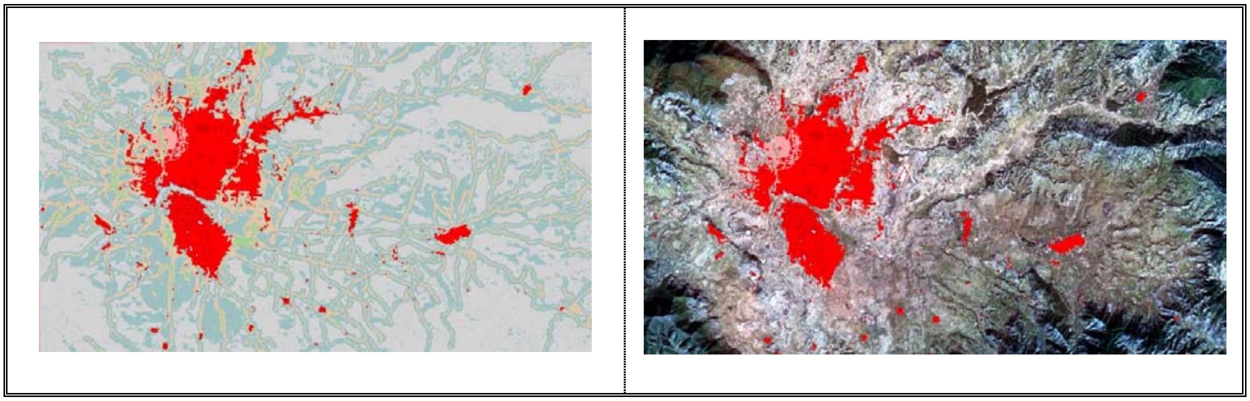
Physical suitability: Rules that reflect the onsite relationship between land properties and urban development. (Land properties, Landscape)

Access Oriented: Rules that manifest the effects of infrastructure and other factors towards urban transition. (Infrastructure, Facilities, Utilities, Services)

Market oriented: Rules for identifying factors that stimulate faster growth in comparison to other areas. (Population, Employment, Housing, Land prices)

Urban-to-Urban: This rule determines that urbanisation is a unidirectional process, existing urban will remain urban and thus an exclusion mask can be created. Further use of the existing urban is to determine the increased affinity towards urbanisation and its use as a superposing variable.

Policy: This rule guarantees that some land will be protected from urbanisation while some land will be forced towards urbanisation. (Constraints, Forced)



High growth probability and final prediction

For this study, the rule-based model predicts the urban growth on the basis of probabilities of growth of various regions through weighting, assigning suitability scores and creation of exclusion and urban gravity masks and the subsequent mapping of chronologically ordered growth through reclassification of high probability areas.

Results and discussions

From the results of the urban prediction, the rule-based model was verified and found to give reliable results. For creating the exclusion mask, buffer zones for road, rivers, open spaces, high-tension lines (utilities), etc. based on actual figures were used. Protected spaces like forests, and hydro were excluded because they are secluded from urbanisation. Based on rules, appropriate layers were used to create the exclusion mask. The remaining area was used for the urban gravity.

High probability areas were derived from the urban gravity and these were evaluated with urban areas derived from classification. The accuracy obtained was 85%. The accuracy was evaluated for the predicted area for vector of 1992 against the urban extents of 1997.

5. Conclusion

This study was undertaken with mainly two objectives. (A). One of the objectives of the Survey Department was to learn to update the landuse maps it had produced more than 20 years back. (B). Study of change in urban land use was undertaken to utilise the land use maps obtained, for further applications. The study addressed it's objectives. It started with the identification and selection of the land use classes for the study and the basis for it, followed by classifications of images and the results of the analysis of sensors and techniques. Urban extents were mapped, prediction model defined and the results analysed. A model for urban prediction was also proposed. These derived urban areas were then tested on the existing ones and the results were found to be satisfactory.

Thirteen image analysis techniques were evaluated for each of the three satellite images, Landsat TM 1988, Adeos 1997 and Landsat ETM+ 2001. Accuracy assessments were done and the overall accuracy, kappa statistics, producer' accuracy and user's accuracy were analysed. The maximum overall accuracy obtained was 92% for the Landsat TM 1988. The classified images were then studied from urban extraction point of view. Each classification technique and each image were then placed on a table with values based on their usefulness towards urban extraction. The results showed that Adeos with a spatial resolution of 18m was the best alternative among the three images and maximum likelihood classification was the best analysis technique among the thirteen tested.

Urban growth was based upon a rule-based model, which projected most of the factors of the rules to a format that could be integrated into a GIS. From the five rules, namely, Physical suitability, Access oriented, Market oriented, Urban-to-urban and Policy, an exclusion mask and a gravity layer was created to calculate the high probability of growth in certain areas. From the probability map, the values were reclassified to rescale the value to appropriate time scale and ranges. This gave the predicted urban for various periods. The 1997 predicted urban area from 1992 vector data was tested against the urban extents derived from Adeos 1997. The accuracy of prediction was found to be 85%. However, the weightage table need to be recalibrated for more accurate projection of existing conditions or factors, and for further prediction.

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Journal # 4

Discussion Forum on Cadastral Survey

Cadastral Survey Branch conducted a three days Discussion Forum from Bhadra 9-11, 2061 (August 25-27, 2004) to review the work progress of Cadastral Survey of the fiscal year 2060/061 and to discuss on the annual programme for the fiscal year 2061/062. During the Closing Ceremony of the Forum, Mr. Bijaya Raj Bhattarai, Secretary, Ministry of Land Reform and Management and Mr. Babu Ram Acharya, Director General, Survey Department gave directives to implement the outcomes from this Annual Discussion Forum on Cadastral Survey programme and to provide services to the people effectively and efficiently.

Civil Servant Day

On September 7, 2004, Survey Department observed the Civil Servant Day by planting tree saplings within the premises of the Department. Mr. T. B. Pradhananga, Deputy Director General a.i.; Mr. S. P. Mahara, Deputy Director General and Mr. B. R. Acharya, Director General addressed the gathering.

Surveyor's Day Celebration

Mr. Babu Ram Acharya, Director General, Survey Department was the chief guest for the celebration of the 6th Surveyor's Day Programme organized by Nepal Surveyor's Association. The programme was held in Survey Department complex on September 15, 2004. Mr. Acharya, key officials and some ex-officials of Survey Department expressed their views related to Survey profession. On the same occasion 56 officials of the Department donated their blood for humanity welfare.

Agreement On JAXA Mini-project

On July, 2004, Survey Department, Nepal and Japanese Aerospace Exploration Agency (JAXA), Japan signed on agreement paper to participate on a Mini-project jointly designed by JAXA and Asian Institute of Technology (AIT), Bangkok, Thailand. The main objective of the Mini-project is to cooperate developing nations to encourage for application of space technology through training programme. The Mini-project comprises of three phases namely, Training component, Field Truth and Evaluation & Report writing. Mr. Jagat Raj Poudel, Chief Survey Officer and Mr. Sudarshan Karki, Survey Officer participated the project.

Preparation of Video on Cadastral Survey

Cadastral Survey Branch, Survey Department prepared a video on Cadastral Survey to educate the people related with this sector. The visual contents of the video tried to provide information on historical background, present and future prospects of cadastral system.

Workshop

In cooperation with Survey Department Mr. Dev Raj Poudyal, Survey Officer conducted a Workshop on *"Evaluation of Alternatives - District versus Central Cadastral Information Updating for the Effective Implementation of LIS in Nepal* on October 13, 2004 in Survey Department, Nepal. Mr. Poudyal is an M.Sc. Degree student of Geo-Information Management, ITC, The Netherlands. The discussion on workshop was focused mainly on the issues related with the research area of his thesis and also discussed to clarify some of the items on the questionnaire developed to collect relevant information for updating of cadastral information by examining the institutional and technical issues.

Obituary

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

1. Late Mr. Niranjan Mandal; Survey Officer 061/ 07/15
2. Late Mr. Jaya Bahadur Bam; Amin 061/08/

Farewell

Survey Department bid farewell to Mr. Babu Ram Acharya; Director General for his transfer on the post of Regional Administrator, Special Class at Doti, on December 1, 2004.

Workshop Seminar

Geodetic Survey Branch, Survey Department conducted a two days Workshop Seminar on Geodetic Network Strengthening, form Magh 5-6, 2061 (January 18-19, 2005)at Kathmandu.

WEB-BASED METADATA ADMINISTRATION SYSTEM

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KEY WORDS: Metadata, Geospatial data search

ABSTRACT: Metadata forms the basis for exploring data. A well structured and detailed metadata supports exploring the existence of a data set, suitability of datasets for the intended application, and also finding out the ways to obtain such a dataset. One of the fundamental purposes of establishing a geospatial information infrastructure is to provide an easy means to supporting such an activity of data mining/exploration etc. National Geographic Information Infrastructure Programme, Survey Department (NGIIP/SD), Nepal is working towards the development of a web-based metadata administration system concerning geospatial data in Nepal. The system was XML based and built upon open source software technology.

This paper describes the content standards adapted followed by system prototype.

1. Introduction

Geo-spatial data are often required for different purposes to users. Consequently collection of such data proceeds with the methods probably most suitable for the intended application. In general, data collected for one particular application could be made useful to scores of other applications. Hence, such dataset should be made available to other users as easily as possible. It is generally found that the data collected and maintained by one agency was not known to other agency or may be difficult to obtain such data due to several reasons. In many cases the other users even have no option of finding out the suitability of such data maintained by other agencies in case of availability too. This generally leads to collection and maintenance of data by individual agencies on their own, probably duplicating the data itself. Such situation can be avoided or the problems can be minimized by setting up a metadata system and thus making suitable provision for sharing the information among the users in the framework of a national geographic information infrastructure. The following sections describe the content of the metadata adopted by the NGIIP/SD and the implementation of the system.

2. Metadata Content

Metadata serves several important purposes including data browsing, data transfer, and data documentation. Considering the usability of existing dataset, metadata could be maintained at several levels of complexities. In the basic form, metadata might consist of a simple listing describing basic information about available data, whereas detailed information may be included about individual dataset. The Content Standards for Digital Geospatial Metadata (CSDGM) of the Federal Geographic Data Committee, US, specifies some 334 different metadata elements for a set of geospatial data. The purpose of the content standards is to provide a common set of terminology and definitions for documentation related to these metadata. Information about what elements of the metadata is mandatory, optional, repeatable, or one of a choice are encoded in the production rules of the CSDGM. ANZLIC Working Group, on the other hand proposed considerably a smaller subset as core metadata elements.

The content of the NGIIP/SD metadata contains only 176 elements mostly taken from the CSDGM/FGDC and few elements are taken from ESRI's adaptation. Besides, variations have also been made in the production rules such as removing certain mandatory elements and also limiting the number of entries. For example, only two addresses are allowed whereas unlimited numbers of address are allowed in the FGDC specifications. Similarly, only 10 attributes are allowed in this system as opposed to unlimited attributes in the CSDGM/FGDC specifications. These limitations are made to simplify the situation from the practical standpoint only which after evaluating the system could be changed in future. Yet, the basic structure of the content remains the same as of CSDGM/FGDC.

3. System Context

The overall system context is shown in figure 1.

Web Client: The actual user interface enables users to Add/Edit metadata along with features to query for desired data in the network and other features.

Gateway: Provides interfaces to client, respond to clients and connects the client to different services available.

Catalogue Service: Provides features to search, retrieve and display metadata.
Building metadata repository.

Metadata Service: Enables adding/editing metadata.
Contains Interfaces/APIs allows to enter metadata and create XML files.

Metadata DB : Metadata repository.
Stores all XML files as a single repository.

Data Access Service: Data download and/or interactive session

Webmaping Service: Interactive session through Data Access Service

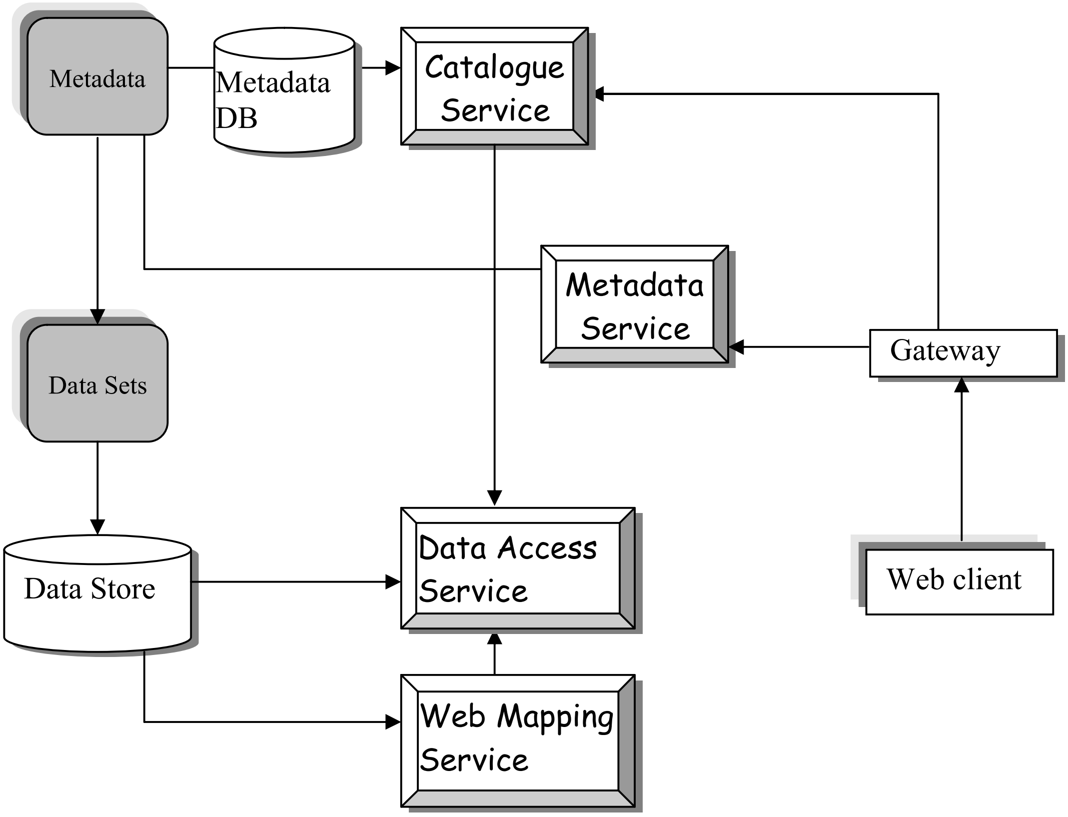

Figure 1. The system context diagram.

4. System Functionality

The system was developed basically to allow the following activities:
1. Metadata service, 2. Catalogue service such as search, visualize and administration, and 3. Web mapping. Only the first two components are discussed in this paper.

4.1 Metadata Service System

This service allows any users with valid username and password to create and edit metadata. User starts by entering metadata file identification details namely File ID and Title. One can add metadata either using the forms provided (figure 2) or directly upload an XML file (Figure 3). This service generates an XML file in the case where users chose the form inputs). The system adds the XML file to a temporary repository for approval by administrator.

The user could edit the previously submitted metadata by invoking the edit module which involves retrieving the data, editing and resubmitting the metadata. The system will add edited metadata to a temporary XML repository for approval by administrator.

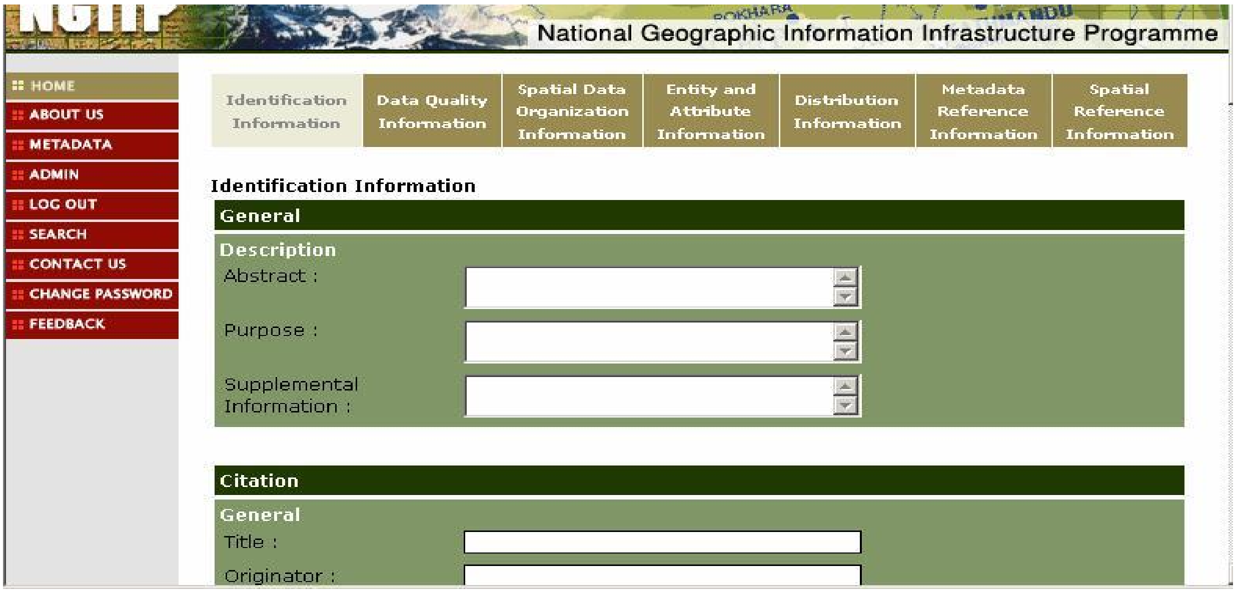

Figure 2. Metadata entry using form.

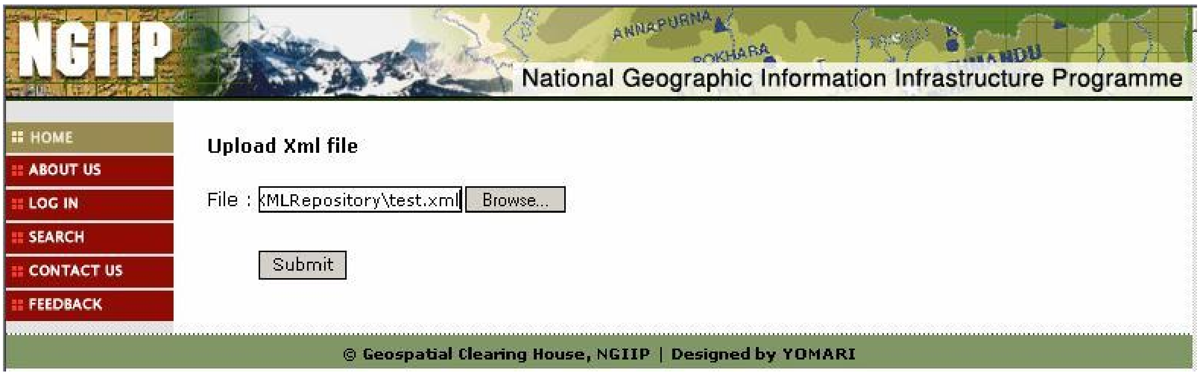

Figure 3. Direct uploading of XML file.

The general process flow of the metadata service system is as shown in the figure 4.

As shown in Figure 4, user fills up the metadata entry form and submits it to create the metadata. Then comes the role of metadata system, which converts the user provided data into a complete set of metadata (a xml file). The creation of metadata xml is based on the xml schema (xsd file) which defines the structure / hierarchy of the metadata along with different constraints and validation rules. Based on this schema, JAXB API is used by the java application code to create a java content tree holding the hierarchical metadata elements for each set of metadata. The content tree is created using the JAXB generated java classes and interfaces corresponding to the xml schema elements. The application code then converts the content tree into the metadata set (xml file) using JAXB API. This process is known as marshalling.

The metadata generated is then stored in a temporary XML repository, which holds all the metadata, submitted by the users. Admin user can view all the newly submitted metadata sets. Upon verifying the validity of the metadata sets, the admin user can then add the metadata to the xml database server (eXist server in our case). All the metadata visualization, search and metadata edit are done for metadata residing in this XML database server.

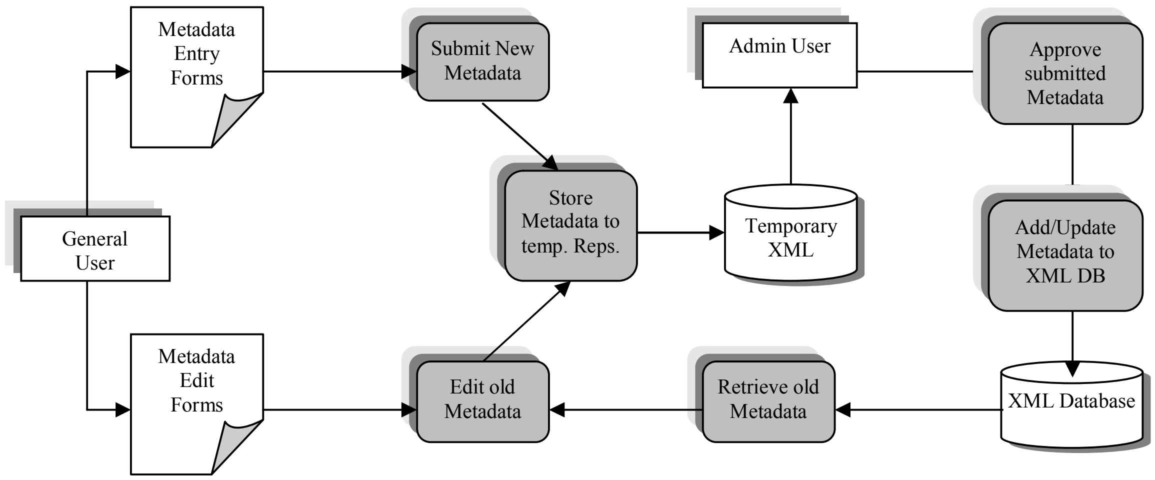

Figure 4. Process flow of the metadata service system

Metadata Edit involves the unmarshalling process, which is the conversion of metadata xml file into java content objects. The data residing in the content objects are then accessed by the application code and displayed in the web forms for editing. User can now edit the metadata entries and then submit it to the temporary XML repository. Processes similar to the creation of new metadata are followed then after till the metadata is submitted to the XML database server where the old metadata set is replaced by the new updated set.

4.2 Catalogue Service

Catalogue service includes search, visualization and administration of metadata.

Search: The search service is available to all the users and do not require login process. Two types of search is available viz. 'Keyword Search' and 'Spatial Search'.

Keyword search employs direct search on metadata repository with given keywords and their values. A selectable list of metadata tags is provided which will be taken as key tags and the search action are performed on such tags only. The key metadata tags taken are – Title, Abstract, Originator, Theme, Place and map coordinates. If none of the keywords are selected the search module will look around all the key tags and find the matching metadata. In case of search by map coordinates, search module will gather all the metadata with map coordinates bounding the coordinates provided by the user as search criteria.

Spatial Search is conceptually similar to keyword search by map coordinates but instead of directly feeding the map coordinates to a search form; the user input is taken from spatial interface itself.

Visualization: The result of the search is a simple listing of available metadata. The list shows the title of the dataset, origin and published date. User can view slightly more information by following the ‘details’ link to view partial metadata page. From this page, if the user is interested, they can view full metadata. The full metadata can be viewed in different formats and layouts as desired by the user. The available stylesheets for viewing full metadata are FGDC, ESRI and core XML standards.

Metadata Administration: A new metadata submitted will firstly be added to a temporary repository. Inclusion of such metadata for publication requires administrator’s approval. Once approved the metadata will be added to the main repository and deleted from the temporary repository.

5. Conclusion

As a prototype, the system has been created around an intranet environment. If this is ported to the web, any publisher or users can access such system with an access to the Internet. The application thus developed is still being tested prior to porting to the web.

XML has been adopted as standard for storing metadata. Various APIs and interfaces have been developed to fetch the metadata contents and finally create an XML document. Similarly, XML document can be edited. As a prototype a fully functional metadata entry system has been created with a partial editing capability to work on an intranet environment. Additional work is still required to include full editing capability.
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The elements of metadata have been adapted from CSDGM/FGDC with modification as per the local context. For creating a single repository of XML documents, eXist server has been chosen as a XML database server. Thus, in general, the overall system is based on open software solution.

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Review the Past, Preview the Future, and Move Ahead with Consensus

Colloquium on the Role and Functions of Survey Department in the Context of Broader Technological Development

(March 4 –5, 2005, Lalitpur)

Ganesh Prasad Bhatta, Survey Officer, Survey Department

A two-days Colloquium on the Role and Functions of Survey Department in the Context of Broader Technological Development was held at the Godawari Village Resort, Lalitpur, Nepal on 4th and 5th of March 2005. About 40 personalities; professionals of Surveying and Mapping sector, experts of Land Administration and Management, and high level decision makers, attended the Colloquium. Among the attendees, there was majority of the professionals of Surveying and Mapping sector including some ex-officials from senior executive level of Survey Department. The colloquium was quite informal but functional.

The National Geographic Information Infrastructure Project (NGIIP) of Survey Department organized the colloquium. The colloquium was conceptualized to materialize the realization of progressivism in the performance of Survey Department in the context of changed leadership in the department. The main objective of the colloquium was to acquire feedback and suggestions; for improvements in the performance including service delivery system, for institutional improvements, for drafting necessary policies and for sustainability of NGIIP.

Colloquium Programme

It took almost 24 hours to get end of the Colloquium. Four different sessions were organized during the Colloquium; Technical Session, Group Discussion, Panel Discussion and Closing Session.

Technical Session: The Technical Session followed the opening of the Colloquium. Mr. Rudra Kumar Shrestha, the Secretary (a.i.) of Ministry of Land Reform and Management presided the first half and Mr. Babu Ram Acharya, the Regional Administrator of Far Western Development Region presided the second half of the Technical Session. The session got started with the welcome speech by Mr. Toya Nath Baral, the Director General of Survey Department. Five papers were presented by the officials of the department during the session. The aim of these papers was to floor ideas and status of the department to make the discussions easier. The papers presented were as follows:

- Survey Department in the General Context of Land Management in Nepal
- Cadastral Resurvey and Updating Land Records
- Present and Future of Geodetic Activities in Nepal
- Remote Sensing and Space Technology Application in Topographic Mapping and Map-updating
- Survey Department and the Context of Geographical Information Infrastructure

Giving remarks on the Colloquium, Mr. Shrestha expressed that the colloquium was commendable and he anticipated a bunch of fruitful suggestions from elder experts. Similarly, Mr. Acharya appreciated the department's endeavor to organize the Colloquium to get affirmative way out and suggested to expose the surveyors role in multidisciplinary field.

Group Discussion: Mr. Rabin K. Sharma, Chief Survey Officer of Survey Department, moderated the session. Group discussions on three different topics were organized during the session. The groups presented their findings in the following aspects:

- Technology Group: The group listed out the short term (less than 10 years) and long term (more than 10 years) programs to be carried out by the department
- Institutional Group: The group proposed a new organisational structure for effective and efficient service delivery system including the human resource development
- Policy Group: The group provided some guidelines to draft policy on surveying and mapping including the objectives of Survey Department, Strategic Policy, Working Policy, Pricing Policy, License Policy, and Copyright Policy.

Panel Discussion: Hon. Dr. Hari Krishna Upadhyaya, Member of National Planning Commission, presided and Mr. Toya Nath Baral, the Director General of Survey Department, moderated the session. Eight distinguished panelists, ex-officials from senior executive level of the department and experts of land management and administration, delivered presentations during the session apart from their involvement in the discussion. The panelists were requested to suggest the ways to which the department should follow for the betterment in the performance and provide effective services to the public. Furthermore, it was urged to let the forum know the activities that could not be completed during their tenure (especially the ex-officials of the departments).

Closing Session

The Closing Session, under the chairmanship of Hon. Dr. Hari Krishna Upadhyaya, Member of National Planning Commission, concluded the Colloquium. Giving his valuable remarks on the Colloquium, Mr. Juergen Stadel, E.C., Co-director, expressed a hope of fruitful outcomes from the Colloquium as expected by the department and he further floored the changing and challenging role of National Mapping Agencies in the modernized world. Mr. Toya Nath Baral, Director General, Survey Department, expressed his gratitude to the participants for taking part in the colloquium patiently devoting their valuable time and he assured that he would try to do his best to implement the valuable suggestions in his further activities. Hon. Dr. Upadhyaya expressed that it was a great opportunity for him to learn something new. He suggested to have a proper vision for better future, and assured that he would help the department as much as he could from his part. Finally, Mr. Raja Ram Chhatkuli, the Project Chief of NGIIP delivered the vote of thanks for the participants and those who supported in organizing the Colloquium in one way or another.

Achievements of the Colloquium

It was a great time for the leadership of the department to **review the past, preview the future and get consensus** for the further steps to be taken by them for providing effective and client oriented services in coming days. Following suggestions can be considered as the major achievements of the colloquium:

- The existing system of cadastral resurvey should be reviewed and then the further steps should be decided; whether to stop the resurveying or to conduct with improved system.
- There is a strong need of one door system of land management and administration.
- Survey Department should hold the key/central role in the Geographical Information Infrastructure.
- The geodetic activities should be carried out with more professional way.
- The topographic maps and databases should be updated in a regular basis.
- The department should focus on proper Human Resource Development activities.
- The department can work with Public-Private Partnership Model or Public-Public Partnership Model.
- The existing organisational structure should be reviewed.

Furthermore, a policy document was drafted, short term and long-term programs were listed out, and new organisational structure was proposed during the colloquium.

Informal Gathering

A night halt at Godawari Village Resort was the part of the colloquium. A dinner was organized for the participants. It was a good time for the professionals and experts to share their views and ideas in an informal way. Apart from the theme of the colloquium, the participants got the opportunity to share their private stories and memoirs. The participants from younger generation had a good opportunity to get interacted with the elders and learn something more on the history of the surveying and mapping activities of Nepal.

Instruction and guidelines for Authors regarding manuscript preparation

Editorial board reserves the right to 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 "12" font size or in digital form on a floppy diskette or on CD in microsoft word or compatible formal 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.
A passport size photograph and a brief biodata of the author be enclosed with the article.
Authors are also requested to send us a written intimation that the same article is not sent for publication in other magazine / journal.
Format : Single line spacing with two columns. With upper 26mm, lower 22mm, left 24, right 22mm.
Length of manuscript : Manuscript should be limited to 6 pages.
Title should be centrally justified appearing near top of 1st page in Times New Roman " 14" Bold font.
Authors name: Authors name should be at after two line spacing after title in Times New Roman "12" with Upper and lower casing, centrally centered with all possible addresses.
Keywords : Four or five keywords on paper theme in Times New Roman "12", with two spacing under the Authors name and address.
Abstract : Single line spacing after keywords, limited to around 300 words in Italic Times New Roman.
References : Should be listed in alphabatical 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 or journal, volume number, page number, country or city, name of publisher etc.
Headings : Major headings should be flushed with the left margin in Times New Roman " 12" Bold font and with Upper casings.
Minor headings should be flushed with the left margin in Times New Roman " 12" 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.

Participation in international events by the officials of Survey department.

+ XXth ISPRS congress
Mr.Babu Ram Acharya, Director General
27 Ashadh – 8 Shrawan 2061 (12-23 July 2004), Istanbul, Turkey

+ Mini_Project Training
Mr. Jagat Raj paudel, Chief Survey Officer, Mr. Sudarshan Karki, Survey Officer
27 Ashadh – 30 Shrawan, 24 Magh- 15 Falgun 2061(11July-14 August 2004, 7-25 February 2005) AIT, Thailand.

+ Training in RS/GIS technology for integrated water and land resource management
Mr. Chandra Mani Sharma, Survey Officer
30 Ashadh – 26 Bhadra 2061 (14 July- 11 September, 2004) Jakarta, Indonesia

+Survey Department officials for Professional Education
Mr. Govind Baral, Survey Oficer, GFM3 ITC, Netherlands, 1 year from September 2004
Mr.Janak Raj Joshi, Survey officer, GFM3 ITC, Netherlands,1 year from September 2004
Ms.Roshani Sharma, Surveyor, GFM4 ITC, Netherlands,9 months from January 2005

+ 11th APRSAF Meeting
Mr.Rabin Kaji Sharma, Chief Survey Officer
18-20 Kartic 2061 (3-5 November 2004) Canberra, Australia

+ GEO-6 & EOS-III Summit
Mr.Toya Nath Baral, Director General
3-5 Falgun 2061 (14-16 February 2005) Brussels, Belgium

+ Open GIS Training & 24th ACRS Conference
Mr. Madan Bahadur Shakya, Survey Officer
6-11 Marga 2061 (21-26 November 2004) Chaingmai, Thailand

Obituary

CONGRATULATIONS

In the fiscal year 2060-61, His Majesty's the King Gyanendra Bir Bikram Shah Dev awarded Mr. Kamal Nath Mishra, Survey Officer of the Survey Department with *Gorkha Dachhin Bahu Class IV* and Mr. Nir Prasad Timilsina,. Surveyor of the Survey Department with *Gorkha Dachhin Bahu V.* All the staffs of the Survey Department express HEARTY CONGRATULATIONS to them for getting such an auspicious medal.

Call for papers

The Editorial Board announced to call for Papers/ articles related with Geoinformatics for the publication in the Fifth issue of the Nepalese Journal on Geoinformatics Last date for the submission of the article is March 31, 2006.

For more information, please contact

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Rates of some publications of Survey Department

1. List of Geographical Names volume I to IV – Nrs 300 / - for each volume.
2. Nepalese Journal on Geoinformatics – NRs 100 / -

Rate of Control Points

Type	Control Points	Price per point
Trig. point	First Order	Rs 2 000.00
Trig. point	Second Order	Rs 1 500.00
Trig. point	Third Order	Rs 800.00
Trig. point	Fourth Order	Rs 100.00
Bench Mark	High Precision	Rs 500.00
Bench Mark	Third Order	Rs 100.00
Gravity Point	High Precision	Rs 500.00
Gravity Point	Lower Precision	Rs 100.00

Rates of Digital Data Layers			
LAYER	Class		
	(A) NRs	**(B) NRs**	**(C) US$**
ADMINISTRATIVE	500	1 000	30
TRANSPORTATION	1 000	2 000	60
BUILDING	300	600	20
LANDCOVER	1 500	3 000	100
HYDROGRAPHIC	1 200	2 400	80
CONTOUR	1 200	2 400	80
UTILITY	100	200	10
DESIGNATED AREA	100	200	10
FULL SHEET	***5 000***	***10 000***	***300***

(A) Napalese Researchers, Students, HMG Organizations, Non-Government Organization (Non-profit), HMG Affiliated institutions.

(B) Nepalese Private Company (Consultant, Contractors)

(C) Foreign Organizations, Consultants, Contractors.

Soil Data	Whole Nepal	NRs : 2000.00

Rates of some publications of Survey Department

1. List of Geographical Names volume I to V – NRs 300 | - for each volume.

2. Nepalese Journal on Geoinformatics – NRs. 100 | -

Price of Maps

S.No	Description	Coverage	No. of shees	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 Capability 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	Western Nepal	7	40.00
8	1:125 000 Districts Maps(Nepali)	Whole Nepal	76	20.00
9	1:250 000 Zonal Maps (Nepali)	Whole Nepal	14	20.00
10	1:500 000 Regional Maps(Nepali)	Whole Nepal	5	20.00
11	1:500 000 Regional Maps(English)	Whole Nepal	5	20.00
12	1:500 000 Maps (English)	Whole Nepal	3	20.00
13	1:1 million Nepal Map	Nepal	1	30.00
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	50.00
18	VDC/Municipality Maps	Whole Nepal	4181	40.00

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

Price of Aerial Photograph and Map Transparency

Product	Price per sheet
Aerial Photograph	
a) Contact Print (25cmx25cm)	Rs 150.00
b) Dia-Positive Print (25cmx25cm)	Rs 500.00
c) Enlargements (2X)	Rs 600.00
d) Enlargements (3X)	Rs1200.00
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

One Plus One Is More Than Two - The Making of The Population And Socio-Economic Atlas Of Nepal

Suresh Man Shrestha
Chief Survey Officer, NGIIP
Survey Department.

Abstract

Survey Department and Central Bureau of Statistics are two major data producers of HMG Nepal. Survey Department is mainly responsible for producing different types of maps and Central Bureau of Statistics is mainly responsible for conducting censuses. Working together can produce a wide spectrum of products needed for overall national development. This "The Population and Socio-Economic Atlas of Nepal" is a good example in this regard. Building a right team, exploring and using existing facilities eg. softwares are some of the reasons behind the successful production of the Atlas. This paper presents some of the major aspects of the making of "The Population and Socio-Economic Atlas of Nepal".

BACKGROUND

Government deals with everything from the delivery of health services to environmental protection to maintaining transportation infrastructure. Geography is the one common element that unites information in these diverse activities. The benefits from geographically based information management – eliminating redundant work, better allocation of resources, consistency of information and improving operational efficiency – can only be fully utilized through coordination between entities. Partnership between government and the private sector, between government agencies, and between different units of an agency must continue to be developed and strengthened.

Though different agencies have used GIS extensively for years, this use has often not been obvious. In many agencies GIS is integrated into the operations of large departments such as forest management or transportation rather than being centralized in a separate agency. GIS use by different agencies is expanding and transforming from traditional planning or monitoring applications to applications focused on management, decision support, and information transfer. The role of government as an intermediary between different agencies has made it more acutely aware of the value of integrating operations and exchange information using GIS. One prominent organization of the government, National Geographic Information Infrastructure Programme (NGIIP), is dedicated to helping different agencies effectively use information and information technologies, particularly GIS, for decision support.

WORKING TOGETHER

Information is usually stored in a tabular format, quite often in hardcopy. With the development in the field of computer technology and software industry, it is now general practice that data are recorded and stored in digital files. Though using such data has many advantages over hardcopy files, it is still quite difficult to visualize the information in the spatial context.

Maps are one of the fundamental assets of the country. The volume and quality of maps may be a measure of understanding the development status of a given country. In Nepal, Survey Department (SD) is the authority in the surveying and mapping activities. SD is making maps and related products required for different development activities of the country. During 1990's, SD has succeeded to publish a new series of base maps at scales 1:25000 and 1:50000.

To fulfill the growing need of digital topographic data, SD has prepared a set of digital topographic database (NTDB) from the existing base maps. Preparation of the NTDB is a big step forward in the mapping history of Nepal and different clients in and outside Nepal are using the NTDB.

On the other hand Central Bureau of Statistics (CBS) is responsible for conducting National Population Censuses in Nepal. CBS has already conducted a series of censuses since 1952 / 54, for which extensive information on demographic and social characteristics of population are available, however population count dates back to 1911. In addition to the censuses, CBS has also conducted several Demographic Sample Surveys since 1974 / 75. The results of censuses are generally published in tabular forms of different formats. The experts of the related fields have used census results, but there has been a growing demand of the maps showing different indicators so that one can understand the spatial distribution of the given indicator.

Neither SD alone nor CBS alone can produce such maps. Here comes the essence of "*One plus one is more than one*". The result of the joint effort of SD and CBS is not only useful for them but also for a wide group of other different users, sharing their resources in the overall national development.

Realizing this need, His Majesty's Government (HMG) of Nepal has included a "Mapping Component" in the Population and Housing Census 2001. One of the main objectives of the Population and Housing Census 2001: *Mapping Component Project assisted by European Commission* is to disseminate the results of Population and Housing Census 2001 in different forms viz. tables, maps (hardcopy, CD ROM and web maps). One of such information dissemination forms is "The Population and Socio-Economic Atlas of Nepal".

IMPLEMENTATION STRATEGY

"The Population and Socio-Economic Atlas of Nepal" is basically an atlas based upon the results of the Population and Housing Census, 2001. However, some very pertinent socio-economic indicators from other sources have also been included.

Preparation of the Atlas was managed by a three-tire structure of academic and technical teams. They are Panel of Advisors, Editorial Committee and Technical Taskforce. Panel of Advisors consisted of well-known national experts in the field of Population Study, Sociology, Statistics, Economics, and Geography etc. Editorial Committee consisted of experts from SD and CBS in the field of mapping, GIS, Demography, Economics, statistics etc. The Director Generals of SD and CBS are also there in the Editorial Committee. Technical Taskforce consisted of the experts from SD and CBS in the field of mapping, GIS and statistics.

Panel of Advisors is basically responsible for advising and reviewing the content of the Atlas. Editorial Committee is responsible for finalizing the working methodology; approve individual maps and the Atlas as a whole. Technical Taskforce is responsible for making required data tables,

PANEL OF ADVISORS

Assoc. Prof. Dr. Chandra Bhadra
Prof. Dr. Devendra Bahadur Chhetri
Dr. Harka Gurung
Prof. Dr. Vidya B.S. Kansakar
Prof. Dr. Bal Kumar K.C.
Prof. Dr. Tri Ratna Manandhar
Mr. Keshav Raj Sharma
Prof. Dr. Parthiveshor Prasad Timilsina

EDITORIAL COMMITTEE

Mr. Babu Ram Acharya, Director General, Survey Department
(Till December 2004)

Mr. Toya Nath Baral, Director General, Survey Department
(Since December 2004)

Mr. Tunga. S. Bastola, Director General, Central Bureau of Statistics

Mr. Raja Ram Chhatkuli, Nationl Co-Director, NGIIP, Survey Department

Mr. Juergen Stadel, EC Co-Director, ALA/98/170

Mr. Radha Krishna G.C., Deputy Director, Central Bureau of Statistics

Mr. Durgendra M. Kayastha, Chief Survey Officer, Survey Department

Mr. Badri Prasad Niraula, Deputy Director, Central Bureau of Statistics

Mr. Suresh M. Shrestha, Chief Survey Officer, Survey Department

Mr. Dhruba Raj Ghimire, Statistical Officer, Central Bureau of Statistics

Mr. Shailendra Ghimire, Statistical Officer, Central Bureau of Statistics

Mr. Bharat Raj Sharma, Statistical Officer, Central Bureau of Statistics

TECHNICAL TASK FORCE

Mr. Suresh M. Shrestha, Chief Survey Officer, Survey Department

Mr. Madan B. Shakya, Survey Officer, Survey Department

Mr. Nab Raj Subedi, Survey Officer, Survey Department

Mr. Dhruba Raj Ghimire, Statistical Officer, Central Bureau of Statistics

Mr. Shailendra Ghimire, Statistical Officer, Central Bureau of Statistics

Mr. Mahesh Pradhan, Statistical Officer, Central Bureau of Statistics

Mr. Bharat Raj Sharma, Statistical Officer, Central Bureau of Statistics

Mr. Suresh Basnyat, Statistical Officer, Central Bureau of Statistics

Ms. Shanti Baba Bajracharya, Surveyor, Survey Department

Mr. Saroj Chalise, Surveyor, Survey Department

Mr. Jit Ram Khayargoli, Surveyor, Survey Department

Mr. Tika Ram Nepal, Surveyor, Survey Department

Mr. Indra Sangroula, Surveyor, Survey Department

Mr. Laba Prasad Shrestha, Assistant Surveyor, Survey Department find appropriate data classification method, aggregate data in higher level viz. district, Eco-Development Region and Development Region, link those tables with respective spatial data and produce effective map in a specific design.

SPECIFICATION

The following are the general specification for the Atlas:

1 Language: English,

2 Size: B3 Europe (353 mm * 500 mm),

3 Color: Multi colors,

4 Cover: Hard cover,

5 Each page contains one, two, four, eight or sixteen maps depending upon the theme,

6 Data aggregation has been done at district level for maps showing whole Nepal, except in case of a few maps, where data has been shown for VDC/ Municipality.

7 Each map page has a brief description of the indicator being mapped,

8 Data at district level are presented for each indicator.

PREPARATION OF SPATIAL DATA

Spatial data showing administrative boundaries (country, development region, eco-development region, district, and VDC/Municipality) has been prepared from the NTDB prepared by SD.

The digital data for the base maps (topographic maps at scales 1:25 000 and 1:50 000) are stored in the sheet level. There are 682 such data sets in total. Since those data sets are prepared in three 3° zones, it is required to convert all data sets into one system. Central Meridian of 84° East from the Greenwich Meridian has been selected for this purpose. The digital data prepared in the Modified Universal Transverse Mercator Projection system has been converted into the Albers Equal Area Conic Projection with the following parameters – spheroid: Everest 1830 (with semi major axis, a = 6,377,276.3 m. and semi minor axis, b = 6,356,075.4 m.), Central Meridian: 84° E, Reference Latitude: 28° N., Standard Parallel 1: 26° 40' Standard Parallel 2: 29° 20', False Easting: 500 000 m., and False Northing: 500 000 m. at the intersection of the Central Meridian and the Reference Latitude.

Since the codes for different administrative units used by Survey Department and Central Bureau of Statistics are not the same, a new field for entering CBS codes is created in the attribute table of the spatial data and codes entered accordingly.

PREPARATION OF ATTRIBUTE DATA

Population Censuses in Nepal carry a history of one century. In the absence of regular and complete vital registration and other nationally representative regular population surveys the main source of population statistics in Nepal is only the decennial Population Censuses. The CBS conducted the last Population Census in 2001. It is the tenth decennial census in the history of census taking in Nepal. The Census was conducted in two phases - the Household Listing Operation followed by the Census Enumeration.

Two types of forms / schedules were introduced to collect information on sample as well as hundred percent count. The detail of sampling scheme employed in census 2001 is provided in Population Census Report published by CBS in July 2002. The short form represented the complete count of the basic information of household, and individuals. While, the long form represented the sample enumeration of other detailed demographic, social and economic variables at the individual level as well as at the household level. As cross cutting issues the census has focused on gender issues and the issues of women, men, children and the disabled.

In the Atlas, the attribute data is primarily from Population Census 2001, but there are several other indicators derived using datasets based on Agriculture Census 2001/2002 conducted by CBS, Census of Manufacturing Establishments 2001/2002 conducted by CBS, Health related data from Department of Health, and School educational data from Ministry of Education and Sports. For mapping purpose, all attribute data are stored in the *.dbf format.

CONTENT OF THE ATLAS

After a series of discussions with the members of the Panel of Advisors and Editorial Committee, it was decided to include 210 themes (6 general maps of Nepal and 204 different thematic maps). All maps are grouped into 10 chapters. They are General, Basic Population Characteristics, Literacy and Education, Economic Activity and Employment, Gender Aspects, Household and Amenities, Environment Health Water and Sanitation, Agriculture, Industry and Population Trends and Projections.

SOFTWARE USED FOR MAPPING

ArcView GIS 3.1 is the sole software used to classify the data and map accordingly. It has been customized to efficiently produce maps for "The Population and Socio-

Economic Atlas of Nepal". Occasionally, for editing the attribute data MS Excel has also been used.

The default facilities available in ArcView GIS 3.1 are not sufficient to compose efficient thematic maps. To meet the requirements many tools have been developed. For example, tools for creating different types of circles, pie charts, and other geometric figures. Similarly, tools for creating standard layout are also developed to ensure uniform standard map layouts.

FROM DATA TO MAP

Most of times the data itself gives very little information to the data user. The same data becomes a major source of information, if it is visualized in a map. But, If the data is presented in a map in "as it is" condition, the resulting map may be quite difficult to perceive and understand the given phenomenon. Useful maps can be made only if they are composed in a systematic manner keeping in the mind the information those maps are to convey to the users. In order to make such meaningful and effective maps a Cartographer should understand the following steps.

9.1. *Classification of data:*

For the proper visualization and meaningful use of an indicator, the data must be grouped in such a way that the resulting presentation shows the basic facts from the data. Classifying data should help to enhance insight in the data. However, to make sense, the number of classes should be limited. "Research has revealed that humans can handle up to a maximum of seven classes to get an overview and understanding of the theme mapped at a single glance." [Cartography: Visualization of Spatial Data, M.J. Kraak & F. Ormeling]. Mathematical approach can be applied to find out the class boundaries.

9.2. *Joining attribute and spatial data:*

In ArcView corresponding theme (VDC / Municipality, District, Eco-Development Region or Development Region) is loaded and its attribute table opened. Next the table containing the data being mapped is loaded and is joined to the attribute table of the theme on the basis of common code field.

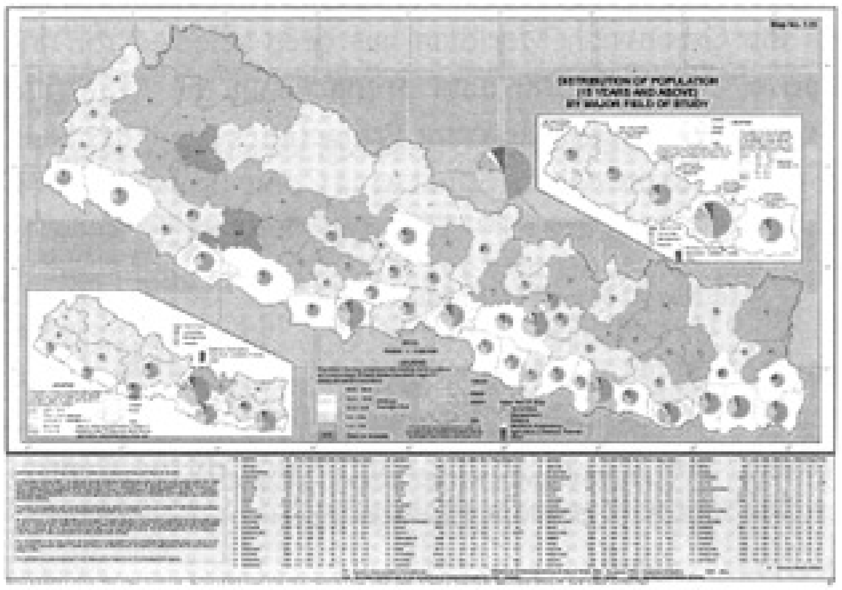
9.3. *Symbolization:*

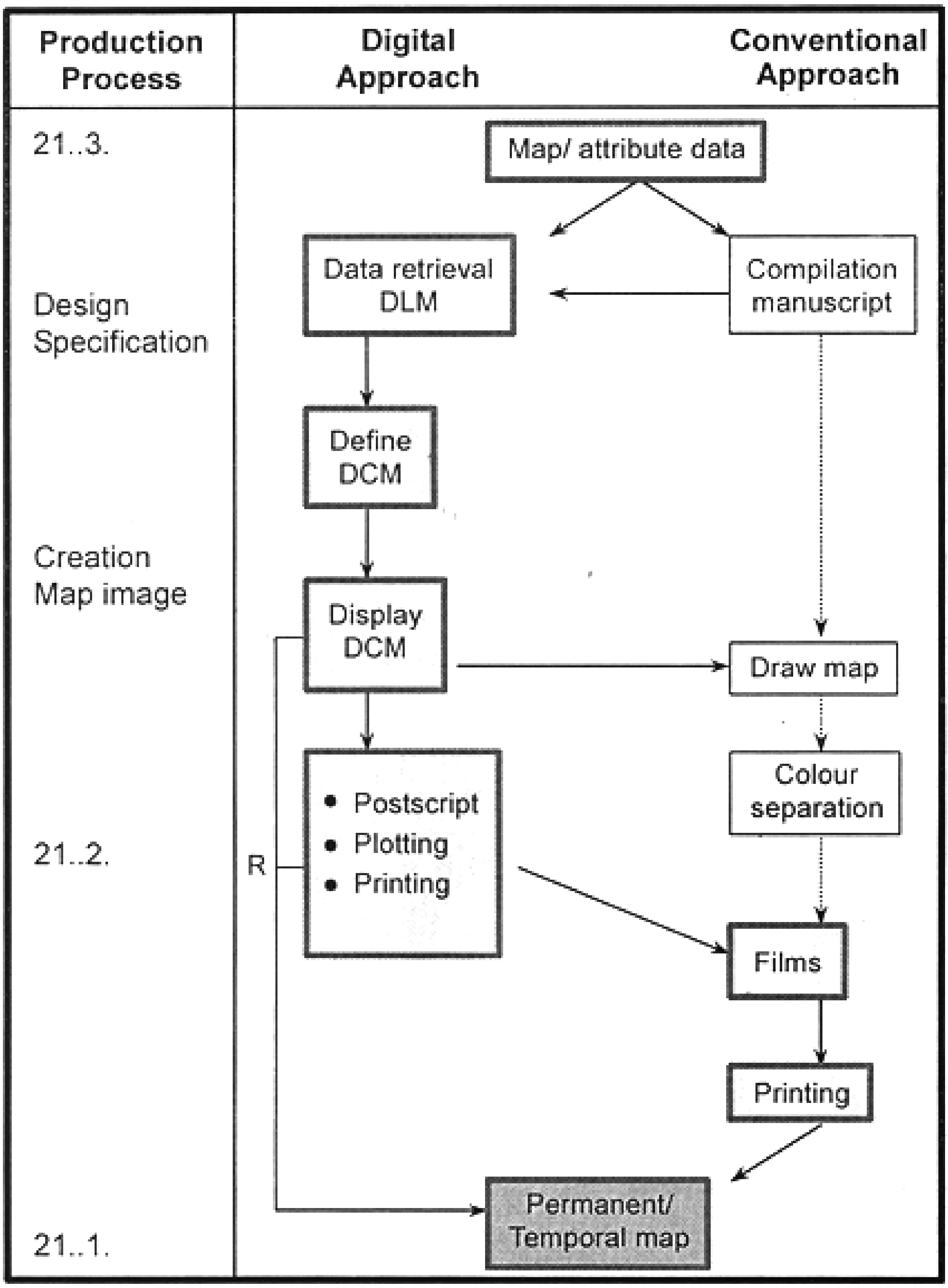
The mapping units are coloured as per the nature of the data. In most of the cases the data are presented with respect to the national average value of the indicator being mapped. In doing this colours are chosen to depict the positive and negative nature of the indicator in comparison to the national value.

Additionally, the data are presented with the help of different geometric symbols like circles, pie, bars, squares, and so on. This helps the map user to perceive the absolute figure being mapped.

9.4. *Preparation of layout:*

In general each map sheet in the Atlas consists of a map of Nepal showing district wise data at 1:2 000 000 scale, map of Nepal showing Eco-Development Region, and Development Region wise data at 1:6 000 000 scales. A brief text to elaborate the indicator being shown is included in each map sheet. Similarly, for easy reference district wise data are presented in tabular form as well.





9.5. Preparation for printing:

For mass printing of maps we still have to rely on the printing press. Mass production of maps using printer / plotter is economically not feasible for now. But the digital working environment has replaced certain phases in the total process of map printing. For example, we do not need to make peel-coats, scribe sheets etc for map printing. Colour separates are directly made from the digital file and this means saving money and time.

9.6. Exporting layout:

For further preparation for printing, the layout is exported into PostScript (EPS) file with 720 dpi resolution.

9.7. Colour separates:

Four colour-separates (Cyan, Magenta, Yellow, and Black) are printed from the corresponding EPS file. For single colour sheets (texts) only one colour-separate is printed. Press Touch and PSM 7 are used to make colour-separates. Colour-separates are printed in Kodak film with the help of Creo DOLEV 450 machine.

9.8. Printing Plates:

The colour-separates are used to prepare corresponding printing plates, which in turn are used to print maps. The plates are from the Fuji company – Fuji 0.25 plates.

9.9. Map Printing:

Maps are printed with the help of Polly Brand Checz / Module:755 / 5 colour 19' * 26" offset printing machine with CPS and IR drive.

The "Population and Socio-Economic Atlas of Nepal" is currently available from NGIIP, Survey Department, Minbhawan, Kathmandu. The Atlas will be disseminated through local market in near future. The price of the Atlas is NRs. 2,500.00 in Nepal and € 200.00 outside Nepal. The CD version of the atlas costs NRs. 250.00. The atlas can be viewed in the web as well. The address is www.dos.gov.np; www.ngiip.gov.np; www.cbs.gov.np

10. CONCLUSION

"The Population and Socio-Economic atlas of Nepal" has been prepared with the joint effort of SD and CBS of His Majesty's Government of Nepal with the assistance of the European Commission. It is first of its kind product. It can be expected that Survey Department will produce many such products with collaboration with other agencies in near future and thus contributing to national development.

The population and socio-economic data is dynamic in its nature and hence the updated version of the Atlas is a must.

Survey Department with joint efforts with other data generating agencies can produce different types of thematic atlases to benefit the users and assist in the overall national development.