Message from Director General of Survey Department

It gives me a great pleasure in publishing this third issue of Nepalese Journal on Geoinformatics (NJG) on the occasion of 48th anniversary of Survey Department. In order to disseminate and circulate the information of geo-informatics to a broader community, some of the relevant articles presented in national and international seminars/ conferences are also included in this journal.

Geo-information as a great power for development, awareness in this field is increasing and there is demand of the information related to it. This journal, to some extent, helps to educate the development of geomatics and to promote the use of geo information and ICT technologies in sustainability of the environment and well- being of humanity.

In recent years, it has been realized that the application of geo information technologies in land management, assessment, monitoring and management of agriculture and forestry, soils, geology, water resources, bio-diversity, disaster, environmental databases, spatial data infrastructure, rural-urban development and establishing geo-information network for education and training (GI-NET) is unavoidable. Survey Department as the responsible producer of basic geo-data, intends working together with public and private institutions to explore feasible technology and co-operation to find a solution on these issues. Department also seek to increase the awareness on the products and services of geo-data and guide geo-information policy onwards. I think NJG could offer opportunity to contribute knowledge and views on geo-information and join together for further works to make this concept more success. I hope NJG will reach to professional readers of geo-community and could play significant role in pursuing cooperation among related institutions.

I would like to give thanks to the Editorial Board members for their continuous effort in publishing this issue and to the authors for their co-operation to include their articles. Finally I would like to express my sincere thanks to the Advisory Board members for their valuable suggestions and support for this journal.

Wish best wishes,

Babu Ram Acharya
Director General

Jestha 2061 B.S.
May/ June 2004

National Geographic Information Infrastructure in Nepal for Strengthening Planning and Resource Management

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Abstract:

Nepal has a tremendous potentiality of water-resources ranking only second in the world and it has also a rich natural wealth like biodiversity, lofty Himalayas, scenic valleys and mountains among others. It has a hardworking and patriotic workforce. However, it is limited by heavily diverse topography and fragile geological conditions coupled with extensive poverty and abundant illiteracy. The thrust of the development problem in Nepal is "poor management". Simply said, management is a cycle of planning, implementation, monitoring/evaluation and re-planning. One of the weaknesses of the Nepalese management process is the lack of adequate geographic information in decision-making thus resulting in poor-management. To support this gap, His Majesty's Government of Nepal initiated National Geographic information Infrastructure Programme (NGIIP) since 2002. This programme is the extension of the digital mapping programme of Survey Department, which was initiated in 1996.

Nepal is a member of the Global Mapping community. The NGII programme will support in the development of a spatial data infrastructure and a geographic information system at the national level. NGII Programme has the overall objectives of strengthening planning and resource management in Nepal and its specific objectives are to develop a platform to facilitate data sharing among Survey Department, Central Bureau of Statistics and participating agencies. As part of its contribution to the NGIIP, Survey Department provides spatial data ranging from 1:25,000 to 1:1Million. To facilitate the success of the NGII initiatives several approaches have been undertaken. Some of them are: the identification of the key players and developing a stakeholders' institutional coordination mechanism, the situational analysis and needs assessment, developing an implementation strategy, and conceptualisation of a NGII centre of excellence for promoting sustainability. The programme has multiple facets like: fundamental- and meta- database production, technology installation and human resource development, and institution building components including standards and processes. The details are explained.

Least developed countries like Nepal are entangled with the vicious circle of lack of information, poor planning, poor performance, and subsequent lack of resources for additional funding for information. A strong will and commitment is necessary to make a breakthrough. This is a time in Nepal, when a breakthrough is underway with the launching of a NGII programme. The programme has a promising future; but it being on a very initial phase, its effectiveness cannot be evaluated as yet.

1. Background:

Nepal is a small mountainous landlocked country in South Asia located between latitudes 26°22'N to 30°27'N and longitudes 80°04'E to 88°12'E and lying between India and China. It has an area of 147,181 square kilometres and a population of 23.4 million inhabitants. It has a rich human culture and natural biodiversity with more than 61 ethnic groups and 70 spoken languages. Nepal- occupying only 0.1% of the earth- is home to 2% of all flowering plants in the world, 8% of all the world's population of birds (more than 848 species), 4% of mammals on earth, 11 of the world's 15 families of butterflies (more than 500 species), 600 indigenous plant families, and 319 species of exotic orchids. Nepal has a rich hydropower potential with about 83,000 MW among which 45,000 MW is economically exploitable. The Nepalese, sometimes also called Ghurkhas, are world famous as honest and hard-working workforce. However, economically the situation is not that encouraging. The per capita income in Nepal is a mere US$ 240. Additional development indicators at the end of Ninth Plan which completed in 2001 are: a total road network of 15308 km, 11 telephone sets per thousand population, literacy 52.7%, power generation 393 MW, and population with access to drinking water 69%. Worst of all, the single indicator showing the condition of people in Nepal is the number of population living under the poverty line, which is 38%.

The Tenth Plan, which started one year back, has set poverty reduction as the national goal. For this the following strategies have been outlined for the improvement of economic, human and social indicators:

- Mobilisation of resources through the coordination of government, local bodies, private sector and civil society;
- Expansion of economic and employment opportunities;
- Access of women, deprived classes, and inhabitants of remote areas to resources and economic benefits through empowerment, human development, security and prescribed programmes.

Despite a tremendous potentiality of water-resources ranking only second in the world, a rich natural wealth like biodiversity, lofty Himalayas, scenic valleys and mountains among others, and a hardworking and patriotic workforce Nepal is limited by heavily diverse topography and fragile geological conditions coupled with extensive poverty and abundant illiteracy. The thrust of the development problem in Nepal is "poor management". One of the weaknesses of the Nepalese management process is the lack of adequate geographic information in decision-making thus resulting in poor-management. To support this gap, His Majesty's Government of Nepal initiated National Geographic information Infrastructure Programme (NGIIP) since 2002. This programme is the extension of the digital mapping programme of Survey Department, which was initiated in 1996.

2. Advent of National Geographic Information Infrastructure programme in Nepal

GIS activities were initiated in Nepal during Eighth Plan (1992-1997) period. Due to lack of a national perspective, sporadic creation of spatial databases and mushrooming of independent and isolated systems were witnessed. Most of the systems started from the digitisation of existing topographic maps and therefore lot of resources were duplicated in these efforts.

The Ninth Plan (1997-2002) states the importance of GIS in more than occasion. It states that "reliable information and data are necessary for programmes for agriculture and forest production, land-use, land-consolidation, the preparation of local and regional housing and physical plans, the preparation of environmental programmes to preserve, develop and use natural resources, and the preparation of poverty alleviation programme and sustainable development".

The base paper of Tenth Plan (2002-1007) is more pronounced on the importance of a "national" geographic information system. One of the key sectoral policies and strategies outlined in the Tenth Plan state that "development of a national geographic information system shall be pursued the easy access and dissemination of geographic information".

Many institutions and organization in Nepal have the legal obligation to prepare management plans and/ or maps and databases, which require the use of geographical information. As an example Forest Act, 1992 makes obligatory for the Forest Department to prepare a work plan for systematic forest management and submit it to the Forest and Land Conservation Ministry. Once approved, it makes obligatory for the District Forest Officer to implement the work plan. Local Self Governance Act, 1998 and the Local Self Governance Regulation, 1999 prescribes for the local bodies like the VDCs, municipalities and the DDCs to prepare local development plans and also prepare resources maps for that purpose. Such work plans/ development plans can only be made through the analysis of spatial and socio economic data. Collection and database creation of such data by individual organizations for individual applications can only be a duplication and wastage of resources.

During the period after 1996, for an approximately 7500 square kilometres densely populated urban areas and the approximately 25000 square kilometres semi-densely populated urban areas of Nepal orthophoto softcopy and maps at scales 1:5,000 and 1:10,000 respectively have been recently created. By the end of 2002, digitisation of all the new topographic base maps prepared between 1992 to 2001 at the scale of 1:25,000 (for the terai and middle mountains) and the scale of 1:50,000 (for the higher mountains and Himalayas) have been completed and a consistent topologically clean spatial database created. Further more, generalization of 1:25,00/ 1:50,000 database and compilation at the scales of 1:100,000 and 1:250,000 have been tested and are now under production. It is expected that the compilation will be completed within a few months. There is a further programme of compiling topographic database at the sales of 1:500,000 and 1:1 Million.

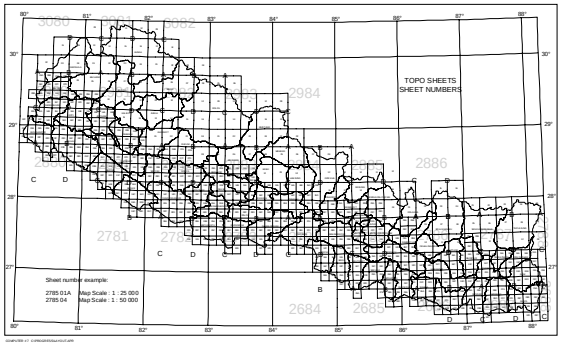

Fig 1: 1:25,000 and 1:50,000 database Index

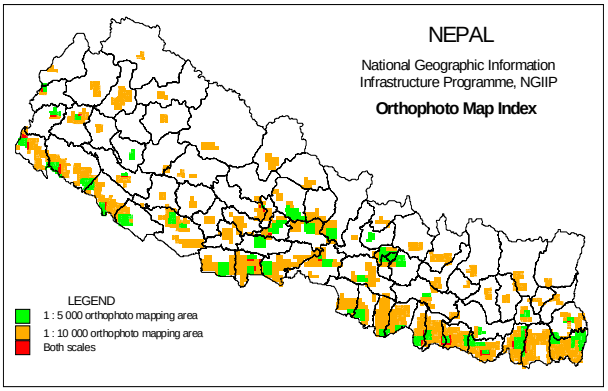

Fig 2: Orthophoto Map Index

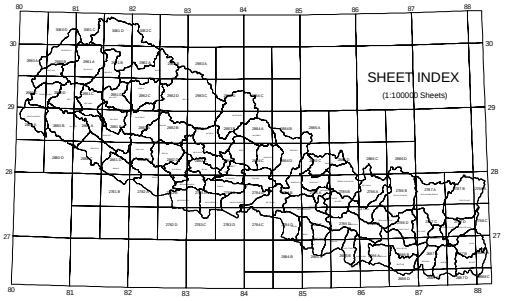

Fig 3: 1:100,000 database Index

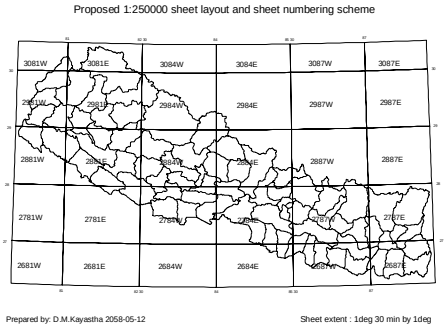

Fig 4: 1:250,000 database Index

With respect to socio-economic data, the Central Bureau of Statistics holds a national census of population and housing every ten years. The results of the past censuses are available in tabular forms, which can be translated into digital database with some efforts. The last census was held in 2001 and the data have been processed and a digital census database created.

The multi-resolution topographic database (NTDB) held at the Survey Department and the multi-temporal census data and the census database (NCDB) held at the Central Bureau of Statistics provides a sound basis for the development of national geographic information system (NGIS) in Nepal. It is against this context that the Survey Department of His Majesty's Government of Nepal launched a National Geographic Information Infrastructure Programme (NGIIP) in 2002 as an extension of its digital mapping programme initiated in 1996.

3. Spatial Data Users/ NGII Stakeholders

The Statistics Act, 1959 gives responsibility to the Central Bureau of Statistics to carryout all censuses and statistical surveys in Nepal, specifies procedures for operations, rules regarding confidentiality, and requirements for public to respond honestly to CBS enquiries. It restricts individual household data from being published and in the meantime authorises all aggregated data for public. The Land Survey and Measurement Act, 1963 and the Land Survey and Measurement Regulations 2001 make Survey Department responsible for all types of mapping and an authority for maps publication. While the permission of Survey Department is necessary for publishing all kinds of maps in Nepal, Survey Department makes its topographic base maps and digital topographic database available to all kinds of users without hindrance. A scrutiny on a section of about 70 key digital topographic database users of the Survey Department in the last two years shows the following categories of users:

Sl. No.	Type of User	Use of NTDB data	Remarks
1.	Watershed Management	Landuse mapping	
2.	Drinking Water project	Engineering scheme and design	
3.	Local infrastructure development	Project planning	
4.	B.Sc./M.Sc./ Ph.D. students	Student's research project	
5.	Environment Conservation	Training	

6.	Irrigation project	Engineering design	
7.	Geological Survey	Landslide inventory and hazard mapping, Environmental geological mapping	
8.	District Development Committee	District development planning	
9.	Hydrology	Water balance study	
10.	Researcher	Environmental change study	
11.	Consultant	Cable Car planning	
12.	Forestry	Forest management plan	
13.	Telecommunications	Access network planning	
14.	Red Cross	Disaster management planning	
15.	Water resources	Water resources study	
16.	Municipality and VDC	Urban planning, local planning	
17.	Education	School Mapping	
18.	Forestry	Site selection	
19.	Roads department	Road survey and design	
20.	Consultants	Small hydropower study	
21.	Power Company	Fishery monitoring	

The above shows that the digital spatial database users are diverse and their applications are equally diverse. The users range from individual students and researchers to organised sectors like power companies, roads and irrigation authorities, local bodies, government departments and ministries. It is therefore no doubt that a NGII is necessary to support these diverse users.

The potential stakeholders in the NGII in Nepal are all producers and users of spatial data. Simply said, the same agencies who have been the major users of paper maps in the past are the major stakeholders in the NGII in the new set-up. Some of the important agencies are:

- Survey Department,
- Central Bureau of Statistics,
- Department of Forests,
- Department of Hydrology and Meteorology,
- Department of Mines and Geology,
- Department of Roads,
- Department of Irrigation,
- Department of Urban Development,
- Water and Energy Commission,
- Municipalities/ VDCs,
- District Development Committees,
- Consultants,
- Planners and developers.
- Ministry of Land Reform and Management,
- Ministry of Population and Environment,
- Ministry of Agriculture and Cooperatives,
- Ministry of Health,
- Ministry of Education,
- Ministry of Local Development,

The stakeholders in the NGII will be of two types, *Stakeholder x* who contributes as well as uses data through the NGII, and *Stakeholder y*, which has nothing to contribute but uses data through NGII. Both types of stakeholders are welcome in the Nepalese NGII. Participating in such a NGII platform is an expensive and high-tech affair. So stakeholders can be attracted to the system very slowly. In the beginning it is expected that a NGII nucleus will be formed through the partnership of six agencies, namely, the Survey Department, the Central Bureau of Statistics,

the Ministry of Local development, the Ministry of Population and Environment, the Ministry of Agriculture and Cooperatives, and the Ministry of Health/ Department of Health Services. It is proposed that other agencies will slowly participate in the NGII system.

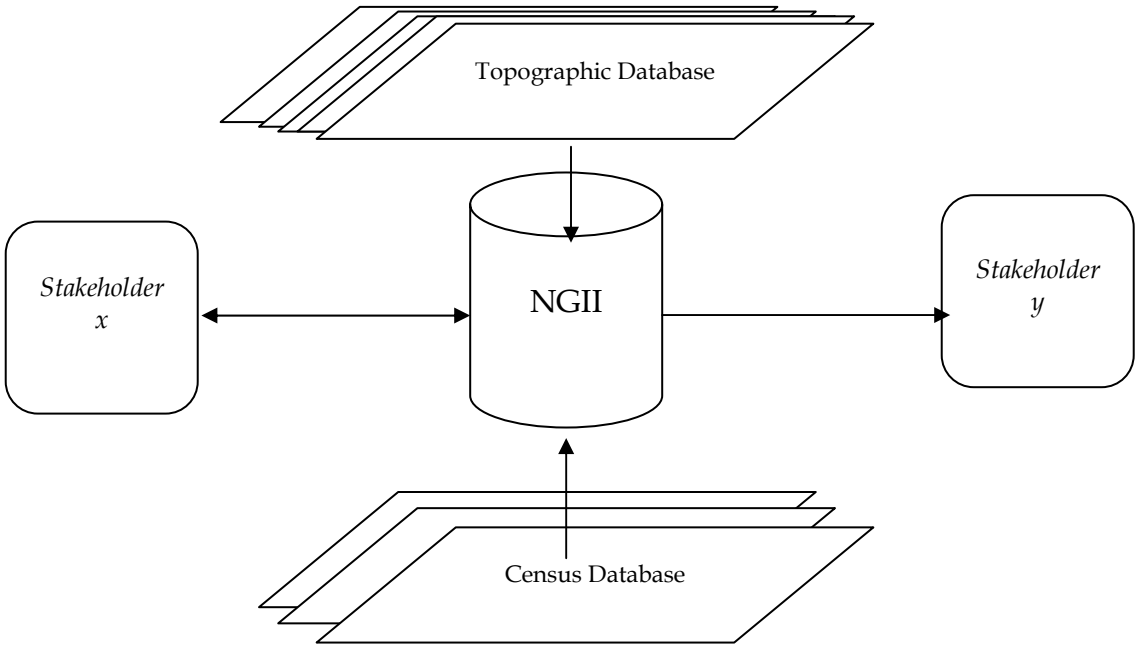

Fig 5: Types of Stakeholders in NGII

4. NGII Implementation Strategy

There have been NSDI/ NGII initiatives in many countries. It is our contention that NSDI/ NGII should be considered in the context of the national environment. The NGII in Nepal is evolving through a user-driven process with bottom-up approach. However the following common features of a NSDI also holds for the Nepalese NGII:

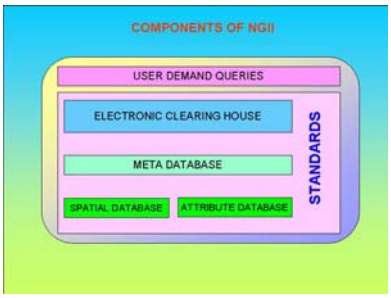

Fig 6: Components of NGII

The NGII implementation strategy has been evolved through the following processes:

1) Stakeholders inter-agency consultation through the following steps:
    a. Stakeholders Workshop,
    b. Secretaries' meeting,

c. Joint Log frame planning,
d. Technical Needs Assessment for each partner agency,
e. Establishment of inter-agency work groups,
f. Sharing Agreements.

2) Overall Objectives of NGII established as following:
" To strengthen planning and resource management through the availability of geographical information necessary for decision making."

3) Specific Purpose established as following:
   a. To develop an NGII platform to facilitate data sharing among CBS, SD and participating agencies,
   b. To disseminate Population and Housing Census 2001 results via an NGII platform

4) Programme launched to achieve the following results:
   a. Result1: NGII platform developed.
   b. Result2: Recommendations drafted to update legal framework for data sharing.
   c. Result 3: Seamless national topographic database established.
   d. Result 4: Population and Housing Census 2002 results disseminated via NGII platform.
   e. Result 5: Co-ordination mechanism established for collection, management, and access of data contributed.

5 Proposed System Architecture of NGII

5.1 Conceptual System Architecture for Metadata System

NGII will provide two basic services namely **"Metadata Services"** and **"Clearinghouse Services".** Metadata service will provide the description of data to the users. The clearinghouse service will help the users to access and retrieve data of their interest. It will facilitate the users to query, download and integrate the data from different sources connected to each other by communication network.

Minimally, all the participating agencies will participate in Metadata System. Metadata system will provide the metadata of all the participating agencies. A central metadata system will be implemented in the NGII Centre. The database server will store and manage the metadata from all the participating agencies.

- An application server/web server will be running in the NGII Centre. This application server will be connected to the database server.
- The application server will provide the following two types of applications:
  - Application for browsing the metadata such that each individual user can log on to the metadata server and then view different agency's metadata.
  - Application for metadata update, which will have restricted access to the participating agencies.

5.2 Conceptual System Architecture for Clearinghouse System

- A central database system will be implemented in the NGII Centre.
- In the first phase, the Census and Topographic data will be integrated in the database, to be slowly enriched with other databases; until the agencies develop their capacity to manage and keep the respective systems up.
- A clearinghouse application will be running on the NGII server.
- A number of predefined queries will be available to the users based on the user's access level.

Some of the technical requirements and Issues are:

- One of the technical requirements for storing the data from any agency at NGII Centre is that the data standard be first developed for agency's data and the database be designed following the developed standard.
- NGII Centre will be responsible for managing the data and ensuring its availability to the users. The data however need to be updated by the respective agency.
  - Different data access level needs to be defined.
  - For payable data, the users have to register themselves in NGII Centre or concerned agency. A registration and pricing policy needs to be developed.
  - Since the data for all the agencies will be stored in the central database at NGII Centre, data access will be faster.
  - NGII database management need only be done at the NGII Centre site.

5.3 Proposed System Network Architecture:

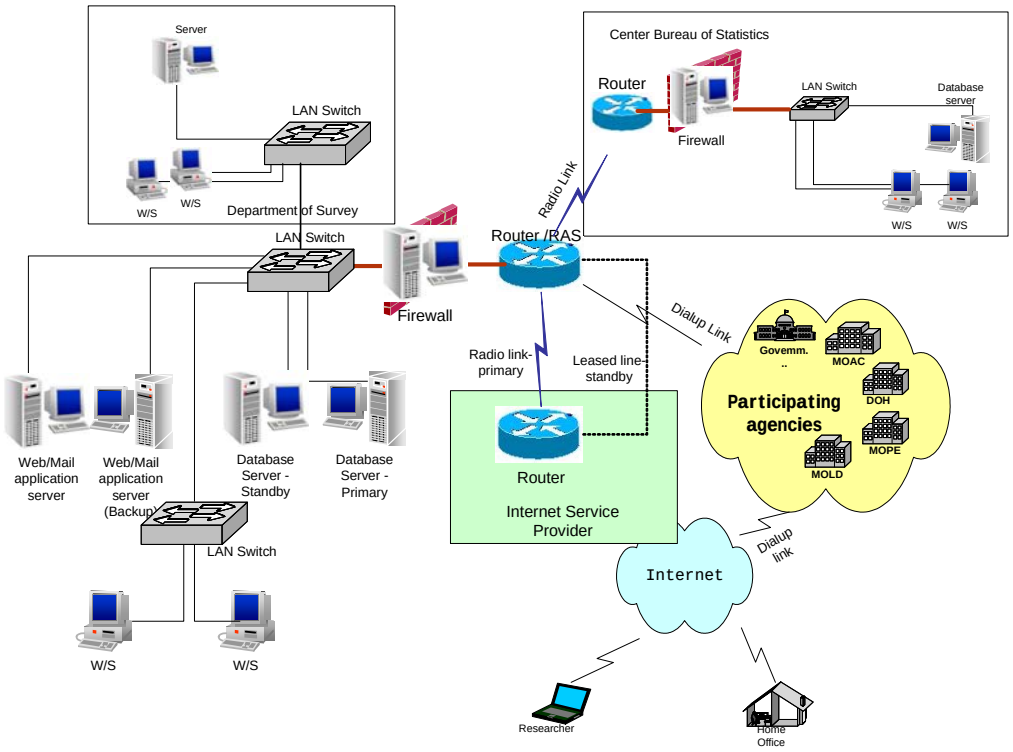

Fig 7: Network Diagram for metadata and clearinghouse service

6. Conclusion

Nepal has been a member of global mapping community since 1998. It was already felt late that a NSDI initiative was lacking in Nepal. With the advent of NGII programme in Nepal a systematic and structured NSDI initiative has been launched. While it is envisaged that the NGII has evolved through a bottom-up approach, due to the local situation it has evolved through a more concentrated efforts of the Survey Department. Though the Survey Department is taking a lead role other stakeholders are involved at the very beginning through out the programme right from the planning process. As the overall objective clearly defines the NGII shall strengthen planning and resource management through the availability of geographical information necessary for decision making at all levels. The availability and easy access of spatial and socio economic data through a NGII shall create an environment for objectively planning, implementation and monitoring of development projects by providing necessary information for effective decision-making. Due to lack of such a system, decisions were made on an ad hoc basis mostly through voice and interests of pressure groups. A more stronger have even more stronger voices and the deprived are sometimes forgotten when a systematic acquisition, analysis and application of information for decision making is not adopted. One of the major reasons of "management problems" in Nepal is the lack of a system of information processing for decision-making. The NGII is expected to cover this gap.
A NGII is a technically high-tech, financially expensive and institutionally complicated proposition. However, the costs with respect to the benefits are better justified. The geoinformation community in Nepal has high enthusiasm for the programme and several work groups are working at the moment to make it successful.

Least developed countries like Nepal are entangled with the vicious circle of lack of information, poor planning, poor performance, and subsequent lack of resources for additional funding for information. A strong will and commitment is necessary to make a breakthrough. This is a time in Nepal, when a breakthrough is underway with the launching of a NGII programme. The programme has a promising future; but it being on a very initial phase, its effectiveness cannot be evaluated as yet. It is said that the taste of pudding is in eating: we have to wait a couple of years before that taste can be effectively made.

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Soil and Terrain Data SOTER Nepal Version: 1 Released

On 27 April 2004,Honourable Member of the National Planning Commission Dr.Hari Krishna Upadhyaya and FAO Representative to Nepal Mr. Kazuyuki Tsurumi released the CD of Soil and Terrain Data of Nepal SOTER NEPAL Version: 1.The release function was attended by participants from different organizations and the people from media. The SOTER Version 1 was prepared by Food and agriculture organization (FAO) of the United Nations in co-operation with Survey Department.

FAO Technical Officer Mr.Arjen Rotmans explained the technical details about the data. Mr.Babu Ram Acharya, Director General, Survey Department, and Mr. Raja Ram Chhatkuli, National Director NGIIP highlighted on the importance of the NGII initiatives in Nepal.Dr.Upadhyaya and Mr. Tsurumi spoke on the importance of the data in the national, regional and district level planning.

C ompletion of Census Mapping Project

The aerial photography and orthophoto map production for the Urban and Semi-urban area of Nepal and the digital topographic database production for the whole country undertaken by Census Mapping Project of Survey Department since 1998 with the assistance of the Government of Finland were completed on 2003.On November 20, 2003 the data and other infrastructure of the project were handed over to Mr. Tika Dutta Niraula, Secretary, Ministry of Land Reform Management, His Government of Nepal by Mr.Asko Lukkainen Charge'd Affairs,Embassy of Finland at a special handing over ceremony. The data are stored and the infrastructures are installed in Survey Department.

Global Positioning System and Strengthening of Geodetic Network of Nepal

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Abstract

Nepal is a country of mountains The higher order geodetic points were mostly established on the top of mountains and these points were used for the geodetic network extension. Lower order geodetic control networks were established at different times and used for the surveying and mapping activities of the country. It has been found that the rate of convergence between north and south borders of Nepal to be 21±2 mm each year and the rate translation of Kathmandu to 55±3 mm/year to the plates. The most intense deformation in Nepal occurs along the belt of high mountains along its northern border resulting in a strain contraction rate normal to the Himalayan Arc. This belt is approximately 40 km wide and extends into southern Tibet.(13). Recently Survey Department of Nepal has lunched a program of strengthening the existing geodetic network of Nepal and re-observed the position of higher order geodetic points by using geodetic GPS receivers to evaluate their position and thus to define the precision of the control points once again. This paper describes the observation procedure and the adjustment results of the existing higher order control network of Nepal established in different time using different types of equipment and techniques; and highlights the observation procedure and the result obtained after the post processing of the GPS observation results. Attempt has been made to give the procedure and identify the methodology for the re observation of existing higher order geodetic points by using GPS receiver and post processing the observed data so that the existing higher order geodetic points are within the given accuracy standard.

Key words: Geodetic control , Global-positioning system, Gravity survey, strengthening geodetic control net, post processing

1.Introduction:

In Nepal, for the first time, Survey of India has established survey frameworks of trigonometric ground control points as an extension of great trigonometric network of India during 1954-60 under the Colombo plan agreement. These controls are then used by Survey of India for the preparation of topographic base map of whole kingdom of Nepal at 1" to a mile. In order to have a new précised geodetic net of the country, Survey department of Nepal has carried out the geodetic Survey fieldwork during 1981-1984 to establish Geodetic Survey control net covering the 800km east-west extent of Nepal and the subsequent mathematical adjustment was completed on 1986 with the Nepal geodetic reference system (Everest1830 reference spheroid, modified UTM projection 3 degree belt). The advantages of Nepal geodetic reference system over the Survey of India Reference System used in Nepal , was that it avoids complication of longitude correction and orientation of Nepal geodetic reference will change by no more than 1.5 second arc from Indian reference (3m at points 400km of datum origin). Elevation / heights was taken from fundamental benchmarks of Survey of India values relative to the mean sea level.

Global positioning system (GPS) was introduced in Nepal by the Japanese consultant in 1988 for the establishment of control points for photogrammetric triangulation in Lumbini zone mapping project(JICA). Latter on Survey department with the collaboration of various donor agencies has carried out the work of precise GPS observation and established the GPS Higher order ground control points in Nepal for their specific purposes. As a result of these experiences, in 1994 Survey Department has introduced the GPS technology for the extension of geodetic network of Nepal. Now a day's GPS is the main techniques for the extension of higher order controls in Nepal.

2.Geodetic control net 1981-84

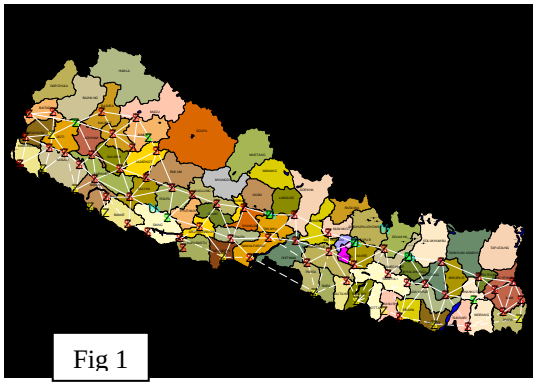

Fig 1

High precision geodetic control point network was established at 68 different places distributed all over the country (fig.1). The control net includes Doppler Stations established in 1980-81, existing stations of survey framework of 1954-60 and newly monument survey stations. The control net also includes microwave communication tower with an associated ground station sites in the terai region of Nepal. In 1976-77 astronomic observation for position and azimuth at 7 station in Nepal was carried out and these laplace stations were also included in the geodetic net of 1984. The distribution of geodetic points is limited only on the assessable ground points. Himalayan part of Nepal was not possible to cover by the geodetic points as this portion of land is still inaccessible or difficult to establish the ground points for the surveyors. Geodetic control net of Nepal has the following characteristics:

- The observational data accepted for the final plan adjustment are 224 horizontal angles at main stations of the net,250 microwave measured lengths on 198 lines,6 short lengths ate local connection,6 Geodometer measurement length,50 Laplace azimuth values on 23 different lines,5 angles & lengths of Doppler translocation lines and 16 latitude & longitudes of Doppler positions at 13 stations.

- The Standard error of unit weight determines in the solution is 1.15 and standard error uncertainly of each azimuth value was based on the estimated positional accuracy of ±0.5 metre over the length of the line concerned.

- Standard error(se) uncertain in the adjusted–positions of the stations relation to the fixed origin station (i.e. Nagarkot) vary from zero up to ±0.30m in latitude and ± 0.45m in longitude at the east and west extremes.

- Values of the combined curvature and refraction correction factor were derived in seconds of arc per kilometers of line length.Standard derivation of an observed value of the combined curvature and refraction correction is ± 0.2 sec/km.

- Misclosure value i.e. mean value of the height differences observed on each line, range from a minimum of less than 0.1m to 4.1m with an average value of 1.1m.The typical standard error uncertainly in an observed height difference was of the order of ±1.0m for a line of 40km in length.

3. GPS Geodetic Control Survey

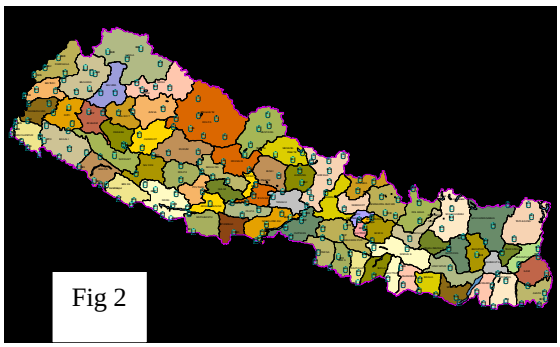

Fig 2

The University of Colorado and Massachusetts Institute of Technology (USA) established the precise Global Positioning system (GPS) geodetic points during 1991. Geodetic Control over the eastern Nepal area was established on the 13 new geodetic primary stations with the help of existing 16 geodetic first order points by using the static relative GPS Survey. Altogether 29 primary stations (fig 2) were established and observed by using Astech LD_SLL GPS receivers. Astech Inc's

Geodetic Post Processing Software version 4.4.01 with fill net version 3.0.00 adjustment program was used for the processing and adjustment of data. Transformation of WGS4 co-ordinates to UTM (Nepal geodetic reference System) was done by affine transformation. Similarly, the Geodetic control net of the western Nepal based on GPS(Global Positioning System) measurement was established on 51 primary GPS stations(fig 2) and computed as free network using existing point of eastern net of the country. Observation were made by four dual frequency GPS receiver using station relative positioning. The accuracy was controlled over 1-sigma accuracy of the base line. These varied mainly between 0.9 to 2.2 ppm

4. Strengthening geodetic control network

The work of Strengthening of Geodetic Network of Nepal includes extension of geodetic control network, the gravity survey and preparation of gravity anomaly of the country , and updating three dimensional geodetic control network with defined positional accuracy. The development of Global Positioning System using satellite techniques for point positioning has given us the various opportunities for the strengthening geodetic control network of Nepal.

4.1 Extension of Geodetic control network

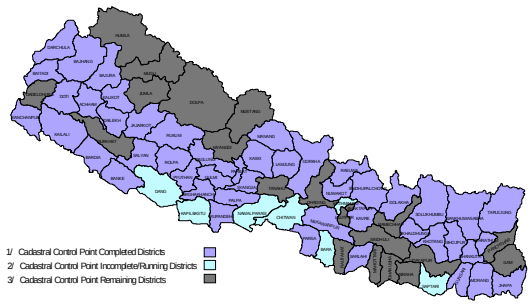

fig3

Survey Department initiated during 1972 to use the geodetic control points to prepare the cadastral map of the country. In order to provide the ground control plotted sheet for the preparation of large scale cadastral map of the country, establishment and extension of ground control network was carried out by using the traditionally established method of surveying i.e, triangulation and traversing. Survey department initiated during 1994 AD to use the global positioning system technology to provide the control points of third order in the Jhapa district of Nepal and continue to other districts of Nepal for the control network extension program of the country. First order /Second order geodetic points were used as the reference points and the results were satisfactory. GPS third order control networks of 8 districts were completed and 11 districts were partially completed. These GPS control points are used for theodolite traversing/triangulation to provide further extension of fourth order controls required for the plane table survey. Out of 75 districts of Nepal, 47 districts (fig 3) are completed to provide the Lower order geodetic net of the country.

4.2 Gravity Survey :

Gravity surveys were made to establish a gravity base station net and to observe gravity values for detail stations of geodetic Survey Control Net of Nepal. Gravity reference system used for the gravity values in IGSN71, modified 1979. International Gravity Standardization Net 1971 was modified in accordance with IUGG Resolution. The Lacoste Romberg Model G gravity meter was used for gravity observation..The standard error uncertainty of the scale factor determine for each of the first two gravity meters was of the order of ±0.00005. A gravity transfer was made from station Kathmandu airport to an IGSN71 station 06230A BANGKOK (**g = 978300.10 ± 0.032 m gal**.). Kathmandu airport station gravity value **g is 978661.22±0.047 mgal.** The adjusted g values of the base stations is calculated and relative to the fundamental base station. The maximum standard error uncertainty in the g-values of a base satiation is ±0.037 m Gal. Values of observed gravity were determined at a total of 375 detail stations.

4.3 Updating the geodetic control net:

It has been found that the rate of convergence between north and south borders of Nepal to be 21±2 mm each year and the rate translation of Kathmandu to 55±3 mm/year to the plates. The most intense deformation in Nepal occurs along the belt of high mountains along its northern border resulting in a strain

contraction rate normal to the Himalayan Arc. This belt is approximately 40 km wide and extends into southern Tibet.(13). Survey Department of Nepal has lunched a program of strengthening the existing geodetic network of Nepal and re-observed the position of higher order geodetic points by using geodetic GPS receivers to evaluate their position and thus to define the precision of the control points once again. It has been shown on the previous paragraph that the high precision GPS geodetic control survey has been carried out first and the extension of ground control is done for the preparation of topographical base map of the country at different time.

5. Conclusion and recommendation

The development of Global Positioning System using satellite techniques for point positioning has given us the various opportunities for the strengthening geodetic network of Nepal. New technique of airborne gravity/ GPS surveys can also be used to determine the precise Geoid of Nepal and the height datum of the country and investigation towards the geophysical changes as well as for the strengthening supplement and expand the existing geodetic control network system of Nepal. Strengthening the geodetic control network of the Geodetic Survey of Nepal should carried out using the developed technology for the work of establishment of National geodetic datum of Nepal and determination of precise geoid of Nepal to strengthen, supplement and expand the existing geodetic control network system.

It has been found from the preliminary report of GPS and gravity observation in Nepal during 1998 that rate of convergence between north and south borders of Nepal to be 21±2 mm each year and the most intense deformation in Nepal occurs along the belt of high mountains along its northern border. In order to accept the results more explanation has to be given to the international community which needs more measurements. It is recommended that further GPS measurements/gravity measurements should be carried for the strengthening the geodetic control net of Nepal and as well as to confirm the deformation along the Himalayan region with rate of convergence between north and south of Nepal. Survey department is willing to go ahead on this type of research project and all the international community are invited to join us in this endeavor.

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A Perspective View on Space Application in Nepal

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Key Words : social order, sustainable development, land information

Population growth, environmental degradation, resource management, poverty, urbanization etcetera are some of the major issues to be discussed in the Asian region including Nepal. All of these issues are related with the land; which is a fixed asset. Unless a proper balance between land and population is maintained, social order in the country is not possible. Although, several efforts have been made in the past for the sustainable use of existing resources of the country, improvements have not been satisfactory. Some of the obstacles are the lack of proper and reliable information on land, lack of skilled human resources and lack of optimum financial resources. In the global context, the above issues are studied using technology based on the space application.

In Nepal, space technology is gradually applied, specifically Global Positioning System for establishment of ground control points, Remote Sensing technology for updating Topographical base maps, forest type classification and change detection, weather forecast including that for aviation and mountaineering and for monitoring snow and glacier lakes, etcetera are in operation. Several departments and organization are involved in the use and analysis of space technology for a variety of applications. Most of these have visualized their needs and application areas but yet to reach their full potential, therefore, it is necessary to promote to make use of space technology in other to address the issues mentioned above. However, the future prospects of use and application of space technology lies in the field of research and development, management of biodiversity, poverty reduction programmes, disaster management, education, health and medicine, tourist promotion, cultural preservations, etcetera. So, national and regional cooperation on data resources, infrastructure, expertise and technology will give a boost to the growth of space application.

1. Introduction

Space technology application in Nepal is at a relatively initial stage. This technology could address to resolve the major issues such as population growth, environmental degradation, resources management, poverty reduction, urbanization etc. As all of these issues are very much related with the administration and management of land, which is a fixed asset, so, proper and reliable land information should be established. Space technology application could be one of the solutions in the present situation. This will ultimately bring the social order in the country when the proper balance between land and the population is maintained. Resources management and human resource development are the another issues in the country, so in the past several efforts have been made for the sustainable development, however, satisfactory results are not achieve. Therefore, it is expected to resolve the issues using space technology through national and regional cooperation.

The aim of this paper is to provide a perspective view on the present status of space technology application in Nepal and also tries to outline some of the potential future prospects for the regional cooperation.

2. Information on Nepal

Nepal is a land locked country surrounding by China in North and India in South, East and West. The elevation ranges from almost from 60m to 8848m, the highest peak of the world Mount Everest. Geographically, it is located between 26 degree North to 31 degree North latitude and 80 degree East to 88 degree East longitude of the globe. The length in the east west direction is about 885km and the width in the north south direction varies between 145 to 245 km. The area of the country is 147 181 sq. km. Depending upon the elevation, the country is divided into five physiographic regions namely : Terai (plain area) 60-300m, Siwalik Hills 200-1500m, Middle mountains 800-2400m, High mountains 2200-2400 and Himalayas 5000m and above.

The population of the country is about 23.5 million and the majority of the people reside in rural areas with diverse cultural heritages. Due to a wide variation in the topographical characteristics different climate variations are available in the country. Accordingly, Nepal offers tropical, sub tropical, temperate and alpine and sub-artic types of weather. The mean temperature is about 15 degree Celsius, however, summer temperature reach over 45 degree Celsius in some places in the Terai. Due to rugged terrain annual rainfall varies gently from place to place from 2400mm to 5000mm. About 80% of the precipitation occurs during the monsoon season from June until September. The country is heavily dependent upon weather conditions even for basic food supplies.

3. Space Application Status

Several organizations in Nepal are involved in the use and application of space technology for a variety of applications. Most of these have visualized their needs and identified the application areas but yet to reach their full potential. Due to lack of coordination, overlapping areas result in duplication of work. However, efforts have been made to create awareness of each other's activities through workshops and interactions, and realized to have an organization to take a lead role to avoid occurrences of such situation. Most of them proposed Survey Department, Nepal to take initiations for the coordination role. It is a challenging role in the context of Nepal and, however, the department is in a state to accept the task.

Some of the organizations involved in space application are as follows:

- Survey Department
- Ministry of Agriculture and Cooperatives
- Department of Forest
- Department of Hydrology and Meteorology
- Department of Mines and Geology
- Department of Agriculture
- Ministry of Science and Technology
- International Centre for Integrated Mountaineering Development (ICIMOD)

Some of their application areas are briefly discussed as follows:

Survey Department

Survey Department has been using Global Positioning System (GPS) for last 10 years. The GPS is being used for strengthening Geodetic Network, densification of control network for subsequent surveys including International Boundary survey and the Cadastral Surveys. On the other hand satellite imagery is being used to update topographical base maps at the scale of 1:25 000.

Department of Forest

The main applications of this department are forest type classification, land use, land cover classification and change detection. Although a nice infrastructure exists for Remote sensing activities, it has not been able to make use of its full potential. Their future plans are to develop systems and algorithms to determine forest density, volume, canopy cover, semi-automated classification; identify proper environments for plant species and to act as a decision support system.

Ministry of Agriculture and Cooperatives

At present, no activity related with space technology application has begun. However, GPS training package has been designed for the application of GPS equipment to locate certain crops, conduct crop cutting survey and identify high value crops. Furthermore, it will also use to calculate the area of the field.

Department of Mines and Geology

Department of Mines and Geology is using satellite data for the Geological mapping. Some of the other activities where the space technology can be applied are the prediction of earth quake, damage detection caused by the earth quake, mineral exploration, etc.

Department of Hydrology and Meteorology

The main activities in space application of this department can be summed up as weather forecasts and predictions. The weather forecast information is made available to the users; which is based on the data download from the internet and after manual interpretation. They also provide services for aviation forecasts, mountaineering forecasts and monitor snow and Glacier Lake. Their future plans are to real time data transmission and to develop mathematical models for predictions such as river flow contribution due to snow melting, annual snow melt, time bound snow melt, and their variations, local effects of carbon cycle, flood forecasts, agro, meteorology, etc.

International Centre for Integrated Mountaineering Development (ICIMOD)

One of the objectives of ICIMOD is to establish and promote a decentralized network of partner institutions in the Hindu Kush-Himalayan region. The aims are to develop applications modality at the local, national and regional levels and create network to form a Regional Geographic Information Infrastructures. This organization seeks to enhance capacity of national institutions to use Geographical Information Systems (GIS) and Remote Sensing (RS) technology for sustainable mountain development.

4. Future Prospects

From the earlier paragraphs it is clearly understood that space application in Nepal is at relatively in an initial stage. Based on the recent technology in this field, organizations working on space application should change its working strategy and develop the system to accommodate the latest technology as far as possible. Some of the future prospects in space technology applications are as follows:

- Poverty reduction programmes : This is one of the principle issue of the current Tenth five year plan of His Majesty's Government. Space based technology could help in better planning of various natural resources and land use thereby helping in balanced development in poverty reduction programmes.
- Disaster management : Space technology could help in various measures for prediction, mitigation and management of disasters such as earth quakes, avalanches, land slides, floods, etc.
- Education : Educate space technology to school children, university students and general public on the issues of environmental awareness through better illustrations.

- Agriculture : Space technology could provide suitable tools to various agricultural crops, yield forecasting and monitoring agricultural areas.
- Forestry : Application of space technology in forest sector could help in better inventory of forest resources, sustainable use of forest resources, reforestation activities and helping the management of community forests.
- Biodiversity : Also helps in better management of biodiversity through better mapping of resources, and strategies for biodiversity conservation.
- Tourism : Tourism is one of the important sector of the country. The use of space technology could boom the industry with better planning of tourism infrastructure, generation and dissemination of information such as by virtual reality, better quality maps, etc.
- Health and medicine : Space technology could help in monitoring and management of areas under herbs, designing herb plantation areas, monitoring disease and epidemics etc.
- Research and development (R&D) : R & D is virtually non-existent in Nepal in this field. So this can be a potential area for the future prospect.

5. Applications Areas

Some of the space technology application areas could be the following:

- High Resolution Satellite Imagery seems to be very much useful for post-earth quake detection and recovery efforts and also useful for mapping to create digital maps in near real time, especially, for environmental preservation and disaster management for homeland security.
- Remote Sensing technology is very effect for the study of seismically prone areas. Furthermore, it can help to detect damage areas after earth quake hit and also to take measures for rescue purposes.
- Remote Sensing technology can be a useful tool to formulate spatial analysis models and to choose strategy for national development activities.
- New space sensors and its application could be very much effective for location based services such as wireless industry.

6. Constraints

It is clear that, space technology is applied in several organizations in limited sectors. Some of the other sectors, besides mentioned in the previous section, could be Telecommunication, Wildlife habitat mapping, Watershed management, Tectonic movement, Natural Disaster prevention, control and monitoring, etc. Though, there are more opportunities and potential to apply space technology, it is not advancing as per the expectations mainly due to the following constraints.

- Lack of proper education and awareness in the field of space technology
- Lack of proper human resources and the expertise
- Lack of financial support at different level such as data acquisition, data processing and data dissemination

- Lack of coordination among the users resulting duplication of works
- Lack of data sharing policies
- Lack of recognized platform to develop the overall space technology to improve access, sharing, integrated and use of space data.

7. Regional Cooperation

Due to lack of proper management of natural resources, lack of skilled human resources and lack of proper and reliable land information, application of space technology is just emerging in several organizations. Therefore, there is a need for regional cooperation for a variety of factors. Firstly, the countries of this region are economically developing nations and can gain from sharing resources and expertise. Secondly, they have similar topography which would enable them to understand each other's geographic and geo-demographic problems. Thirdly, they face similar problems like flooding, droughts, lack of proper infrastructure and so on. Hence, regional cooperation would be useful and beneficial to all. Application areas for mutual collaboration can be identified and working modality can be settled with mutual understanding. So, national and regional cooperation on data resources, infrastructure, expertise and technology will give boost to the growth of space application technology. Consequently, it will support in sustainable development of the country as well as in the region.

8. Conclusion

Despite numerous constraints, the importance of space technology applications is realized to serve as decision support system for the overall development of the country. Future visions and working areas seems to be interesting and feasible to implement the plans. Due to lack of satellite imageries and technical expertise, organizations have not been able to realize their full growth and application potential of space technology. So, national and regional cooperation is the possible solution to address the burning issues of the country and that of the region.

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Milestones achieved in the fiscal year 2059\60& 2060\61 B.S.

- Publication of Civil Charter and Working Procedure of Survey Goswara and District Survey Office.
- Completion of 1:5000 scale orthophoto maps of all urban areas and 1:10000 scales orthophoto maps of all semi-urban areas (total 32000 sq.km.).

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Workshop on the Role of Survey Department in the context of NGII In Nepal

Workshop on the Role of Survey Department in the context of NGII in Nepal was held on October 20-21, 2003. The Chief Guest Mr. Tika Dutta Niraula, Secretary, Ministry of land reform and Management inaugurated the workshop. Mr.Babu Ram Acharya, Director General of Survey Department, chaired the session. Mr. Juergen Stadel EU co-director also addressed the workshop.

Papers presented in the workshop:

- Digital topographical and orthophoto database production-- status and challenges
- Advent of NGII and Surveying and mapping –general policy issues
- Geographical names—collection and production
- Draft result of the study of pricing policy issue
- Data dissemination, copy rights, pricing, and institutional issues

The workshop was concluded with the drawing of recommendations.

Traffic problem in Kathmandu and Use of GIS in Urban Traffic Management

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Abstract

This paper first points out the root causes of traffic problem in the capital city of Nepal (Kathmandu) and hence some of the remedial measures to solve the problems are put forward along with the introduction of the concept of urban traffic management planning which is relatively new in the context of Nepal. At last this paper gives a comprehensive view to how GIS can be applied in the field of urban traffic management especially focusing on the travel demand analysis.

Keywords: urban transport, traffic problem, remedial measures, traffic management planning, GIS technology, travel demand analysis, urban traffic management.

1. Introduction to Present day Traffic Scenario in Kathmandu Valley

During the past some years, the populations of many have doubled and this is accompanied by the rapid growth of city centers. In Nepal, although fast urban growth is fairly recent, around 5% annual population growth rate of Kathmandu (table-1) generates a strong demand for the further land development, expansion of infrastructure and other important urban services. These changes have placed new and heavy demands on urban transport that the city has been unable to meet. This problem is particularly acute in the case of Nepal because of the lack of resources and the very high cost of transport infrastructure. It has arisen more rapidly and officials have been less able to deal with it as the major roads and the networks are generally small and of low standard. Beyond the failure to match supply and demand, the problem is exacerbated by failure to use the available roads efficiently. The main traffic problems that exist in the city can be summarized as below.

- Small road space available for roads despite higher number of vehicles most of them being two and three wheelers (table-2).
- Heavy traffic congestion despite low level of private car ownership (table-2)
- Increasing level of accidents in terms of numbers and severity (table-3).
- Mixed traffic condition: Wide variety of traffic sharing the limited right of way is a serious factor in congestion. Most road sections in Kathmandu city are not channelized for motor vehicles, bicycles and pedestrians.
- Scarce parking spaces: There are only 13 authorized paid-parking zones in Kathmandu Metropolitan city which are mostly situated at the city centers like Bishal Bazar in New Road, Bir Hospital vicinity and Durbar Marg area.
- Inadequate public transport services: The development of public transport is often hindered by a lack of capacity, low operating speed, and outdated equipment and management practices. As there is no single bus terminus and very little traffic related information on display it is very difficult to find different places from where buses leave.
- Lack of attention to pedestrians and cyclists in planning and managing roads
- Poor road maintenance: Roads are inadequately maintained. Visual inspection and evaluation of road network conditions show failures of the road pavement. A key factor contributing to this situation is the lack of funding for the maintenance by the government.

- Poor road users behavior: The striking feature of the city traffic is the poor driving behavior. Our license issuing system is also extremely unscientific and impractical, and it is helping in adding traffic accidents indirectly. It is reported that in Kathmandu valley the number of accidents are higher than in the rest parts of Nepal and it can be said that the root cause of increasing traffic accidents is the lack of traffic awareness among drivers and also pedestrians.
- Encroachment of road space and footpaths by street shops, illegal parking etc.
- Inadequate and inefficient traffic control measures: The reduced road capacity of the city is due to uncontrolled parking of vehicles of all kinds and ineffective signal timings and other traffic control measures. Manual control of junctions at peak hours is often required and traffic signal timings are not appropriate. None of all the existing traffic signals in the urban area are coordinated, most of them operating under two phase fixed time control. The majority of the junctions have not been channelized and sometimes traffic island itself is creating the traffic problem due to its inappropriate placement and bad design. Traffic signs and markings are too much insufficient. There is still a striking need for better provision of pedestrian crossing facilities to give pedestrians safer ways to cross the road.
- Air and Noise pollution: According to a report published by the Nepal Health Research Council, noise level at the Bir Hospital area is on an average of 80- 85 decibels (DBA) that is 54.5 and 21 per cent higher than the recommendations made by the United States Environment Protection Agency (USEPA) and the World Health Organization (WHO) respectively.
- Urban patterns: Physical patterns of cities also compound the difficulties. Central business districts are typically not so clearly demarcated as in the developed world. The main activities centers are however often concentrated in narrow streets prone to the intense congestion.

2. Remedial Measures: -

As mentioned earlier, with the rapid growth in demand for transport, Kathmandu is facing serious traffic problems. The immediate concern in the city is to maintain the existing levels of service of the road system and personal mobility, whilst reducing the potential for road accidents. For this, traffic management measures are to be utilized which typically will include junction improvements, one way streets, segregation of two wheel vehicles with motor vehicle, channelization, markings, signaling, selective road widening and provision of pedestrian facilities, continuous traffic awareness program through the involvement of all the sectors of the society. But traffic management is the concern of the number of policy and executive agencies. As a result there is pressing need for close coordination, effective decision making machinery and enforcement, and clearly defined responsibilities because the success or failure of traffic management measures largely depend on the institutional arrangements. If the traffic management is to be truly effective in contributing towards the development of an efficient and safe urban transport system, it must interface and be coordinated with five other areas of responsibilities, which include:

- Strategic planning of urban development
- Engineering, design and construction of transport infrastructure
- Public road operations
- Road safety programs
- Law enforcement

The following steps are helpful in managing the traffic problem of the Kathmandu city:

- **Change in Urban Pattern*:* -** Land use must be arranged so that residential areas are mixed (in income and type) and are provided with nearby opportunities for employment, shopping, education and entertainment, as much as these things can be efficiently provided on a local scale. With this the demand management for the transport facilities

can be pursued efficiently. There is also a need to correct structural deficiencies in the road network while improving traffic management. The roads should be widened where possible and necessary and intersections should be redesigned to optimize its capacity.

- **Road safety: -** From a traffic management perspective, the requirement is to optimize both road safety and the need to ensure public mobility. Consideration of the needs of the most vulnerable traveler groups, cyclists and pedestrians, should be adequately addressed by providing separate cycle track and enough space for the footpath. All of the concerned agencies including the traffic police, department of roads, department of transport management, municipalities, private vehicle entrepreneurs should have better coordination to prevent accidents.
- **Public transport: -** There is an urgent need to finance on public transportation sector by the government. The trolley bus and "Sajha" Bus in the valley have restarted their services recently but their management still needs to be restructured. There is a need to improve public transport sector by replacing expired assets, catching up on maintenance and rehabilitation backlogs and expanding capacity. A policy is needed which a) maximizes operational efficiency of public transport b) improve cost recovery by setting fares at a reasonable level and c) sets user charges for private sector modes at a level which recognizes true costs and uses the revenues to assist public transport.
- **Air pollution: -** Combating the air pollution problem in the Kathmandu valley requires the introduction of efficient transportation system. Environment friendly vehicles (like Electric Vehicles) have a reduced noise level. They are appropriate because EV operations suit low traffic speeds, short traveling distances, and mobility in narrow roads. Therefore EV operation should be accorded a high priority in the context of the ever-deteriorating air quality of Kathmandu but it may have some problem in the undulated areas due to its tractive power.
- **Parking control: -** Parking control is an important traffic control management tool. There is a need to carry out a parking study in order to develop a parking plan for the city that is coordinated with other road network, traffic management measures and urban development strategy. Some open space available can be effectively used for this purpose and bus bays are to be constructed for the public bus service in the city.
- **Urban traffic control measures: -** In their most simple form, such systems may control one or a few sets of traffic signals, often incorporating some form of co-ordination in order to minimize overall travel time. More complex systems may be demand responsive either optimizing a particular set of traffic signals or a wider grouping of signals. Further developments of such systems allow the detection of incidents such as accidents, the provision of special priority for emergency vehicles, priority to public transport vehicles and travel information systems, which issue warnings of delays, or parking information. The use modern traffic management system like Intelligent Transportation System (ITS) should be gradually started in the city to cope with the traffic problem. The use of GIS technology in city's urban traffic management should be gradually introduced.

3. Concept of Urban Traffic Management Planning

Over the past some decades, the solution approach of urban transportation problem in the developed countries has changed from capital-intensive to management-intensive schemes. It has been recognized that many transport problems can be resolved without large-scale investment in transport facilities. But the transportation facilities in the developing country like Nepal are far from required and the available facilities are also not evenly distributed. Therefore implementation of efficient traffic management plans and the construction of basic transport infrastructures should be conducted side by side. It should be noted that emphasizing only in the construction of facilities is not going to solve the urban traffic problem as the construction of new transportation facilities, though reduces the travel time, but also

produces new demand, and after some period of time the new level of congestion will be reached.

As the urban traffic management is the sole direction in solving the urban transport problem, there should be a scientific solution to the questions like what does urban traffic planning do, what is the target group, when, where and how to apply the urban traffic management schemes. Answers to these questions have given scope to the development of the concept of urban traffic management planning**.** It is a scientific process of determining the rules of vehicle movement (transporting objects) in the urban road network and the policies to obtain the required target or the operational process.

In the context of Nepal, there is lack of serious attention by the concerned authorities in the field of urban traffic management. There is no institution involved in conducting the systematic study of urban traffic management planning which results in the lack of theoretical basis for management techniques that further causes inappropriate decision-making and further wasting of scarce resources. In addition, whole burden of traffic management is carried by traffic police. So there is an urgent need for the institute building with sufficient human and physical resources to perform the traffic management task and to conduct the study on traffic management planning to produce some results in this field that is best suited to the traffic condition of the country.

4. GIS in Urban Traffic Management

Urban traffic management being a spatial phenomenon can be effectively managed by GIS technology. This is because most of the data related to urban transportation have spatial distribution characteristics and GIS is the effective method in processing these kind of data. Though GIS technology is being successfully applied in many areas within the country, its use in transportation field is not so obvious till this date. The following are some of the areas from where the use of GIS can be started:

- Transport planning: - Urban traffic planning should be based on the reliable traffic data which can be of the following two types viz. traffic survey data (survey data related to individual's travel, vehicles travel, road side interview, public transportation, traffic volume, land use, road facilities etc.) and traffic survey related data which can be urban road related data (length, travel distance, passenger seats on vehicles etc.), public transport related data, census data (distribution of population, residential areas, job locations etc.), land area (city centers, CBDs, suburban areas, government office areas etc.). All these data have spatial characteristics and GIS can be used to produce traffic characteristics distribution maps like land use distribution maps, urban roads/traffic facilities distribution maps, traffic production/attraction center distribution maps. These kinds of maps can be used in analyzing characteristics of present and future urban transport.
- GIS also has the network analysis capacity, which can be used in urban road network to determine shortest path, route choice, network corrections etc. The concrete and visible information provided by GIS makes urban transport planners and decision makers more convenient.
- Traffic demand analysis: GIS not only can be used to store traffic data but the latest trend is to concentrate on the development of traffic analysis models. Spatial analysis technique of GIS provides the opportunity for the developments of disaggregate demand modeling, which is based on individual's travel behavior. The spatial analysis technique of addresses and network can support the disaggregate demand modeling in traffic survey, modal development etc. GIS can also be used for the integration of land use and transport analysis model, which are two important aspects of traffic analysis.
- Public transportation: Depiction of bus routes on road maps at selected bus stops (in addition to depicting all bus routes passing via the bus stops), the details of bus timings

and frequency along with the origin and destinations. Web based GIS can provide bus routes and timings, distance-fare calculations and driving directions.

- Traffic management: By the use of GIS and GPS, the locations of vehicles can be continuously tracked at any point of time in the network. For this, the vehicles should be fitted with small GPS device so that the central traffic control room can view and analyze every vehicle on the roads. By the use of this advanced technology it is also possible to generate alternate routes in case of congestion and to know the number of vehicles plying on the roads everyday. This data can be stored and used for traffic planning and management. Data related to number of vehicles, information about the congested road sections, details of alternate roads, availability of parking spaces etc. can be displayed in electronic message boards that can be installed at important junctions, road sections or even on the internet. This kind of information can be disseminated using FM radios at certain time interval.

By the use of GIS technology in urban traffic management, the following major benefits can be achieved:

- Timely receiving of spatial and non-spatial data during model development
- Minimum loss of information during the data collection
- More frequent data capturing and updating for the respective database
- More meaningful presentation of transportation analysis reports with the help of supportive information available with another agencies

5. Conclusion: -

The urban transport problem is fundamentally similar in all large cities throughout the world. The basic causes are the same and so are many of the consequences although there are some differences of degree between developed and developing cities. But while the problems are similar, the solutions are not. Rich cities can afford motorways, multistory car parks, rapid transit and sophisticated control systems but in the case of Nepal and its capital Kathmandu it is irrelevant since it can't afford them anyway. The only possible solution at present is a low cost solution, which in practice means extensive bus priorities, traffic management and traffic restraint together with selective road improvements. And for this purpose there is a great need of proper transport management planning to determine cost effective solution. There should also be long-term policy to gradually implement modern traffic management measures like ITS and can be started by the use of GIS technology in the field of urban traffic management.

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List of tables:

Table-1 Population and growth rate of urban population by municipalities, Nepal (1991-2001)

(Data of municipalities with more than 4.5% growth rate are shown)

Municipality	Census year		Average Annual Growth rate
	1991	2001	
Birgunj	69,005	112484	4.89
Bharatpur	54,670	89323	4.91
Kathmandu	4,21,258	671846	4.67
Pokhara	95,286	156312	4.95
Taulihawa	17,126	27170	4.62
Dipayal	12,360	22061	5.79
Kamala Mai	19,266	32838	5.33

Source: Central Bureau of Statistics, 1998 and 2002

Table-2 Road Length and vehicles number

Road Length (Kathmandu District)*	Total 750km among which National Highway-21 km, Major Feeder Road-17 Km, Minor Feeder Road-43 km, District Road-238 km and Urban Road-431 km.
Total Number of Vehicles (Bagmati Zone)**	1,83,402 among which Bus-1786, Mini Bus-2063, Truck/Tanker-5609, Car/Jeep/Van-41433, 3 wheeler-5065, 2 Wheeler-122099, Tractors-1673 and Others-3674.

*Source: Nepal Road Statistics 2000, Department of Roads, HMG/N

**Source: Department of Transport Management, HMG/N

Table –3 Accident Data

Year	050/051	051/052	052/053	053/054	054/055	055/056	056/057	057/058	058/059-3
No. Of accidents	1987	2755	2372	2396	2081	2197	1875	2055	1805
No. Of fatal accident	93	85	104	72	82	98	75	124	109
No of injured	852	1028	1052	1120	945	1448	1042	1294	1336
No of seriously injured	94	143	175	145	124	184	89	265	182

Source: Valley traffic police office, Ram Shah Path, Kathmandu.

Workshop on Cadastral Survey

On 16-18 Bhadra, 2060, Cadastral Survey Branch Organized a workshop to discuss the issues in Cadastral Survey.

Main Issues discussed:

- To conduct audio-visual programme to aware the people to increase the participation in cadastral survey.
- To prepare directives for parcel maps
- Prepare proposal to constitute task group for adopting suitable technology as per the concept of **FIG "Cadastral 2014"**.
- To provide required security measures and budget to protect maps and documents in the present situation

Workshop on problem concerning cadastral survey

On 4-7 Baishakh, 2061 Cadastral Survey Branch organized workshop to address the issues in cadastral survey.

Main issues discussed:

- Low participation of the people in re-survey
- Lack of co-ordination between the annual program of geodetic survey branch and cadastral survey branch concerning trig sheets
- Time required to complete re-survey in a district
- Error caused by using trig sheets prepared by two or more systems
- The security issue for the field work

Mr.Bijaya Raj Bhattarai, Secretary, Ministry of land reform and management, and Mr. Babu Ram Acharya, Director General, Survey Department gave directions to the participants to deliver the service fast, smooth and people oriented.

Paper presented at the 7the Conference of the Global Spatial Data Infrastructure, Bankgalore, February 2-6, 2004

Building Geographic Information Infrastructure at National Level: Nepalese Experience

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ABSTRACT

Geographic information becomes necessary in most of the human decision-makings. To rationalise decision-making at all levels, it requires that there exists an infrastructure to facilitate seamless access and purposeful integration of geo-spatial data from various sources. In this context, geographic information infrastructures have increasingly attracted the attention of planners, policy-makers and academicians at all levels in the developed as well as developing countries. Developing countries face a twin problem of lack of capacity for the development of such infrastructures, while they need it more than the developed countries in order to optimise their limited resources.

His Majesty's Government of Nepal has formally initiated National Geographic Information Infrastructure Programme (NGIIP) since 2002. The programme is now at a pilot phase with a participation of six stakeholders namely the Survey Department, the Central Bureau of Statistics, the Ministry of Local Development, the Ministry of Agriculture and Cooperatives, the Ministry of Population and Environment, and the Ministry of Health. One of the first activities undertaken at the programme was to assess the participating agencies in terms of their human capacity, technical infrastructure and strategic thinking for their meaningful participation in the NGII. The assessment led to the design of the subsequent activities, which are currently underway.

The paper presents the findings of the assessment and the experience in its implementation at an early phase of the project. The NGII objectives and the progress status will be discussed. On the basis of the key experiences gained so far, some of the critical factors in the smooth expansion and sustained operation of such an infrastructure in the settings of developing countries are identified.

1. INTRODUCTION

The 1990s witnessed the sporadic GIS activities in Nepal. Perhaps, it was the unprecedented growth of information technology (IT) worldwide and its gradual adoption in Nepal that the agencies were drawn into the GIS activities. The activities however, were primarily focused on digital conversion of maps, without sufficient understanding of the whole range of utilities geo-spatial data in digital form could offer.

As a result, island of geo-spatial databases were built in the country. Digital topographic database developed by Survey Department, database developed by Local Governance Project (LGP) and Participatory District Development Project (PDDP) are the major outcomes of these efforts. Besides, there were other smaller databases created for their own specific purposes.

Beginning in the late 1990s, discussions on the need of a comprehensive IT policy for Nepal were embarked- national information technology development committee was constituted, IT policy sub-committee was formed and subsequently, His Majesty' Government of Nepal approved Information Technology Policy 2000 in October that year (NPC, 2001).

In the late 1990s, the concept of GDI were increasingly being adopted in many countries-governments around the world were either started with or planning for building some kinds of infrastructure to facilitate the creation and sharing the geo-spatial data at different levels. Those who attended different academic courses, trainings and/or symposiums in geo-spatial science and related fields returned back with fresh energy and lobbied the concept of GDI.

The country conducted its tenth population and housing census in 2001 (CBS, 2001), and the Population and Housing Census 2001 (PHC2001)- Mapping Component project was formulated to function under the umbrella of the NGII programme. The goal of the project was to disseminate the census results both in hardcopy as well as softcopy maps, atlases on CD and web using the latest GIS technology.

2. THE ADVENT OF NGII IN NEPAL

The previous section has shortly described some of the notable activities during the 1990s, which one way or another propelled to the advent of NGII in Nepal.

Like elsewhere, sharing of geographic information has historically existed in Nepalese society mostly in the form of hardcopy. Due to their inherent deficiencies (size, portability, maintainability, analysis etc.), the hardcopies did have potential impediments for wider sharability among the users. The digital databases were gradually catching the eyes of the users. (Chhatkuli, 2003) identifies about 70 different key digital topographic database users in the last two years alone. Thus, the existence of digital data soon came into high demand. Since, sharing of digital data was a new paradigm in Nepal, it required addressing the pertinent issues and creating a requisite infrastructure.

The sporadic GIS activities required to be systematized and trends towards building the island of geo-spatial databases called an immediate intervention for their standardization.

There was increased realization in the professional sphere that Nepal would be wasting a huge sum of its limited resources in the (duplicated) creation of geo-spatial data unless a mechanism for coordinated development of these databases are devised soon. The tactful and visionary thought of some of the GIS professionals soon conceptualized and advocated that PHC2001- Mapping Component project would not only be preparing the census atlas, it would also be utilized as an opportunity to develop the NGII platform. Population and housing 2001 results would be disseminated via the platform- thereby testing the performance of the platform.

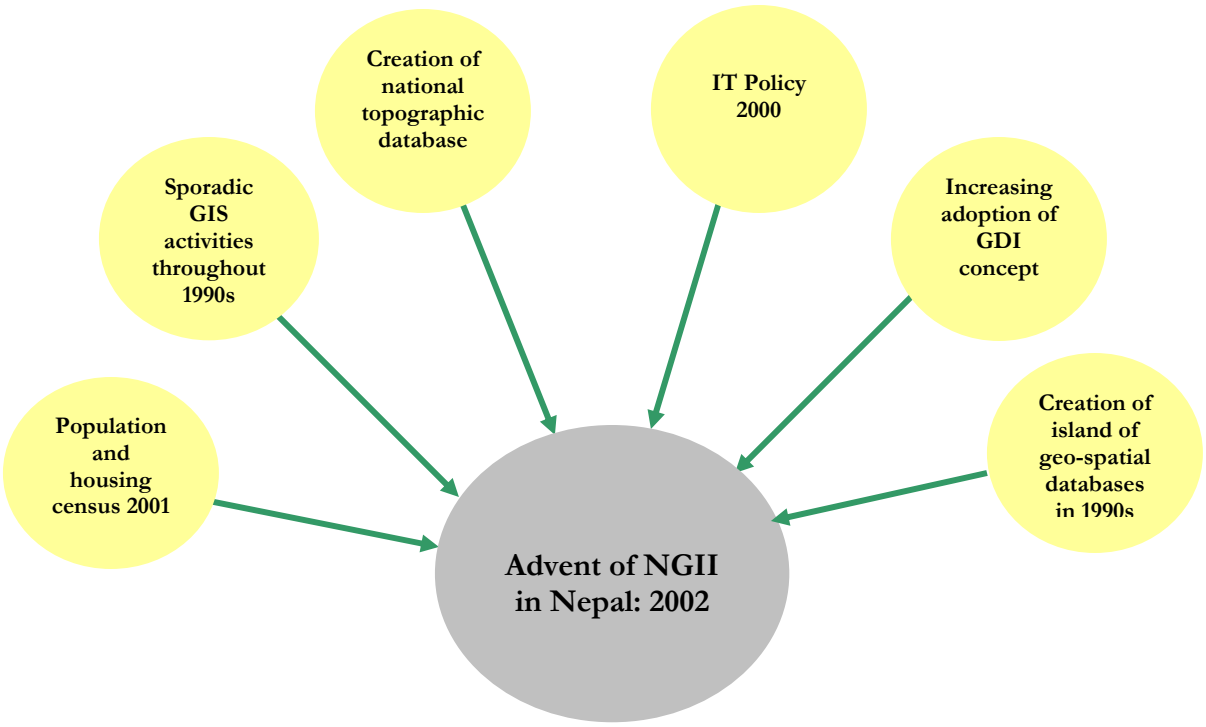

Fig. 1: Some of the driving forces for the advent of NGII in Nepal

The tenth five-year plan (2002-2007)- formulated around the time NGII came into existence- has clearly made the policy enunciation on the need of NGII e.g. "development of a national geographic information system shall be pursued for the easy access and dissemination of geographic information" (NPC, 2002).

3. NGII OBJECTIVES

The PHC2001- Mapping component project has a two years time period and is running on the second year. (Mann, 2000) has reported the overall objective of NGII, the purposes and the expected results of PHC2001- Mapping Component project developed as a logical framework through the participation of all the stakeholder agencies.

Overall Objective:
To strengthen planning and resource management through the development of national Geographic Information Infrastructure (NGII).

Purpose:
- Develop an NGII platform to facilitate data sharing among the Central Bureau of Statistics, Survey Department and participating agencies.
- Disseminate Population and Hosing Census 2001 results via an NGII platform.

Expected results:
- NGII platform developed
- Legislative framework for data sharing drafted
- Seamless national topographic database prepared
- Population and housing 2001 census results prepared and disseminated via NGII platform
- Coordination mechanism established for data collection, management and access among the participating agencies

4. ASSESSMENT OF THE PARTICIPATING AGENCIES

Six agencies have participated at the first phase of NGII namely: Survey Department, Central Bureau of Statistics, Ministry of Local Development, Ministry of Agriculture and Cooperatives, Ministry of Population and Environment, and Ministry of Health. One of the first NGII activities was the assessment of these agencies in terms of their existing infrastructure (computer hardware and peripherals, software and communication facilities), data, human resources and strategic planning (Kayastha et.al, 2002).

The mix of questionnaires, meeting with relevant officials and observation of information system unit in respective agencies was used as the methodology. Altogether 34 questions were designed and discussion (based on the questionnaires) was held.

The findings of the assessment are summarized below:

- All the agencies do have certain level of computer hardware, which are being used in word processing to specialized applications. The machines, in many cases, have also been connected in the local area network. However, the notion of an organization wide information system does not seem to be clear.
- Some of the agencies have developed their websites; some have access to the Internet through the dial up connection.
- Among the participating agencies, only few have substantial digital data. The remaining agencies need to convert their data in the digital form. Therefore, all the agencies cannot be supplier of data at this stage; they can however be the user in such an infrastructure.
- All the agencies do have shortage of human resources (both mainstream information and communication technology as well as GIS). Among the agencies, the survey department

has quite a good number of GIS professionals however it is also lacking with mainstream ICT professionals.

- Both GIS and GII seem to be new concepts to many of the agencies. Therefore, despite certain level of awareness, there lies a clear lacking of strategic planning regarding the meaningful participation to NGII.
- In certain cases, the duplication of work was found especially in the digital conversion of topographic maps.

5. CURRENT ACTIVITIES AND THEIR STATUS

The following four working groups have been formed with representation from project management unit and participating agencies:

- Working group for standard,
- Working group for pricing and commercialization issues,
- Working group for institution and legislation issues,
- Working group for Atlas preparation.

A number of activities (both technical and policy-level) are being carried out since the inception of the project. Most of the activities are being carried out through different working groups- the working groups perform the tasks more at the conceptual level and in turn collaborate with the consultants or experts, as need be, at the detail technical level.

The major activities that are currently underway are shortly mentioned below:

Transformation of a seamless multi-resolution spatial database:

The topographic database of scale 1:100000 and 1:250000 are being prepared from the digital data (scale 1:25000 and 1:50000) created earlier. These databases will be used to prepare the databases at scale 1:50000 and 1:1000000 later.

Preparation of census atlas:

The major census indicators have been identified and the derived tables are being generated for them, using the raw data from STATA. Discussions are going on to finalize the list of remaining indicators.

Development of metadata standard and metadata system for geo-spatial data:

An extensive study of the existing metadata standard revealed that maintenance of such a comprehensive metadata elements imposes a significant burden on data producers. Furthermore, it is unlikely that the agencies in Nepal have data to populate all of the metadata elements so comprehensively defined in these standards. Therefore, it was concluded to develop a custom list of metadata elements for Nepal, still keeping these elements to comply with the existing international standard as far as possible.

A preliminary list of the metadata elements has been identified and is currently under discussion. A prototype metadata system is also being developed. It is expected that once the metadata elements are finalized, the prototype system will be developed to a full system.

Development of geo-spatial data standard:
The existing topographic database, although file based structure, uses certain database model. However, it is realized that the existing model be reviewed in the context of NGII in consideration to the requirements of other agencies. In this context, the prior works are being reviewed and enterprise geodatabase model is being developed- this will evolve to a national standard ultimately.

Development of clearinghouse application:
Despite the static census 2001 products, most pertinent services will be made available on the web enabling the users to generate these services dynamically- the proposed architecture is as shown in the figure below:

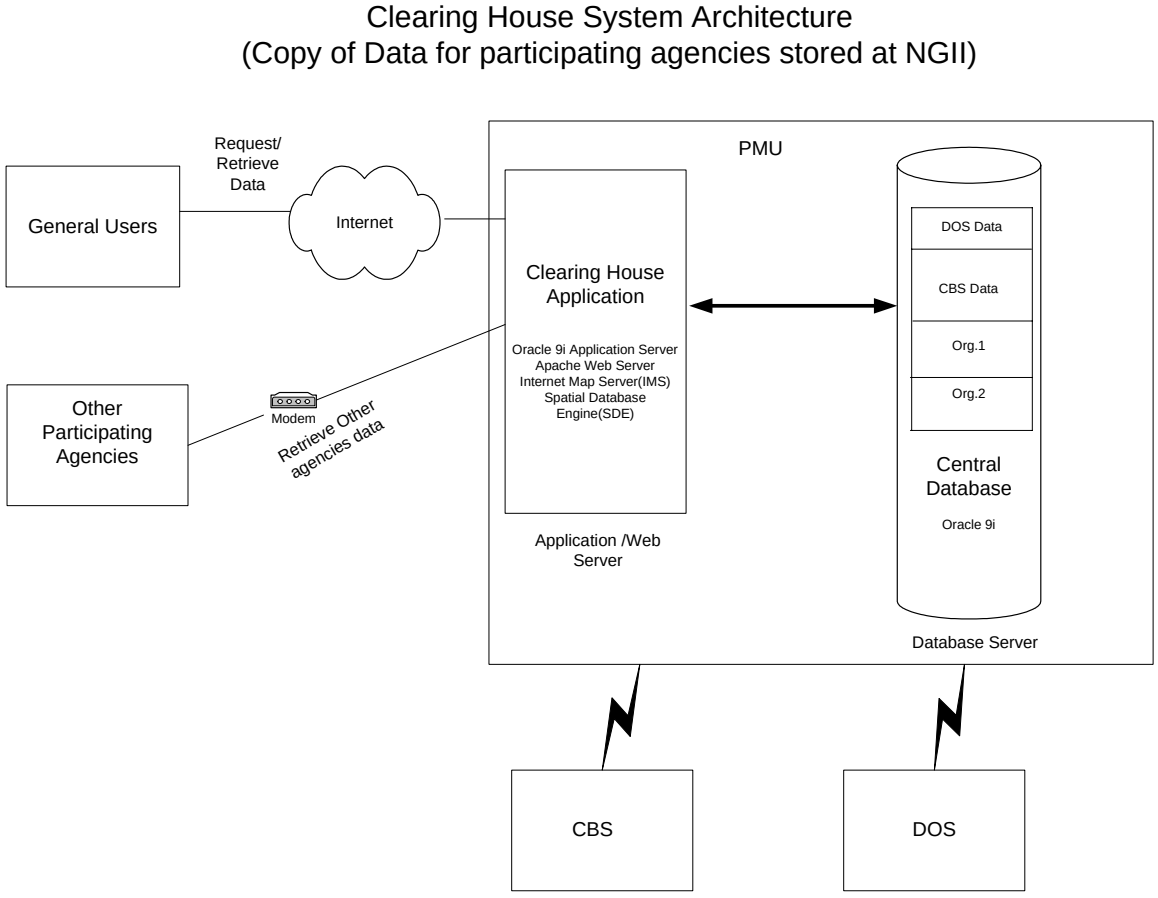

Figure 2: Conceptual architecture for clearinghouse system

Development of policy regarding pricing, copyright and other institutional issues:
Discussions are taking place on most crucial policy issues such as pricing and copyright of the digital data. The institutional issues are being dealt with.

6. THE EXPERIENCE

The NGII in Nepal is at a very infant stage and it has not received a full-fledged concentration yet- the primary objective of the efforts currently underway is the dissemination of the population and housing census 2001 results as a NGII node. Nevertheless, during this period, associated issues are being carefully looked at, which we believe will be of great significance during the upcoming phases in developing such an infrastructure at national level. An attempt is made to outline these experiences below:

- The assessment of the participating agencies reveals that most of the agencies do not have data in digital form. Even if digital data exists, they need significant amount of processing to bring them in sharable form. Since data development is generally time-taking and resource-consuming task, the NGII efforts should start developing data. Otherwise, we may come up with an infrastructure that will be severely underused.
- Agencies mostly private and non-governmental requiring relatively smaller volume of data are spending their resources in the development of data in isolated manner while the data could have already been in existence or when not currently existing could be developed in collaboration with others. Actions need to be directed towards avoiding such duplicated efforts.
- Only those users who have been users of traditional maps were considered as potential NGII stakeholders. However, new users with different information demands are coming up. Therefore, it is realized that efforts are not fully driven by the needs and expectations of the users. Ultimately, users' satisfaction will be crucial for the smooth expansion and sustained operation of the infrastructure.
- There is a very low level of awareness with decision-makers regarding the NGII and its potential benefits. Most of the agencies consider GIS as a map-producing tool. Thus, agencies- including those, which have participated in the consortium- lack the strategic vision for a meaningful participation in the infrastructure. As a result, there is a very low level of preparation with the agencies and this will be one the greatest challenges NGII may have to face in its expansion.
- Most of the participating agencies have acquired few computers, related devices and GIS software. However, they have not been able to transform these resources to full use. The existence, communication and diffusion of GIS knowledge among end-users, technical professionals and decision-makers are crucial if GIS is to advance within an organization.
- The rationale behind the development of NGII is to minimize the gap between the users and suppliers of the geographic information- concept of metadata and clearinghouse services have indeed evolved around this. Paradoxically, accessing these services require certain level of infrastructure (computer, telephone, skill etc.) with the users.
- In addition to the complexities associated with the handling of geo-spatial data, NGII deploys the tight integration of diverse technologies and tools for database management system, data communication, development of custom applications etc. It is imperative to develop realistic coalition with the private and academic sectors for successful implementation of the system. However, there are very few private companies, which can contribute to the technology implementation in Nepal. Regarding the academia, the level of GIS or SDI course in the Bachelor and/or Masters level course in the Universities in Nepal are far from satisfactory. This implies that implementation of NGII is certainly a challenging task ahead.

7. CONCLUSIONS

Nepal has launched NGII with relatively limited participation of the agencies and in practical terms, it is considered as a preparatory or pilot phase- exploring the issues that are associated with the full-fledged building of the infrastructure at national level.

During this period, perspective change with the participating agencies are seen- a stronger preparation is going with them, and have received growing concerns from the agencies that will be potential NGII nodes in the future. These can be considered as encouraging signs. The underlying technical complexities and the need of diverse skill sets has come to front- this helps to better prepare in these areas.

A smooth expansion of NGII requires that due consideration and meaningful alliance be developed with key stakeholders. At the broad level, these are the private sector, academic sector and users community. A timely involvement of the users- for whom the whole infrastructure is being developed- will ensure that NGII will ultimately meet the expectations of the users and will be operational in a sustainable manner.

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Calendar on international workshop\Seminar\Conference

FIG Working week 2004
Athens, Greece, 22-27 May, 2004
E: **fig@central.tee.gr**
W: **www.fig2004.gr**

Geodesy, Cartography, cadastre in the service of Russia
Moscow, Russia, 24-25 May, 2004
E: **yambaev@miigaik.ru**
W: **www.miigaik.ru**

12th International Conference on Geoinformatics 2004
Gavle, Sweden, 7-9 June, 2004
W: **www.hig.se**

The 17th International Geodetic students Congress
Helsinki. Finland (in Simmer)
E: **igsm2004@tky.hut.fi**
W: **www.tky.hut.fi\igsm2004**

XXth ISPRS Congress
Istanbul Turkey, 12-23 July 2004
E: **oaltan@itu.edu.tr**
W: **www.isprs2004.istanbul.com**

ESRI, International User Conference
San Diego, CA, U.S.A 9-13 August, 2004
E: **ucregis@esri.com**
W: **www.esri.com**

Map Asia 2004
Beijing China, 18-20 August, 2004
E: **info@mapasia.org**
W: **www.mapasia.org**

14th International Symposium on Remote Sensing and Development
Damascus, Syria 27-30 September, 2004
E: **gors@gors.syr.org**

FIG Regional Conference for Asia and Pacific
Jakarta, Indonesia, 3-7 October, 2004
E: **fig@fig.net**
W: **www.fig.net**

The 12th Australian Remote Sensing and Photogrammetry Association Conference
18-22 October 2004
Fremantle, Western Australia
E:
W:

International Conferences on Remote Sensing Archaeology
10-21 October 2004 Beijing China
E: **wcl@irsa.irsa.ac.cn**

8th Congress in Surveying and Cartography-TOPCART
19-22 October 2004 Madrid Spain
E: **coit-top@arvakis.es**

Asian Conference on Remote Sensing 2004
Cheng Mai Thailand, 22-26 November, 2004
W: **www.aars-acrs.org**

1st International Conference on Advanced Remote Sensing for Earth Observation

Riyadh, Saudi Arabia, 04-07, December 2004

E: info@remotesensingarabia.com

W: www.remotesensingarabia.com

Survey Department in the Forum of International Activities: A Brief Overview

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Abstract

The scope of work of the Survey Department, Nepal is also related to Agenda 21 of Rio de Janeiro Earth Summit. In order to support this Agenda, the Department has joined the number of International Organizations as a member and participated in the forum of the activities organized by these organizations. Besides, the department has participated in the activities organized by some of the other institutions in which it is not a member. Therefore, the aim of this paper is to provide some views on the membership details and related activities of those organizations with which Survey Department, Nepal is actively involved. The role of the department in the forum has also been discussed.

1. Introduction

United Nations Conference on Environment and Development organized the "EARTH SUMMIT" on June 3-14, 1992 in Rio de Janeiro, Brazil. Representatives from 180 countries with 108 Heads of Government participated the Summit. The participants gathered to discuss many environmental and development problems facing the world. In this summit, Agenda 21 - a programme of action for sustainable development worldwide, the Rio Declaration on Environment and Development, and the statement of principles for the sustainable management of forests were adopted by consensus. Eight chapters of the plan relates to the necessity to provide geographic information.

Agenda 21 stands as a comprehensive blueprint for action to be taken globally by governments, United Nations organizations, development agencies, non-governmental organizations and independent sector groups, in every area in which human activity impacts on environment. It is believed that no nation can achieve sustainable development on its own, so global partnership is being sought for the cause. Guided by the philosophy, Survey Department is trying to participate in international programmes as much as possible to contribute in its own way to fulfill partially the objectives of Agenda 21, besides having its own problems and constraints.

In this connection, Survey Department presently is directly involved in a few regional and international organizations as an active member and trying to participate in few other international programmes of the organizations in which the department is not a member at all. This certainly improved the status of the department in broadening its scope and helped to direct the activities towards sustainable development. The following paragraphs will deal with the organizations in which the department is involved in the programmes of these organizations.

2. SAARC Networking Arrangement on Cartography (SNAC)

With the realization of common problems of SAARC countries, i.e. Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, especially on environmental degradation and unplanned land and other natural resources, it was felt that in order to overcome these issues, updated and appropriate geographical information in the form of maps/data become necessary. Therefore, a thought was evolved to have a meeting of the heads of surveying and mapping organization of the member countries of SAARC.

Since the subject area belongs to the scope of SAARC Technical Committee on Science and Technology, the12th SAARC Technical Meeting held on September 6-7, 1994 in Kathmandu gave permission to conduct the First SAARC Technical Meeting on Cartography in Kathmandu. Accordingly, His Majesty's Government, Ministry of Foreign Affairs, Royal Nepal Academy of Science and Technology and Survey Department of Nepal organized first meeting jointly in Kathmandu from March 14-15, 1995. Twenty one delegates from Bangladesh, India, Nepal, Pakistan and Sri Lanka participated the meeting.

During the two days of deliberations, SAARC Networking Arrangement on Cartography (SNAC) was constituted in order to pursue further for common benefit of the SAARC member countries. The heads of the National Survey and Mapping organization of the member countries will represent respective countries to the SNAC. The Director General of Survey Department, Nepal shall lead the SNAC until the next meeting as Chairperson to coordinate the activities of the Arrangement.

Some of the major activities identified in the meeting were as follows:

- Prepare a SAARC Directory on Cartography education and training
- Compile an inventory of atlas, maps and digital database at the resolution which can be made available by the country to the member countries
- Circulate periodicals and journals among the member countries
- Exchange experts and technicians
- Conduct workshop/ seminars/ conferences
- Share knowledge on technology and experiences
- Launch collaborative projects to strengthen the geodetic network of the region

In the context of SNAC, Survey Department, Nepal should review its progress on the activities mentioned above and should act accordingly. Furthermore, the department should take initiative to arrange the second meeting in one of the member countries of SAARC.

3. Asian Association on Remote Sensing (AARS)

Asian Association on Remote Sensing (AARS) was born on April 25, 1980 in San Jose, Costa Rica. The name of the association was formalized during the second conference held in Beijing, China in 1981, whereas the first conference was held in Bangkok, Thailand in 1980. Professor Shunji Murai is leading the association. The prime aim of the association is to organize an Asian Conference on Remote Sensing (ACRS) every year in one of the Asian countries in Asian style as it is termed. The purpose is to create a forum where agencies from Asia or otherwise related to remote sensing, leading remote sensing practitioners and researchers meet to exchange views and experiences. Due to advanced development in high resolution and hyper spectral imaging, its field of application is widening everyday even in Asian countries.

In AARS there are three types of membership namely Ordinary Membership, Associate Membership and Sustaining Membership. Ordinary membership is given to the organization related to surveying, mapping and remote sensing disciplines of Asia and the Pacific regions. Associate Membership is given to the professionals from other parts of the world and Sustaining Membership to the companies related with the concerned field and at present the number of members in the category of ordinary, associate and sustaining are 24, 8 and 12 respectively.

From the historical record, it appeared that the National Remote Sensing Centre, Department of Forest, Ministry of Forest and Soil Conservation, Nepal have been participating the annual conference since the 3rd conference held in Bangladesh on 1982. The association awarded the membership of AARS to the Centre in the 3rd ACRS. The Centre organized the 5th conference in Nepal. Then, from the 19th ACRS, which was held in Hong Kong on 1999, Survey Department, Nepal, has been participating the conference regularly. In this Conference, the membership was transferred from Department of Forest to Survey Department. The department convened the 23rd ACRS in Kathmandu in 2002, to commemorate the International Year of the Mountain 2002, declared by United Nations. The Conference was organized jointly by Survey Department, Nepal and AARS on November 25-29, 2002.

Being an active member of the association, the Department should therefore have regular participation in the conferences organized by the Association in future as well to enhance its activities in remote sensing.

4. Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)

At the 13th United Nations Regional Cartographic Conference for Asia and the Pacific held in Beijing, China May 1994, the resolution 16 was adopted to form a Permanent Regional GIS Infrastructure Committee. Pursuant to the Resolution, Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) has been formally established at the inaugural formation meeting held in Kuala Lumpur, Malaysia on July 12-14, 1995. The PCGIAP operates under, and reports to, the UN Regional Cartographic Conference for Asia and the Pacific.

The aim of the Committee is to maximize the social and environmental benefits of geographic information in accordance with Agenda 21 by providing a forum for nations from Asia and the Pacific to:

a. Cooperate in the development of a regional geographic information infrastructure
b. Contribute to the development of the global geographic information infrastructure
c. Share experiences and consult on matters of common interest; and
d. Participate in any other forum of activity such as education training and technology transfer.

The membership of the PCGIAP consists of the directorates of national survey and mapping organizations or equivalent national agencies. At present, there are 55 member nations from Asia and the Pacific as advised by the United Nations. Each nation nominates a single representative to the PCGIAP. Survey Department is also the member of Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) representing the country since the establishment of the committee.

The mandate, its scope of work and the activities are based on the Statutes of the Permanent Committee on GIS Infrastructure for the Asia and the Pacific, May 1999. Recently, on 16th UN Regional Cartographic Conference for Asia and the Pacific, Japan, 2003, articles No. 6 and 10 have been amended. Accordingly, in Article 6 among the linking of other relevant UN programs and international bodies, EUROGI and CERCO was replaced by EUROGI and **EUROGEOGRAPHICS** and in Article 10, the provision of number of members in the Executive Board Members have been increased from seven to **nine** members.

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At present, the following Working Groups of PCGIAP are constituted to undertake projects in pursuit of the PCGIAP aims and objectives and to prepare recommendations and its report to UNRCC-AP by PCGIAP as per its mandate:

Working Group 1: Regional Geodesy
Working Group 2: Fundamental Data
Working Group 3: Cadastre
Working Group 4: Institutional Strengthening

These working Groups organize meetings and workshops to discuss and to prepare reports on their operational areas as per the requirements.

5. International Steering Committee for Global Mapping (ISCGM)

The Ministry of Construction, Geographical Survey Institute (GSI), Japan has proposed a plan for a Global Mapping Project to the international communities. The objective of the Global Mapping is to provide a biological and geographical database useful for both global environmental studies and large scale regional development planning. The spatial resolution of the Global map database is 1 km x 1 km that corresponds to a scale of 1:1M for printed maps. The information content of the database are Geomorphologic Data such as terrain elevation, watershed and geomorphologic unit boundary, environmental data such as vegetation, hydrology and land use and geographical data such as rivers, coast lines and administrative boundaries. So, the Global Map is defined as "*a group of global geographic data sets of known and verified quality, with consistent specifications, which will be open to the public*". Global Map is considered as a common asset of mankind, and will be distributed worldwide at marginal cost. In order to implement this project, International Steering Committee for Global Mapping (ISCGM) was constituted.

The primary purpose of this Committee is to examine measures that concerned national, regional and international organizations can take to foster the development of Global Mapping in order to facilitate the implementation of global agreements and conventions for environmental protection as well as the mitigation of natural disasters and to encourage economic growth within the context of sustainable development.

The expectation of ISCGM is to have complete Global Map coverage by 2007 to provide a spatial framework to facilitate the actions of the countries of the world both individually and collectively to conserve the fragile world societies more viable and sustainable for future generation through global change monitoring and environmental analysis. So, the Global Map is used to protect the global environment in the 21st century.

Global Map data are produced mainly by National mapping Organizations participating in Global Mapping project under international cooperation. However, depending upon the capabilities and available resources of the organizations, the following three types of Membership exists in this committee:

Category A: The organizations which produce data not only of their own, but also of other countries based on materials developed on their own or those provided by ISCGM

Category B: The organizations that produce only data of their own countries

Category C: The organizations that do not produce the data by themselves, but provide ISCGM with information such as administrative boundaries and recent version of paper maps needed for data production, and or validation.

HMG, Council of Ministers sanctioned HMG Survey Department to apply for the membership of this committee on 2056/03/10 and ISCGM awarded membership to Survey Department for the category B. At present, 130 countries of the world, including Nepal, are participating in the Global Mapping programme and 20 more countries are in a state of consideration for participating in this programme.

The recent programme of the Committee is to prepare a digital database of the member country at the resolution of 1: 1 000 000. Although, Nepal is in the Category B member, it was not in a state to prepare such database due to lack of technology, human resources and financial resources. So, GSI, Japan assisted to prepare the global mapping database for Nepal. The basic document used to prepare the database are 1 : 500 000 scale maps of development regions administrative maps published by Survey Department of Nepal and the population census map of 1991 published by Central Bureau of Statistics of Nepal.

The Global Map data of six countries including Nepal was released by ISCGM as a version 1.0 on November 28, 2000. By July 12, 2003, the data of 17 countries has been released. The data is available in website http:/www.iscgm.org. The Secretariat of ISCGM will attempt to make Global Map more easily available on the World Wide Web to facilitate linkages with other global data sets.

At present, Survey Department has a capability to build the digital database and it has established the National Topographic Data Base using topographical base maps at the scale of 1:25 000 and 1:50 000 prepared during the period of 1989-2000. Furthermore, Central Bureau of Statistics of Nepal has published the population census data of 2001. So the global mapping database of the country could be updated or replaced by using newly developed database and information.

6. International Federation of Surveyors (FIG),

The aim of Federation Internationale des Geometres or International Federation of Surveyors (FIG), mentioned in the FIG work plan 2000-2003 (No. 20) is as follows:

> *"To be the premier international non-governmental organization that represents the interests of Surveyors and users of surveying services in all countries in the world. It is a federation of member associations all of whom seek excellence in the services that they deliver."*

More than 100 countries are represented in FIG in the following four categories of members

- Member Associations: national associations representing one or more of the disciplines of surveying
- Affiliates: groups of surveyors or organizations undertaking professional activities but not fulfilling the criteria for member associations
- Corporate Members: organizations, institutions or agencies which provide commercial services related to the profession of surveyor
- Academic Members: organizations, institutions or agencies, which promote education or research in one of the disciplines of surveying.

In order to achieve the aim, FIG regularly organizes events such as conference/workshop/meeting etc. In some of these events the officials or ex-officials of Survey Department participated and they shared their experiences from the events with the officials of the department. In 2002, the department realized that the time has come to affiliate the department with FIG to give its exposure in international communities of the field concern. Accordingly, a three member team led by Mr. Ananta Raj Pandey, Secretary, Ministry of Land Reform and Management participated XXII FIG Congress which was held in Washington D.C. from April 22-27, 2002. In the general assembly, Mr. Babu Ram Acharya, Director General, Survey Department, Nepal applied for the membership of FIG and President, Dr. Robert N. Foster of FIG on April 23, 2002, awarded an Affiliate Membership of FIG to the department. It was approved by HMG (Hon. State Minister level) on 2059/1/29 (May 12 2002).

In order to support the FIG Congress the following Ten Commissions are constituted and in each of these Commissions one person from Survey Department is also commissioned to participate in the activities of respective Commissions:
Commission 1: Professional Standards and Practice
Commission 2: Professional Education
Commission 3: Spatial Information Management
Commission 4: Hydrography
Commission 5: Positioning and Measurement
Commission 6: Engineering Surveys
Commission 7: Cadastre and Land Management
Commission 8: Spatial Planning and Development
Commission 9: Valuation and the Management of Real Estate
Commission 10: Construction Economics and Management

Now, Survey Department has additional responsibility to keep pace with the activities of FIG. Therefore, the department should contribute to achieve its goal and should manage for the participation of events of FIG as much as possible so that the department could gain maximum experiences from it and for furthering development in surveying and mapping activities in Nepal.

7. Group on Earth Observation

The goal of the Earth Observation is to develop an implementation plan to achieve the following objectives:

a. Move toward a comprehensive, coordinated and sustained Earth Observation System if Systems
b. Address developing countries capacity building needs
c. Improve the world wide reporting and archiving of data

In this context, Earth Observation Summit I was held in Washington D.C. on July 31, 2003 where an *ad hoc* intergovernmental Groups on Earth Observation (GEO) was established and also established the following 5 Subgroups

i. User requirements and outreach
ii. Data Utilization
iii. Architecture
iv. Capacity building
v. International cooperation

Nepal applied for the membership of Geo as per the decision of His Majesty's Government dated 060/12/11 and the membership was awarded to Nepal by GEO-4 meeting, which was held in Tokyo, Japan on April 22-23, 2004. At present, there are 48 member countries and 29 international organizations.

The major tasks of Geo, at present, are to give guidance for establishing Global Earth Observations System of Systems and to draft 10 year implementation plan before the Earth Observation Summit III to be hosted by the European Union in early 2005 in Brussels.

8. Some other Organizations

Besides the abovementioned activities, Survey Department is also participating in the activities of the following organizations though not regularly but as and when possible:

United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP), International Society for Photogrammetry and Remote Sensing (ISPRS), Map Asia, Cambridge Conference, etc.

9. Why the Participation?

The basic reasons for the department to participate in these international events are obvious and could be listed as follows:

- To report the present status of the department in the field of Geoinformatics
- To give exposure of the department in international communities of its existence
- To make acquaintance with the recent developments in its working areas
- To gain experiences to fulfill its responsibilities when the task is assign
- To share knowledge with experts, professionals, individuals
- To develop confidence to face with the foreign counterparts
- To widen the scope of the department.
- To evaluate the status of the department with respect to other related organizations in the world.

10. What are the Results?

The results from the participation of international activities could be evaluated in terms of quantity and outcomes. Every year, numbers of international activities are organized in different parts of the world. It is not possible to have participation in each and every event and it is not necessary also but there should be

participation, at least, on the events organized by the organizations in which the Department is the member. However, due to some unavoidable circumstances, it is sometimes not possible to participate even in such activities. The department always tries to participate in as many programmes as possible.

The major outcomes by participation of the programmes are number of officials from the department got opportunity to gain experiences by sharing the knowledge with the professionals from other parts of the world and helped to introduce new feasible technologies in the department. So, the department expanded its scope of work when it felt appropriate. The participant submits the detail report of the event along with the Proceedings, other important documents and some brochures of the different organizations to the Director General. In case, the Director General participates the event, he has to submit the report to the Secretary, Ministry of Land Reform and Management; however, a copy of the report is available in the Department. The interested officials from the Department could update and enhance their knowledge by studying these documents.

11. What are the Roles?

The main roles of the department after the participation of an international event are as follows:

- Study the resolutions and future programmes of the event
- Identify and select the technologies which are suitable to the country and which can be implemented with its own resources.
- Implement the activities that are necessary to fulfill to support the programme of the event that are decided by the concerned forum. Then, report the progress in the following programme of the related event.

12. Conclusion

In the present context of globalization, Survey Department should expose itself to the international communities. This will help in reorganizing its activities and to remain at par with the technology trends. So far, the Department has direct affiliation with five international organizations. The progress from the participation of the events of these organizations is quite satisfactory; however, more participation is expected by optimizing its existing resources.

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Digital Conversion of Analogue Cadastral Maps of Kathmandu Metropolitan City

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Abstract

Land is the only immovable property that can be used as a means for agricultural production as well as a means for mortgage for financing industrial or commercial enterprises. Spatial technologies play a key role in managing our land, water and natural resources. Cadastral data is a major component for the development of Land Information System. Therefore, systematic land registration system based on accurate and scientific cadastral map are found inevitable for poverty alleviation, good governance and women empowerment through security of their rights on property, as well as the planning and development of a sustainable environmental protection within Metropolitan city. Digital cadastral parcel is the fundamental spatial unit on which database is designed, created, maintained and operated. Availability of accurate and updated cadastral maps is a primary requisite for successful planning, policy formulating and maintenance of city utility services, which need cadastral and utility information together. Flawed cadastral maps can put land, revenue and taxation system at stake. Kathmandu the capital city of Nepal still is lacking utility maps combining cadastral information with the utility. There is an urgent need to have an effective, accurate and easy to access land revenue and utility services system within the urban areas which could be achieved after the production of reliable base maps and land registration system to guarantee land allocation and property rights which can well be achieved by digital conversion and correction of base cadastral maps. This paper highlights the drawbacks of the conventional cadastral maps and the possible advantages of digital cadastral maps over these. Also the problems, issues and implications during digital conversion and creating database of the same will be discussed.

Keywords: ***Cadastral, Database, Topology, Land Information System***

1. Introduction

Systematic cadastral mapping in Nepal began in 1964 with the promulgation of land reform act 1962. The focus was to enact new land reform act nationwide that requires land records to generate revenue after defining land holding by the individual citizens. Both neither the national geodetic network was established nor any national coordinate system was developed to base such mapping, ground controls based on local base lines were being used to map the parcels during cadastral mapping.

Authority of the Kathmandu Metropolitan City is actively involved in the development of its planning support system. One component of the system involves the establishment of an Urban Management Information System (UMIS) for the city. At the heart of the system are new digital topographic maps of Kathmandu Valley and Kathmandu Metropolitan City at the scales of 1:10,000 and 1:1,000, and a digital cadastral database at the scale of 1:500. The Survey Department of His Majesty's Government of Nepal has undertaken the above said task.

In addition to topographic mapping, KMC has decided to use urban digital cadastral database as major source of information for physical planning and improving

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urban service delivery of KMC. The cadastral maps will serve as the base map for urban planning and development, and to improve specific KMC activities such as tax collection, building permit issuance and billing processes.

2. Objectives

- Search a system that is more effective in serving the people concerning the maintenance of cadastre data that make land administration easier and effective.
- Support the land information system and land consolidation program.
- Evaluation of constraints in the conversion of graphical cadastral data into digital format.

3. Existing Situation

The cadastral analogue data only bears georeferenced graphical map of parcels and parcel number with some symbols of transportation and building feature. It does not bear other classified land cover features. It was only prepared for revenue collection. The Kathmandu metropolitan city requires LIS data for development process. It is not only limited to the formation of digital cadastral map but cadastral information with other land cover types. In a true sense, it needs large-scale topographic map with cadastral information.

4. Problems

It was soon realized that conversion of cadastral maps into the digital form is not an easy task. Already the cadastral maps bears lot of edge matching problems. The cadastral maps have been adapted to the conformal modified UTM projection, which is the problem beforehand. Some of the maps are fragmented into different sheets, which had to be brought into the same sheets. Basic problem in the conversion process is the physical condition of maps, in many cases they were found very bad due to continuous use for long time such as dimensional distortion and legibility of drawings. Inconsistencies in basic data to be used for digital conversion created a lot of problems in edge matching. Second problem is the degree of update of details and thirdly mismatching of details at the edges of the map sheets. Parcel boundaries were found updated where as other features like building geometry and land use type was not updated. There are problems associated with conversion of parcel map/file maps.

(i) A cadastral map having no data in the upper boundary.

(ii) Edge matched cadastral map

Sheet fragmented into different sheets.

5. Finding the Solution

Erroneous data were examined and solutions were found out, in some cases, by defining logical consistencies. Some map sheets were rescanned and re-vectorized. In some cases, data were re-georeferenced. Unmatched data but falling within error limit was ignored. Since cadastral data are not subject to change without any justification and at the same time other land cover details had to be incorporated on to the final map, the final product was not treated as digital cadastral map but the topographic map, just to liberalize the edge matching procedure.

6. Input Raw Data

As the primary requisite on a GIS is the input of raw data by processing which one can go forward for geo-processing to get the desired output, it is supposed to be supplied by the KVMP (Kathmandu Valley Mapping Programme) itself. The input raw data should have been vectorized with line and polygon information both having feature identity. At the same time, all these 1:500 scale digital data sheets should have been edge matched.

Digital mapping unit under Survey Department then proposed the following norms for digitization to the Kathmandu Valley Mapping Programme.

1. All ARC (linear) data in the master coverage (coverage with all layers) should have the user_id

that would indicate which feature boundary it encompass of. (Superficially it seems that arc ids for the polygon feature are not needed for the work proposed, but it is indispensable for data processing in the operational level.)

2. All lines in the master coverage must be assigned by the unique feature type code.

3. It is suggested that CFCODE (Cadastral Feature Code) to be assigned according as priority order expressed below in case of common boundary. River, Road, Curb, Building, Fence, Pond, ... Parcel

4. If a common boundary occurs between features of same type, CFCODE must be assigned in the order provided by KVMP itself. E.g. CFCODE of a line between a concrete building (Pakki) and a ruined house (Bhatkieko) may be the assigned as that of the Pakki building.

5. Polygon features in master coverage must be assigned by label point of arc/info database

6. All sheets should be provided edge matched (except in case of arcs of parcel boundary going beyond threshold value indicated).

7. After Vectorization, data referring to each feature (only from indicated part) must be usable for printing to make a reference base map for fieldwork for updating.

7. Field Survey

Four 1:500 scale digitized maps was merged into one to generate a digital map sheet of 1:1000 scale map. Accordingly, this map was printed and was taken in the field to pick up the any change in data. After the filed work, the updated data are traced into different layers depending upon the feature class. The Field Section of the Topographical Survey Branch adopted plane tabling or tachometric survey for data acquisition to update the data printed in the scale of 1:1000 using the geodetic control points established by GPS.

8. Symbol Design

Since it is the first time that the work of conversion of cadastral data from analogue to digital form (also in the form of cartographic database) took place, a hard time was felt to design the digital symbol that to be incorporated into the hard copy final map (along with digital) to be delivered to the Kathmandu Metropolitan City (KMC). Since the GIS data were numerical as well as attribute code based, a proper significant symbol had to be designed which are symbolic and at the same time show the characteristics of the feature of reality. Similarly most of the features become conspicuous in the map if they are assigned with the same symbol as used in the conventional hard copy maps. Considering the time frame of the project, only point symbols were digitally created in the same pictorial form. Line symbol and polygon symbols were managed to prepare by manipulating the existing symbol that comes with the software.

9. Software Used

Following are the tools used to generate the data in the GIS.

(i) Arc View (ii) R2V Able Software (iii) Arc/Info (iv) Macromedia Fontograph (to design in new fonts, which were ultimately converted into point symbol)

10. Application Development forPerpetuating the Process

Programs necessary to automate the tasks of editing, data integration and visualization have been designed to accomplish the total work within the given period. Hundreds of customized programs were designed to carry the GIS work efficiently in the environment where some of the working personnel were even untouched with the computer and at the same time they are expert in mapping by manual method. Training and teaching were performed within the working clusters during the performance of the digital data creation. Programs regarding datum conversion, Projection, transformation and final visualization have been designed within the Survey Department to accomplish the task in the predefined time period.

11. Methodology

The workflow diagram in general form has been shown in the flowchart at the last of the paper. The real practice done due to inconsistency of the primary data supplied by the first party has been given in the flow chart.

12. Preparation of Digital Updated Element

The re-traced field-picked hardcopy element are scanned in the tiff format and then vectorized in the R2v software. They are assigned by the proper user_id (later to

be converted into CFCODE.) The database model was kept in mind to incorporate the attribute data to each feature while they are being assigned by the user ids.

13. Data Conversion

The R2V prepared format of the point and arc data was converted into the arc info format by using the customized program named as R2V2INFO.sml. It is this program, which adds attribute field necessary for updating and generates topology. The status of the existing old arc data was numerically assigned as 4 where as the new updated data will have the status as 2. An extra column called FCODE is added for further code-security for technical purpose.

14. Data Overlaying and Updating

The new vectorized updated (geo-referenced) element is overlaid onto the old data. It is here the actual digital updating work starts. The data are interpreted by the code already assigned. Referring to the hard-copy updated map brought from the field, the data are updated in the computer. Finally, different layers are generated from the master coverage by using the code assigned.

15. Edge Matching

When updating is finished, all the sheets are undergone into edge matching. An attribute "fixed" or "Edit" assign each alternate sheet. All "edit" sheets were edge matched with respect to the "fixed" sheets. After the edge matching, the data are undergone checking and supposed to be prepared for printing. A fantastic methodology was designed for edge matching procedure. If it were done as mentioned by the general methodology described in the Arc/info system, it would almost difficult to accomplish as expected, though the editing as well as edge matching was done in the arc/info environment.

16. Visualization of data

After having all the data edge-matched they are transferred from the Arc/Info system to the Arc View environment. Any polygon assigned by false feature code is checked and corrected. Data are loaded into the view by the automated system, which triggers them to be visualized with the pre-specified symbol of consistent size. In this way a consistent cartographic database is generated and finally printed the hardcopy maps. The maps so generated are put forward to the Mapping Committee of HMG/Nepal, which gives guidelines if there are any comments to be checked and corrected.

17. Conclusion

Digital cadastral database is fundamental to the success of land information system. In order to enhance the capability of the system, it is therefore, imperative that data on land parcel must be available in proper format, which will enable the system to gradually migrate to full-fledged multi purpose cadastral system.

Cadastral database design is not a single step phenomenon, which starts and ends within the performance of the same nature of works. It is, in fact, by virtue of different natured performance by integrating, which an integrated information system can be modeled.

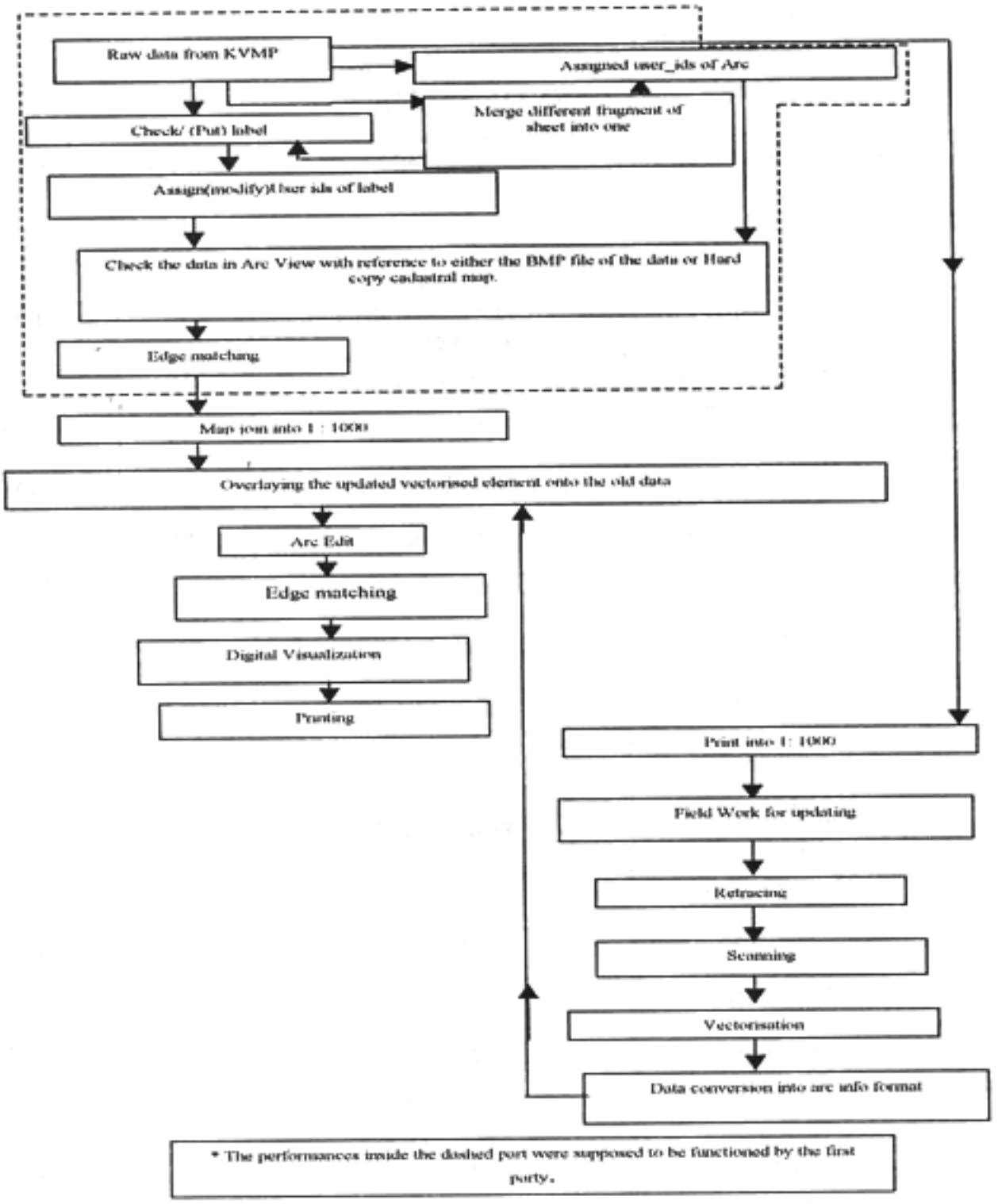
Cadastral Information System can be a basis for effective Land Administration of 21st Century since updating the fragmented land parcel is easier if done digitally.

Data accessibility can be made via the web (easy accessibility) but data security issue is equally sensitive. They tend to negate each other in real functioning.

Attributes of Cadastral data are highly volatile (in Urban area as the rate of transaction is high and effect of prevailing law of inheritance) and sensitive since it is connected to the property of people so that the metadata should be regularly maintained.

Technically, it is very sensitive to deal with the cadastral data in editing since any small inherent movement in geometry of data may raise legal issues. (E.g. an arc must be snapped at the ends to form a polygon, which may tend to alter the area of the parcel).

Moreover, if there exist problems of mismatch between map sheets of original data, then it needs to be focused to analyze and rectify prior to the GIS input. Due to serious mismatch of data between sheets of cadastral maps, the final output of data was considered to be the topographic maps with the physical features since the metropolitan city needs such maps for infrastructure development.



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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
19	Orthophoto Map	Urban Area (1: 5 000) and Semi Urban Area (1: 10 000)	-	1 000.00
20	Administrative Map	Nepal		5.00

Price 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

Participation in international events by the officials of the Survey Department

Workshop on Cadastral System in Asia and Pacific Working Group 3
16th united Nation Regional Cartographic Conference for Asia and pacific
Mr. Rabin Kaji Sharma, Chief Survey Officer, Survey Department
28- 29 Asad, 2060(12-13 July 2003)
30 Asad- 2 Shrawan, 2060(14-18 July 2003)
Okinawa Japan

ESRI Conferences and Global Mapping Forum
Mr.Raja Ram Chhatkuli, Project Chief, NGIIP
20 Ashadh-2 Shrawan 2060 (4-18 July 2003) U.S.A./Japan

Cambridge Conferences
Mr.Babu Ram Acharya,Director General, Survey Department
4-9 Shrawan 2060 (20-25 July 2003) U.K.

Survey Officials Meeting of Nepal-India boundary work
Mr. Tirtha Bahadur Pradhananga for Deputy Director General
Mr. Narayan Prasad Adhikary, Chief Survey Officer
Mr. Mahendra Prasad Sigdel , Chief Survey Officer
Mr. Bhaskar Prasad Sharma, Survey Officer
Mr .Purna Bahadur K.C., Survey Officer
Mr. Deepak Sharma Dahal, Survey Officer
1-5 Bhadra 2060 (18-22 August, 2003) Dehradun, India

Boundary map study
Mr. Mohan Bahadur Gurung,Surveyor,Topographical Survey Branch
Mr. Puspa Lal Balla, Assist. Surveyor, Topographical Survey Branch
22-29 Bhadra, 2060 (8-15 September 2003) Dehradun,India

Workshop Training on Land Cover Mapping
Mr. Umesh Kumar Joshi, Survey Officer, Topographical Survey Branch
15-20 Marga, 2060 (1-6 December 2003) Bangkok, Thailand

7th South East Asian Survey Congress
Mr. Toya Nath Baral Deputy Director General, Survey Department
17-21 Kartik 2060 (3-7 November, 2003) Hong Kong, China

Training course on Space Technology and Remote Sensing Application in Environmental Monitoring and Disaster Mitigation.
Mr. Jagat Raj Paudel, Chief Survey Officer Topographical Survey Branch
1-30 Kartik, 2060 (18 October- 16 November 2003) Shanghai, Beijing, China

Seminar\Workshop on mapping from High Resolution Satellite Imagery
Mr.Rabin Kaji Sharma, Chief Survey Officer, Survey Department
Mrs. Shushila Rajbhandary, Surveyor, Survey Department
15-16 October 2003, Bangkok Thailand

Session of the Asia Pacific Regional Space Agency Forum
Mr.Babu Ram Acharya, Director General, Survey Department
30 Paush-2 Magh 2060 (14-16 January, 2004) Bangkok, Thailand

Survey Officials Meeting of Nepal-India boundary work
Mr. Tirtha Bahadur Pradhananga, Deputy Director General (a.i)
Mr. Narayan Prasad Adhikary, Chief Survey Officer
Mr. Bhaskar Prasad Sharma, Survey Officer
Mr .Purna Bahadur K.C., Survey Officer
Mr. Ramesh Rajbhandary, Survey Officer
4-6 Marga, 2060(20-22 November 2003) Nepalganj, Nepal

Moderate Resolution Satellite for environmental monitoring
Mr. Govinda Baral, Survey Officer, Topographical Survey Branch
5-16 Magh 2060 (19-30 January, 2004) Bangkok, Thailand

Group of Earth Observation Fourth Meeting
Earth Observation Summit II
Mr. Rabin Kaji Sharma, Chief Survey officer, Survey Department
10-11 Baishakh 2061 (22-23 April, 2004)
13 Baishakh 2061 (25 April 2004) Tokyo Japan

GSDI-7 Conference, PCGIAP-10 and ISCGM-11 Meeting
Mr. Raja Ram Chhatkuli,Project Chief, NGIIP
15-25 Magh 2060 (29 Janaury-8 February, 2004) Banglor India

GSDI Conference
Mr. Suresh Man Shrestha,Chief Survey Officer,Survey Department
Mr.Shushilnarsingh Rajbhandary, Survey Officer,Survey Department
19-23 Magh (2-6 February, 2004) Banglor, India

26th Joint Technical Meeting of Nepal-India boundary work
Mr. Babu Ram Acharya, Director General, Survey Department
Mr.Shri Prakash Mahara,Deputy Director General

Mr. Toya Nath Baral, Deputy Director General
Mr. Tirtha Bahadur Pradhananga, Deputy Director General (a.i)
Mr. Raja Ram Chhatkuli, Project Chief
Mr. Narayan Prasad Adhikary, Chief Survey Officer
Mr. Mahendra Prasad Sigdel,Chief Survey Officer
Mr. Bhaskar Prasad Sharma, Survey Officer
Mr. Purna Bahadur K.C., Survey Officer
5-7 Paush 2060 (21-23December 2003),Kathmandu,Nepal

Study tour led by
Dr. Hari Krishna Upadhyay Honorary Member, National Planning Commission
Mr. Bijaya Raj Bhattarai, Secretary, Ministry of Land Reform and Management
Mr.Babu Ram Acharya, Director General, Survey Department
Mr. Raja Ram Chhatkuli , Project Chief ,NGIIP
15-20 Chaitra 2060 (8 March-2 April), 2004 Melbourne, Sydney, Australia

Survey Department Officials for higher study\training
Mr. Ganesh Prasad Bhatta, GFM-3, ITC, Netherland, 1 year from Sept.2004
Mr. Janak Raj Gautam, GFM-3, ITC, Netherland, 1 year from Sept.2004
Mr. Deva Raj Paudel GIM-3, ITC, Netherland, 1 year from Sept.2004
Mr. Amir Prasad Neupane, GFM-3, ITC, Netherland, 1 year from Sept.2004
Mr. Sijan Kumar Dhakal, GFM-3, ITC, Netherland, 1 year from Sept.2004
Mr.Ganga Lal Pokhrel, GFM-4, ITC, Netherland, 9 months from March 2004

. 24th ACRS Conference
Mr.Babu Ram Acharya, Director General, Survey Department
Mr.Raja Ram Chhatkuli, Project Chief, NGIIP
Mr. Rabin Kaji Sharma, Chief Survey Officer, Survey Department
Mr. Durgendra Man Kayastha, Chief Survey Officer, Survey Department
17-21 Kartik 2060 (3-7 November 2003) Busan Korea

Nepal-China Boundary meeting
Mr. Tirtha Bahadur Pradhananga, Deputy Director General (a.i), Topographical Survey Branch
Mr. Narayan Prasad Adhikary, Chief Survey Officer, Topographical Survey Branch
12-13 Chaitra 2060 (25-26 March, 2004) Beijing, China

Survey Officials Meeting of Nepal-India boundary work
Mr. Tirtha Bahadur Pradhananga,Deputy Director General (a.i)

Mr. Raja Ram Chhatkuli,Project Chief
Mr. Narayan Prasad Adhikary, Chief Survey Officer
Mr. Mahendra Prasad Sigdel, Chief Survey Officer
Mr. Bhaskar Prasad Sharma, Survey Officer
Mr. Purna Bahadur K.C., Survey Officer
Mr.Madhur Man Maskey, Survey Officer
Mr.Deepak Sharma Dahal, Survey Officer
9-11 Baishakh 2061 (21-23 April 2004) Kathmandu, Nepal

CONGRATULATIONS

In the fiscal year 2058-59, His Majesty's the King Gyanendra Bir Bikram Shah Dev awarded Mr. Babu Ram Acharya, Director General and Mr. Krishna Raj Neupane, Survey Officer of the Survey Department with *Tri Shakti Patta Class IV* and *Gorkha Dachhin Bahu Class IV* respectively. 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 third issue of the Nepalese Journal on Geoinformatics Last date for the submission of the article is March 31, 2004.

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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 / -

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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

Rate of Maps

Rates of Aerial Photo and Map Transparency

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Aerial Photograph	
a) Contact Print (25cmx25cm)	Rs 150.00
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Diazo/Blue Prints	Rs 40.00
Photo copy	Rs 50.00
Photo lab facilities	US$ 200/day

(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.

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

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 | -

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

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

Issues on Land Management and Land Fragmentation

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1. Introduction

Land is the fundamental resource for the existence of human as well as animals on the earth. This resource is very limited and the population is ever growing. Therefore, each and every moment land to man ratio is decreasing. If a proper balance between land and population is not maintained social and political stability in the nation would not be possible. Again, Nepalese economy is based on the agriculture production, so that about 80% of the population is engaged in agriculture Due to lack of basic infrastructure, haphazardly farming practices leads to low agriculture production. Further, due to increasing population, it is being a global concern that there is need to minimize the effect of environmental pollution. This is applicable in our context also otherwise grave consequences to be faced by our coming generation is imminent.

Therefore, a careful consideration in these issues should be seriously addressed. One of the key tool to address these issues is a land management. It is a complex tool and it is associated with number of disciplines for instance, agriculture, forest, tourism, industry, population, surveys, etceteras. Therefore, without proper coordination and mutual cooperation among the concerned organization proper land management could not be achieved.

Nepal being the agriculture based economy country, the major concerns is to increase in agriculture production and productivity in order to establish sustainable development and to support poverty reduction programme of the nation. One of the obstacles to maintain this is a regular process of land fragmentation. So this paper will try to discuss the land management and the land fragmentation issues.

2. Components of Land Management

Land Management covers a wider range of spectrum, a brief introduction of its main components in the context of Nepal is relevant to mention and are given below :–

2.1 Land use Zoning :

Nepal is extended with various physiographic regions, which are categorized into Terai, Chure, Siwalik, Middle Mountain, High Mountain and snow covered Himalayan regions. Those areas should be categorized in the context of land use as the following :

- Agriculture area (including grass land grazing land)
- Industrial area (big, medium and small)
- Commercial area
- Residential area (Including Governmental and Non–governmental Office Area)
- Forest area

The other aspects regarding land use belong to rural and urban categories. The elements of rural land use and that of urban area should have a clear distinctions based on the availability of amenities for instance the facilities of drinking water, sanitation, health, electricity, communication, sewerage, telephone, entertainment, etceteras

2.2 Land Development

Land development has direct impact on agriculture products. In the presents practice, agriculture output has suffered significantly due to fragmentation of land parcels. Therefore, the policy needs updating and modifications for the betterment of agriculture products. The land development elements are considered as consolidation, fragmentation and distribution. These aspects of land development play a vital role for the improvements of land management.

Land development could also be utilized for transforming bigger villages to small towns and cities, by upgrading and improving its infrastructures such as roads, drinking water, sewerage, etceteras and social environment such as education, public awareness, health facilities etceteras.

2.3 Revenue Generation /Taxation

The revenue generation based on land includes land tax, land transaction and property tax, which supports the land management system. Therefore, these should be systematized and the concept of property tax should be introduced in order to increase the revenue by proper land valuation and asset valuations.

2.4 Environmental Conservation and Pollution Control

The efficient and effective land management is greatly affected by environmental condition, which include the environmental pollution as well. Therefore, the plans for land management should include the program for environmental conservation and pollution control. Public awareness in education, health and population is one of the controlling factors for environmental conservation and pollution control.

Migration within the districts and from the village to urban areas is one of the element affecting environmental imbalances which is very difficult to manage, however, it could be controlled to some extent by keeping records of individual moving from one place to other and by proper country planning. Infrastructure development covering basic amenities rural sectors may help to check migration.

The pollution caused by solid waste and industrialization is another element in land management which could be kept minimum through proper solid waste management and through proper planning of large and medium scale industries respectively .

3. Trend in Land Management system

As land management is very much related with land administration so in the implementation process many challenges on the issues of land administration are facing on daily basis. Some of the major issues are as following :–

- Lack of skilled human resources
- Shortage of adequate resources and infrastructure
- Requirement of amendment in existing laws
- Lack of coordination between the related organization
- Difficulties in access of land by landless and economically poor groups of people
- Hesitation in application of modern techniques
- Existence of dual ownership in practice
- Fragmentation of agriculture land
- Lack of effective implementation of land use planning
- Rehabilitation of landless people still exists .

The traditional systems are no longer adequate to support the sustainable development. As such these systems were designed to fulfill the limited needs whereas due to technological advancements and realization of diverse needs the present trend have been driven to improve land administration system and so pressure has been gradually built–up to improve the system to the organization related with this system. So the existing land administration systems need to be analyzed to identify the requirements to fulfill the demands and appropriate system can be designed accordingly.

For the implementation of land management programme and land consolidation programme, the cadastral maps and the related information are the basis for such applications. At present, these cadastral plans and information is available in a form of paper maps and manual records. However, these data should be well maintained. But due to the development of computer based land information system, the demand has emerges to prepare in digital formats and it is still a problem area in our present context mainly due to the volume of task and the availability of time and resources required for preparation of such data. However, efforts should be made towards utilization of existing data to create a digital cadastral database.

4. Land Reform Programme

All the land management and land fragmentation related activities are part of the land reform programme. A brief history of land reform programme is worthwhile to mention here.

The land reform programme was launched in 2021 BS . It has certainly brought awareness in the people. The programme such as relieving peasants from burden of loans, freed from local exploitation, fixed land ceiling on land holding and providing agriculture credit through compulsory saving scheme have given social security and justice. Although there have been some achievements but due to lack of political commitments and administrative efficiency the programme has witnessed losoing momentum. So, His Majesty's Government realized to consider seriously to review the land reform programme. Accordingly, in 1996 AD, a ten points time bound package programme was designed. They are as follows :

- Abolition of dual control on land
- Settlement of the remaining cases on land holding ceiling
- Protection of public and government land
- Settlement programme for Sukumbasi people
- Implementation of agriculture development programme for uplifting Kamaiyas
- Providing agriculture credit facility
- Application of land use planning
- Development of integrated land information system
- Implementation of land consolidation programme
- Protection of Guthi land

Again, due to political instability and the slackness in administrative efficiency, most of the programmes would not materialized. So, once again HMG decided to reengineer the land reform programme and on Srawan 32, 2058 BS, HMG announced to launch a revolutionary land reform programme. In order to implement the programme, land reform legislation has been passed in the parliament and later on this has obtained royal ascent. The major highlights of this new legislation are a revised land holding ceiling, provision for the land use planning and land consolidation. The objectives of these measures are to acquire land for landless as well to improve the productivity and the production of land in order to support the following :

- Poverty reduction
- Environmental protection
- Good governance
- Social security and justice

5. Reasons of Land Fragmentation

The following are some of the reasons for land fragmentation :

- Non–creation of alternate employment
- Increase social and culture activities
- Not adequate irrigation facility
- Property distribution within the family

6. Necessity of the Programme

The gradual increase in land fragmentation and scattered small parcels belong to a land owner causes the following negative impact :

- Difficult in getting returns against the investment
- Considerable investment required to manage necessary irrigation facility
- Difficult in use of manures, pesticides and even to monitor the activities
- Expensive to use modern equipment
- Difficult to increase in agriculture employment

So, to overcome these issues the following activities should be envisaged :

- To organize and to make progressive the traditional agriculture profession
- To adjust scattered small pieces of parcels or near by parcels to one piece of land
- To manage canal, road, manures, seeds, etc .
- To fence and to maintain the boundany to use improvised tools.
- To discourage land fragmentation and to determine the minimum size of agriculture land.
- To develop agriculture system through land consolidation approach.

In the mean time land fragmentation should be discourage. Some of the measures or to control land fragmentation are following :

- Legal provision should me made not to make a parcel smaller than a specified size and the distinction should me made for urbanization and agriculture purpose
- Legal provision also should be made such that ownership could be changed while land fragmentation but the land should not be fragmented during distribution of heredity property
- First priority should be given to neighbour during land transactions of minimum size parcels. In such process, a single parcel number should be given after amalgamation of two or more parcels and registration fee should be exempted
- Gradually reduce the people depend on agriculture profession in other words divert the people of this profession to other sectors of economic development.

7. Methods of Land Consolidation

As the topography of the country has a diverse nature so a single system is not feasible throughout. Consequently, a method should be designed as per the nature of the terrain. Hence, land consolidation and land fragmentation control programme can be launched in selected areas of the country as a pilot project. Based on the results, an extensive campaign to convince the people is inevitable and should give them opportunity to implement the programme by their own initiation. The leading organization should play a role of facilitator to provide financial, technical and legal advices to these people, groups or organizations.

Some of the methods of land consolidation are as follows :

- Mutual transformation of the land
- Cooperative or group farming system
- Leasing the land
- Distribute land by the Government after land pooling
- Intensive farming by a single person

8. Expected Result

The following results are expected after the implementation of land consolidation programme :

- GDP will be higher due to increase in agriculture production .
- Decline in dependant on others in food sector
- Help in development of group work
- Construction of infrastructure framework
- Increase in employment opportunities due to creation of agriculture industries
- Alleviate poverty
- Preservation of environment
- Create a background for sustainable development in agriculture sector.

9. Conclusion

From the discussions it is clear that land management and land fragmentation are directly linked with land administration, which could be handled carefully if a reliable cadastral data and information are available. Furthermore, the land consolidation programme cannot be handled by a single organization as it has a direct relation with number of organizations so the leading organization should also play a role of proper coordination. In order to increase the agricultural production and productivity, an appropriate land consolidation approach should be adopted depending upon the nature of the terrain.

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Assessment of Accuracy of IKONOS Image Map, Traditional Orthophoto Map and Conventional Line Map of Kathmandu Valley : A Pilot Study

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Abstract

IKONOS image mapping is being considered a possible replacement to the traditional mapping in many countries due to their ease of access to current data and their potential high resolution. Survey Department of His Majesty's Government completed traditional orthophoto mapping of all urban and semi-urban areas of the country. The 1:5000 monochrome orthophoto maps of Kathmandu Valley were completed in 2003. In 2002, as a test, production of a near natural colour Image Map at 1:5000 scale of a part of Kathmandu Valley based on IKONOS data was carried out. A conventional line map plotting of the same area at 1:5000 was also prepared. The objective of the pilot project was to assess the geometric accuracy and the information content of these maps. The details of the study and their results are underlined. The findings of the study helps to explain whether IKONOS image map can replace conventional orthophoto map at 1:5,000 for urban areas of Nepal like Kathmandu.

Keywords: *Orthophoto, Rectified image map.*

Introduction

Digital ortho-image maps based on satellite imagery are becoming one of the major sources of data for various GIS application especially in urban sector due to availability of high resolution imagery and related software. Also geo-referenced image maps may be used, because of short processing time required in producing an image map. The trend now is on the rise towards using such ortho-image if possible and also image maps (georeferenced but not ortho corrected) in certain context e.g. in plain areas.

Several studies are reported on the assessment of the spatial accuracy of IKONOS imagery. One such study indicates the suitability of IKONOS imagery for preparation of large scale (1:4800) topographic maps in terms of spatial accuracy, while the information content of such ortho rectified image maps is found to be slightly inferior to conventional line maps [2]. Considering the spatial accuracy and the spatial information content, it is indicated that IKONOS ortho rectified images conforms to 1:10000 scale topographic maps [3].

The purpose of this study is to assess the suitability of such image maps compared to conventional line maps and traditional orthophoto maps based on aerial photograph in terms of spatial accuracy and information content. The study however does not include the case of ortho-imagery. In addition the paper reports the accuracy test on traditional orthophoto map and line map both at 1:5000 scale.

Orthophoto and Traditional Line Map

Monochrome orthophoto maps at 1:5000 scale based on the aerial photographs of December 1998 at 1:15000 scale for urban areas of Nepal [7] were completed in 2003. Similarly, a vector map of a part of study area was compiled photogrammetrically at the scale of 1:5000 based on the same 1:15000 aerial photographs.

[Paper Presented at the 24th ACRS, Busan, Korea, November 3-7, 2003]

The Study

In the given context, the study looks into the spatial accuracy of rectified (not ortho rectified) IKONOS image map only of a nearly plain area, to see if avoiding orthorectifications in such area does not entail serious degradation in the spatial accuracy.

IKONOS Image Map

An IKONOS Geo product (10km x 10km) in UTM projection, WGS84 datum was rectified using existing GCP points. The nominal accuracy of the image was considered to be of 15 m on the ground without including the effects of terrain effects (90% confidence in circular error) [5]. The root mean square error (rmse) of the rectification was 1 m (1 pixel). The image was then resampled to obtain a rectified image in Modified UTM projection, Everest Spheroid 1830, the datum being used in Nepal.

The resulting image map along with the orthophoto map and the line map at 1:5000 scales were then tested by comparing against a set of 40 coordinate pairs of well defined points spread evenly in the map area (Fig. 1) measured in analytical plotter. The accuracy of the control

Fig. 1. Control points

The Result

Before analyzing the result, it should be noted that pointing the position of control points over the image map were found to be inferior to that over the orthophoto map owing to the resolution of the image. We estimated that the pointing accuracy was about three pixels. The pixel size of the IKONOS image map was 1 metre whereas that of the orthophoto map was of 0.5 metre.

The topography of the study area was partly hilly (approximately 25% of the area towards the northwest) and the elevation in the remaining areas ranged from 1280 metres to 1300 metres.

IKONOS Image Map

Considering all 40 points, as expected, the rmse was calculated to be 5.4 m which was significantly higher than the permitted value of 4.25 m for 1:5000 scale mapping [1].

Consequently, testing was done by removing nine points lying in and around the hilly areas in the north west part of the map and the resulting rmse was found to be 2.63 m (Table 1), which is within the permitted value.

This has suggested that the simple rectification process is not suitable for the areas having significant topographic variations; however, the process may be good enough for areas having little topographic variations. But considering the difficulty in pointing the control points as well as extracting the features from the image due to spatial resolution, the image map do not meet the expectation as from the conventional line or orthophoto map of the same scale. Nevertheless, the image map of plain areas thus produced may be of wider acceptance in the GIS community as against costly orthophoto generation using aerial photographs, owing to the ease in producing them and using them at least as a backdrop for further analysis and presentation.

Table 1. Discrepancy in x and y in metres

NR_	dx_I	dy_I	dx_O	Dy_O	dx_m	dy_m
1			0.72	0.31	0.30	-0.43
2			0.07	0.30	0.77	0.53
3	-3.90	0.07	-0.16	1.34	-0.52	1.18
4			-0.11	0.96	-0.51	0.02
5			1.26	1.49	0.84	-0.13
6	0.25	2.02	0.09	1.96	1.52	0.72
7	0.57	0.53	0.88	1.16	0.31	1.88
8	0.74	0.37	0.17	0.97	0.17	0.19
9	3.52	-0.83	1.56	0.76	1.34	0.26
10	4.38	-0.21	0.93	0.20	0.25	0.04
11	-0.35	-0.95	0.49	1.64	0.64	1.10
12	2.27	0.20	0.49	1.52	2.11	1.81
13	3.67	0.53	0.40	1.25	0.03	1.88
14	1.68	0.82	-0.11	1.14	0.62	0.41
15	3.67	-0.78	0.84	2.56	-0.25	2.37
16	0.34	0.25	0.00	1.21	0.71	0.32
17	0.70	1.07	-0.03	0.57	-0.39	0.32
18	0.55	0.25	-0.65	1.11	-0.30	1.27
19	1.00	-1.37	-0.14	0.61	0.55	0.77
20	0.32	-0.60	-1.00	0.73	-1.55	-0.78
21	-1.02	-0.42	0.41	0.77	-0.23	0.31
22	-0.80	0.50	-1.27	-0.13	-1.27	-0.95
23	-1.11	-0.39	-0.04	1.36	0.67	-1.12
24	-1.68	1.32	-0.43	0.71	-0.43	0.71
25	0.50	0.50	0.67	0.97	1.17	-1.36
26	-0.63	2.40	0.30	0.30	0.71	-0.66
27	-3.55	0.76	-0.92	1.09	-0.70	-0.02
28	-2.92	1.87	1.37	1.17	0.24	-1.27
29	-4.73	0.46	-0.28	0.48	0.39	-0.30
30	-2.50	2.59	-1.16	-0.05	0.46	-1.94
31			0.40	0.63	1.07	-0.53
32			-1.67	0.42	0.47	-1.44
33			-0.88	0.47	0.78	0.80
34	-1.74	2.84	1.10	1.63	1.10	1.63
35	-2.34	-0.44	-0.12	1.23	-0.12	1.85
36	-4.04	2.19	-0.45	0.87	0.69	0.58
37			-0.30	0.42	0.24	-2.42
38	-0.62	1.53	0.33	1.15	0.18	-1.26
39	0.36	1.33	0.58	1.77	-0.87	1.39
40			0.53	0.73	-0.15	0.73
	rmse=	2.63	Rmse=	1.32	rmse=	1.39

Orthophoto Map

One orthophoto map of the same area was also tested using the same procedure and the result was found to be much better. The rmse of 1.32 m (Table 1) suggested that the orthophoto map conforms to the standards [1].

Line Map

Similarly, the result (rmse 1.39 m) of the test in case of line map (Table 1) was also found to be at par with the accepted standards.

Conclusion

Though orthorectification yields a better result in terms of spatial accuracy, the findings of the pilot study showed that in plain areas a simple rectification with carefully selected GCP also resulted in a suitable image map which could be useful for many GIS applications as it was found to meet the geometric accuracy standards. But, the information content may not be up to the requirement of 1:5000 conventional mapping compared to the orthorectified photo mapping at the same scale, as the latter possesses a superior quality in terms of geometry as well as information content. In spite of the reduced quality of such image in information content, rectified IKONOS image could still be a useful information source owing to ease with which such product could be generated at a lower cost and in a shorter time. Furthermore, when applications require a recent image or of a particular date, this is much easier and cost efficient compared to obtaining aerial photography.

The study also indicated that the conventional orthophoto map production and photogrammetric compilation of maps at 1:5000 scales as per the standard procedures established at the Survey Department; both conformed to the geometric accuracy standards of similar products.

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