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Features

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The front cover

Topographic map and Satellite image of Mt. Everest Area.

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Editorial

We have completed almost seven years of our journey of the publication of this journal, which is relatively a long span of time. During this period two issues were published as special issues: the second issue was on the 23rd Asian Conference on Remote Sensing held in Kathmandu and the sixth issue was on the occasion of Silver Jubilee celebrations of Survey Department.

As per the recent decision of the Survey Department, the Advisory Council and the Editorial board has been restructured. Editorial Board hopes for appropriate directions from newly formed Advisory Council. We are continuously trying to get as many new articles as possible for publication. In this respect, we are trying our best to motivate the esteemed authors as far as possible.

I would like to express sincere gratitude to Mr. Raja Ram Chhatkuli, Director General and Chairperson of the Advisory Council for his valuable suggestions. Similarly I would like to express my sincere appreciation to all the authors, members of the advisory council, members of the editorial board and to all who contributed towards the publication of this issue.

I would like to request all the readers to provide suggestions for the improvement of the journal and to provide quality articles in the coming issues.

Jagat Raj Paudel
Editor-in-chief

Message from Director General of Survey Department

This is a great pleasure to have the publication of this issue of the Nepalese Journal on Geoinformatics (NJG). Survey Department has been making this annual publication since 2002 and this current issue is the seventh in this series. These seven years have seen important changes in the development of the discipline of geoinformatics in Nepal. In 2002, Survey Department, for the first time, organized an international conference, Asian Conference on Remote Sensing (ACRS). Same year, National Geographic Information Infrastructure (NGII) was launched in the country with the active and pivotal role of Survey Department. Remote-sensing, GIS and numerical survey have been implemented as normal production line at the Survey Department. Since last year, Kathmandu University (KU) jontly with Land Management Training Centre (LMTC) has started Bachelor of Engineering (BE) course in Geomatics. A natural consequence is that the products and services of Survey Department and the science of geo(infor)matics, in general, have gained wider acceptance at home and abroad, and the Survey Department and its publication have gained greater popularity. The different issues of NJG have been witnesses to these important events.

This is in this perspective that Survey Department brings out this issue of NJG. Article related to the KU/LMTC course of BE Geomatics and several other topics related to the production of geo-data and application of geo(infor)matics from Nepal and abroad have been incorporated in this edition. I am confident that this Journal will help, to some extent, esteemed readers from the geo-community to raise awareness on the production and usage of geo-data in their decision-making. I look forward for their continuous support in bringing out the next issue in an even better format.

Finally I would like to thank the Advisory Council members, the Editorial Board members and the authors of the published articles for their cooperation in brining out this publication.

June 2008
Kathmandu

Raja Ram Chhatkuli
Acting Director General

Concepts towards cm-geoid for Nepal GPS to replace conventional leveling using airborne gravity

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Abstract

This paper gives the concepts of the principles of graimetric geoid and summarizes the airborne gravity survey and the determination of new national geoid for the height determination by GPS. The paper also deals with the technique of fitting the computed geoid model with leveling benchmarks and therefore improvement of the geoid will primarily be related to improvements in the vertical datum and GPS data.

Introduction:

Geoid is the shape of the earth that is described as the equipotential surface of the earth's gravity field; resultant of rotational and gravitational potential which fits most closely with the mean sea level, ignoring the long periodic effects of dynamic sea surface topography and it extends through the continents. The geoid is commonly used as the elevation datum to which topographic heights are referred. It is then referred to points on coastlines using tide gauges and relative to these points the orthometric heights of the topographic surface is determined using geodetic spirit leveling technique.

The Global Positioning System (GPS) can achieve height differences accurately to a few parts per million of observed base line length when used in differential mode. It is defined in Geocentric Cartesian World Geodetic System 1984, which is in practice identical to the Geodetic Reference System 1980 (GRS 80) ellipsoid (Moritz, 1980a). Now in order to convert GPS derived geometric height differences into the physically relevant orthometric heights, an accurate knowledge of the position of the geoid relative to GRS 80 is required. If the gravimetric geoid is of sufficient precision, then GPS has the potential to be used as a rapid and cost effective alternative for geodetic sprit leveling orthometric heighting.

In addition to the geodetic application, the geoid contains other valuable information of the Earth's geology and geophysics. The geoid is an equipotential surface in the earths gravity field, and thus a complicated surface, the shape of which is the determined by the earth's mass distribution. Geoid heights are produced by sub-surface density excesses, and lows correspondingly by deficiencies. Hence by identifying the short and intermediate wavelength trends and features in the geoid, the shallow geological structure can be deduced.

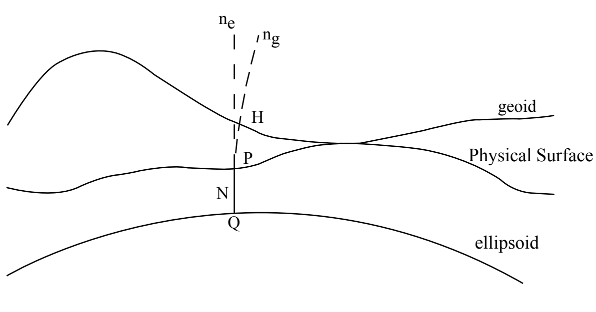
Geoid height with GPS and geodetic leveling :

Here we discuss in relation to quantities such as geoid height, GPS derived geometric height and physical height derived from geodetic leveling. We therefore have a means of determining GPS derived geometric height, also called ellipsoidal height, relative to the GRS 80 reference ellipsoid (h) and the orthometric height (H) relative to the local height datum. The datum equipotential has been defined by mean sea level, which is assumed to be the geoid. This assumption is very important. If it is true then only the network defines the geoid relative to the Earth's physical surface otherwise the datum is not the geoid but another non-parallel equipotential surface. For the case of Nepal, the datum of heights is determined by the Bay of Bengal; this differs from the global average height of the ocean by the local sea-surface topography, which can be up to 1 m or more depending on region.

The difference between the ellipsoidal height and the orthometric height gives the geoid height relative to reference ellipsoid. Therefore the simple equation is

$$N = h^{GPS} - H \qquad (1)$$

All the three quantities have the same unit. Studying in depth we find that the orthometic height is measured along the plumbline, whereas, the ellipsoidal height is measured along the ellipsoidal normal and the two do not coincide. The linear approximation must be extended between the geoid and physical surface of the earth.



Relationship between geoid and ellipsoid quantities

Figure 1

This is validated in the same way as was done between the ellipsoid and geoid. The discrepancy of ~ 2ppm is negligible compared to the uncertainty in either GPS derived or orthometric height can be ignored. Therefore, GPS in conjunction with geodetic leveling can provide geometric estimates of geoid height at discrete points to control the gravimetric geoid. However, it should be remember this control refers to the local sea-level height datum.

Gravimetric determination of geoid :

From the fundamental equation of the physical geodesy the gravimetric geoid height N is determined by Stokes' equation which gives the expression of the geoid height N as an integral of gravity anomalies around the earth (σ)

$$N = \frac{R}{4\pi\gamma}\iint_{\sigma}\Delta g S(\psi)d\sigma \qquad (2)$$

where Δg is the gravity anomaly, R the earth radius, γ normal gravity, and S a complicated function of spherical distance ψ (Heiskanen and Moritz, 1967). In the practical determination of gravimetric geoid, the solution is typically split into three components such as:

$$N = N_{GM} + N_{DEM} + N_{gravity} \qquad (3)$$

Here the first part is the global field, coming from a spherical harmonic expansion of the geopotential. The global spherical harmonic solution is found from the a set of spherical harmonic coefficients C_{nm} and S_{nm} by

$$N_{GM} = \frac{GM}{R\gamma}\sum_{n=0}^{N}\left(\frac{R}{r}\right)^{n}\sum_{m=0}^{n}(C'_{nm}\cos m\lambda + S_{nm} snm\lambda)P_{nm}(S\sin\phi) \qquad (4)$$

Where C' indicates that the ellipsoidal part of the coeffecients (primarily due to the earth's flattening) has been removed. The current model in global use is EGM96 and in this model of the geopotential from analysis of satellite data and global mean gravity anomalies are used. e.g. for the current global model EGM96 (Lemoine et. al., 1996).

$$N_{EGM96} = \frac{GM}{R\gamma}\sum_{n=2}^{360}\left(\frac{R}{r}\right)^{n}\sum_{m=0}^{n}(C'_{nm}\cos m\lambda + S_{nm}\sin m\lambda)P_{nm}(\sin\phi) \qquad (5)$$

Here the spherical harmonic coefficients Cnm and Snm for EGM96 complete to degree and order 360 define the long wavelength gravity field (degree 360 corresponds to a resolution of 55km). The online information on EGM96 can be found at www.nga.mil. Correctly a new global model EGM08 is being prepared in cooperation with the International Association of Geodesy; this new spherical harmonic model will have a maximal degree of 2160 (5' resolution), and global data collection activities are ongoing to support this model development, including the planned airborne gravity survey of Nepal, which is primarily supported by NGA.

The second part is the contribution from the local topography. This data is the digital elevation models (DEM's), which provide details of the gravity field variations in the mountainous area. The mass of the mountains can change the geoid by several 10's of cm locally. The handling of digital elevation may be done by analytical prism integration assuming known rock density (Forsberg, 1984). On the global scale, the recently released Shuttle Radar Topography Mission (SRTM) data means that 100 m-resolution DEM's are globally available; therefore geoid determinations in mountainous areas are much improved by these data, especially for the short wavelengts.

The third part is residual contribution from local terrestrial gravity. In the process of determining the gravimetric geoid the computation of gravity anomaly (Δg) which is the difference between observed gravity at the earth's surface reduced to geoid and the normal gravity on the reference ellipsoid. This (Δg) is used in Stokes' formula given by e.g. (2) in the evaluation of the geoid height. If the distribution of the local terrestrial gravity is sparse, then airborne gravity can be used to densify the gravity values in a most efficient way. Airborne gravity has only recently been operational, mainly due to the developmentes in precise kinematic GPS positioning of aircraft.

Finally the data from the spherical harmonic models, local or airborne gravity and DEM's the gravimetric geoid is constructed by remove-restore techniques as the sum

$$N= N_{EGM} + N_{gravity} + N_{DEM}. \qquad (6)$$

To be consistent with GPS and local leveling system, a correction between the global and local vertical datums must be made: In principal N_{GPS} = N (gravimetric geoid heights). But we find,

$$N_{GPS} = N + \varepsilon \qquad (7)$$

Where "ε" the GPS corrector surface taking into account datum difference and possible error in GPS, spirit leveling and gravimetric geoid "N".

In practice"ε" in determined by fitting the gravimetric geoid at points with coincident GPS and leveling; in these points "ε" can be directly determined by

$$\varepsilon = N_{GPS} - N = h_{GPS} - H_{leveling} - N \qquad (8)$$

and "ε" then interpolated to other points by least square collocation.

Test result of GPS derived and leveled height :

The initiative was taken in order to study agreement of heights derived by GPS and leveled heights in Nagarkot area in the course of conducting the detail survey.

$H = h^{GPS} - N$ (H derived from GPS using global geoid height)

H' = orthometric height from geodetic leveling

Leveled height were provided to all the third order GPS points and newly established traverse points. Results are given in table below.

TABLE 1

ST.	PLACE NAME	ELEVATIONS			DIFFERENCES	
		GPS (DERIVED HT.)	LEVEL (MSL HT.) (H)	ELLIPSOID HT. (WGS-84) (h)	GPS-MSL)	(MSL-WGS84) (N)
001	ARMY CAMP T3	2085.488	-	2057.592		
002	ARMY CAMP T2	2085.537	2085.482	2057.643	0.055	-27.839
003	STONE T1	2117.621	-	2089.706		
004	STATION A	2066.951	2067.093	2039.051	-0.142	-28.042
005	PANICHAURE	2099.917	2099.930	2072.014	-0.013	-27.916
006	DEVI DHUNGA	2104.682	-	2076.776		
007	GHIMIRE GAUN	2060.424	2060.460	2032.478	-0.036	-27.982
008	GENERATOR HOUSE	2088.252	2088.279	2060.322	-0.027	-27.957
009	PHULCHWOKI DEVI	2130.784	2130.767	2102.865	0.017	-27.902
010	GUEST HOUSE	2125.107	2125.091	2097.182	0.016	-27.909
011	GUARD HOUSE	2131.064	2131.120	2103.139	-0.056	-27.981
012	LABORATORY	-	2151.711	-		
013	OBSERVATORY HOUSE	-	2154.422	-		
014	OBSERVATORY HOUSE	2154.285	2154.268	2126.344	0.017	-27.924
015	HELIPAD	2158.724	2158.721	2130.780	0.003	-27.941
016	MAHADEV POKHARI	2138.646	2137.630	2110.692	0.016	-27.938
017	TOWER S/W	2145.799	2145.736	2117.837	0.063	-27.899
018	TELICOMUNICATION (T5)	2098.850	2097.813	2070.826	1.037	-26.987
019	TELICOMUNICATION (T4)	2092.655	2092.340	2064.626	0.315	-27.714
-	TOWER 1/157	2165.394	2165.358	-	0.036	
-	DOPPLER POINT	2151.722	2151.787	-	-0.065	
-	TRACKING STATION	2151.780	-	2123.827		

Interesting result is seen. The difference between GPS derived orthometic height using global geoid model and MSL height is observed. The difference is only in the centimeter level in most of the points where as in some points result agreed in the millimeter level. The difference between the MSL height and WGS84 ellipsoidal height, i.e. geoid height, is found to be around 28 meter in this area. The negative sign indicated that geoid in this area is 28 meters below the mathematical surface WGS84 ellipsoid. Thus in a local area GPS is already now useful for determine heights.

Gravimetric geoid information of Nepal:

A geoid NEPAL97 for the whole of Nepal was computed using material (GPS, leveling, gravimetry) collected over many years in both East and West Nepal. The technique used was "GPS-gravimetric": First a gravimetric geoid was computed using geopotential theory (the Molodensky approach). Then, this geoid was "fitted" to a set of given geoid undulation values obtained from GPS heighting and (classical as well as trigonometric) leveling.

The reference surface obtained this way is a regionally GPS-adapted geoid, i.e. a representation of an equipotential surface near sea level, inside the topographic rocks, which is consistent with the existing Nepal height datum. This means that it can be used together with orthometric heights, as have been traditionally used in Nepal.

The datum of the computed geoid is the *Nagarkot* datum, i.e. in Nagarkot (GPS40) the geoid height is assumed 0.0 m and its height above the reference ellipsoid (GRS80) as determined by GPS is assumed equal to its orthometric height, 2151.78 m. Therefore GPS measurements should be transformed to this datum by adding a constant to all height values *h* before its is attempted to compute orthometric heights from them using NEPAL97 geoid. For the GPS measurements in Eastern Nepal, such a translation had already been made; for the Western Nepal measurements, 22.733 m has to be added (Definition of gravimetric geoid Vol. III)

Determination new gravimetric geoid by airborne gravity measurement:

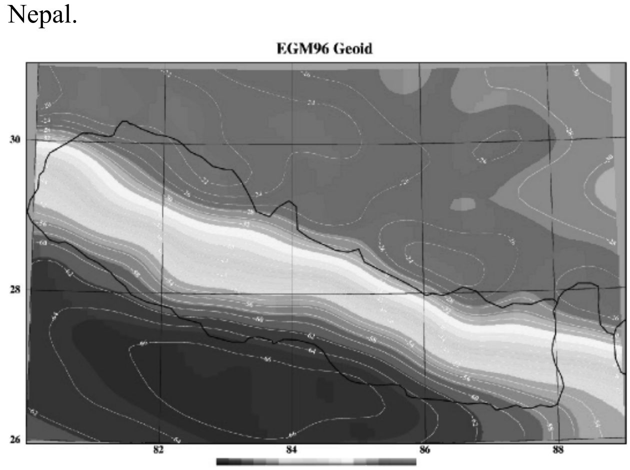
A cooperative venture/assistance programme to allow height determination accurately by modern satellite survey methods in Nepal, and increase scientific research in the field, by Survey Department/Geodetic Survey Branch and The Danish National Space Center is expected in near future. This would foremost involve a complete coverage of Nepal with airborne gravity data, including data in the high mountain regions, where little gravity data exists, and thus makes geoid prone to errors. Cooperation will also involve utilization of new satellite gravity fields, derived e.g. from GRACE.

The new airborne gravity survey is planned for November 2008, and an accuracy of 2 mgal is expected, corresponding to geoid errors at 5-10 cm over most of Nepal.

A very special application of the geoid would be to determine the real height of Sagarmatha/Mount Everest. In recent years we have seen several international press releases of GPS projects on the mountain, none of which have been able to address the geoid issue of this region. If this project is implemented it would settle these issues and likely generate further media attention by providing a much more accurate height for the world's highest mountains.

Challenges in geoid determination:

The geoid of Nepal is incredibly rough due to the Himalayas, and the complex geology of the region. A rough estimate of the geoid is provided by global models (EGM96), based on satellite information and the sparse available gravity survey data, and shown below. The geoid is only known to an accuracy of a few meter generally in Nepal.



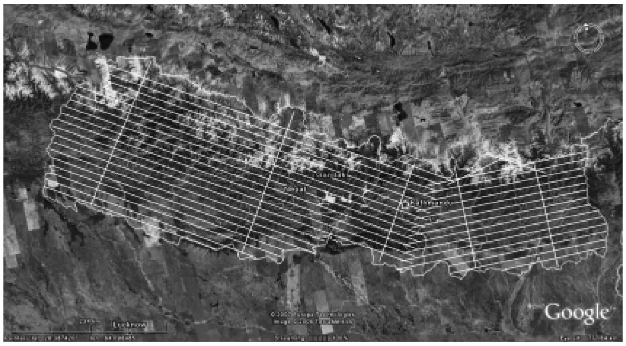
Global geoid of Nepal, 2 m contour interval. Geoid is height of sea-level above GPS reference ellipsoid.

To improve the situation the following data are needed:

- Additional gravity data, to be provided by *airborne gravity measurements.*
- *Digital height data* of the topography (from recent Finnish-Nepalese mapping projects and the recent

US satellite radar topography mission SRTM).

- *GPS observations* on levelling benchmarks of the existing Nepal height network (restricted essentially to the lowland and central valley along roads).



Planned airborne tracks (10 km spacing) of the airborne gravity survey.

Mixing of all these data for the best possible result represent a major scientific challenge, and the Nepal geoid determination might produce global interest for physical geodesy research. It is planned to do the Nepal geoid by the method of least-squares collocation for downward continuation of airborne data and merging with existing surface data; by spherical Fourier transformations (Forsberg and Sideris, 1993); and by using analytical prism integration for the best modeling of the topographic effects on the geoid.

Conclusion and recommendation:

Fundamental geodetic networks are needed for general mapping, environment, development of communication system, irrigation, water supply and hydropower as well as study the crustal dynamics. Measurement of heights was carried out in Nepal by traditional methods of leveling. Because of the topographical irregularities of Nepal, measurement of heights are traditionally a very complicated and time consuming techniques.

Modern geodetic satellite positioning by GPS, survey operations have become much more efficient and accurate. Heights can, however, not be obtained directly from GPS measurements. But in the present context one of the main objective in using GPS with full potential is replacing the geodetic spirit leveling by GPS measurement.

The main practical goal of this project will be a determination of new national geoid of Nepal – consistent with older measurements – accurate at the cm level or better over the main important areas of the country.

Then national height system of Nepal will be much improved if surveys can be carried out using modern satellite techniques. New technique of airborne gravity/ GPS surveys can be used to determine the precise Geoid of Nepal. Precise Geoid is used for defining the height datum of a country and investigations towards the geophysical changes as well as for the strengthening, supplement and expand the existing geodetic control network system of Nepal. In this context Surey Department will take necessary steps regarding this project, and enter the international cooperation.

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2007-2008 at a glance

1. Radio broadcasting on surveying and mapping activities of Survey Department

A radio program Hamro Jamin Hamro Napi has been on the air to make aware the general public about surveying and mapping activities of Survey Department. The program broadcasts from Radio Nepal on 1st and 3rd Thursday of every month at 8:15 pm to 8:30 pm.

2. Mini-Project training

Mini-Project training on " Flood Risk Assessment of Kamala River using GIS and Remote Sensing" was conducted at the Asian Institute of Technology, Bangkok, Thailand on September 2007 to February 2008. The project was completed in three phases in which the participants worked in the project at AIT from 9-29 September 2007 secondly field work was done in Janakpur area with an instructor from AIT on 5-12 October 2007 and lastly final analysis, report writing and presentation was done on 6-9 February 2008. Mr. Shijan Kumar Dhakal participated from Survey Department.

3. Fact finding mission from ITC

High-level fact-finding mission of ITC visited Survey Department on 18th April 2008. The members of the mission were Dr. Klaus Tempfli and Dr. A.M.Tuladhar. The mission expressed the ITC's interest to work in close cooperation with Survey Department to strengthen the land administration sector in Nepal. Papers were presented by Dr. Klaus Tempfli on behalf of ITC and by Tirtha Bahadur Pradhananga on behalf of Survey Department.

4. New leadership in Survey Department

Government of Nepal appointed Mr. Raja Ram Chhatkuli, the Deputy Director General a.i. of Topographical Survey Branch as Director General a.i. of the Survey Department. Mr. Chhatkuli assumed the Offfice of Director General on 14th May 2008. The staffs of the organization welcomed him as a new dynamic leader.

After taking charge of the Department Mr. Chhatkuli addressed the staff in the meeting hall of Survey Department. Mr. Chhatkuli addressed that his prime focus will be the institutional development and improvement of the performance by motivating the staff of the organization. He also stressed the importance of teamwork as the strength of the organization. Further more, he added that to develop the efficiency of the department co-operation from all sectors is a must and hopped that during his tenure, a better environment will be created in providing efficient and effective services to the stakeholders and general public.

5. New Geoid for Nepal

The State Geodesist Mr. Rene Frosberg from the Danish National Space Center visited Survey Department from 20th to 24th May 2008. The objective of the visit was to finalize the working procedure and develop a draft Memorandum of Understanding for joint cooperation with mutual discussion with the team members of the Survey Department. The discussion was chaired by Mr. Raja Ram Chhatkuli, Director General a.i. of Survey Department and other officers of the Department. The discussion took place in a cordial atmosphere.

Danish National Space Center is willing to support Survey Department of Nepal in establishing the National Geoid of the Country. A new geoid model would make it possible to use GPS for precise height determination. Determination of precise height will benefit the large engineering projects, hydropower, irrigation schemes etc.

6. Visit at Chinese State Bureau of Surveying and Mapping

Mr. Raja Ram Chhatkuli together with Mr. Durgendra Man Kayastha, Mr. Maheswor Prasad Bhattarai and Mr. Purna Bahadur K.C. visited Beijing China during 27-29 May 2008 as part of the Nepalese delegation to the Third Joint Inspection Committee of Nepal-China Boundary. During the period, the delegation visited the

Chinese State Bureau of Surveying and Mapping (SBSM) and held discussion on expanding future cooperation in the field of surveying and mapping between the two countries. The Chinese team was led by Mr. Li Weisen, Deputy Director General and also attended by several senior experts of SBSM.

7. Digital Cadastre works in Tikathali and Imadol VDC of Lalitpur district

Digital cadastral work was first implemented in ward No. 6 of Banepa Municipality. It was introduced in 2005 A.D. to prepare the cadastral database in areas having high land value. Due to its successful result the same methodology is in the implementation process in Tikathali and Imadol VDC of Lalitpur district. All the necessary prerequisites have been completed to conduct the digital cadastral work in these VDCs.

8. Support from Government of Japan in the infrastructure Development in the field of Cadastral Mapping

Government of Japan donated one hundred "Total Station" surveying equipments to Survey Department of Nepal to adopt the numerical cadastral system in the country. The equipment will help move from the existing graphical cadastral system into the numerical system and will support to keep the land records more efficiently and effectively in the country. The adoption of the numerical cadastral system will be a milestone in re-engineering the existing cadastral system for scientific administration and management of land records.

9. Computerized System in all the Survey offices in Kathmandu valley.

Survey office Dillibazar Kathmandu nitiated computerized system in service delivery in providing copy of the cadastral map and the field book from computer since 2006. Now all the offices of Kathmandu valley shall start the computerized system.

10. Issuing of Surveying and Mapping License

Survey Department issued the surveying and mapping license to 27 survey professionals on the recommendation of the Assessment Committee formed under Rule 27 of Land (Survey & Measurement) Regulations-2001. The scope of the work of the Licentiate Surveyors will be mapping and updating of the parcel, engineering survey, topographic surveying and mapping (except base maps of Nepal) and thematic surveying and mapping.

11 Survey Office Buildings under construction

Ten District Survey Office buildings are under construction according the programme of the Ministry of Peace and Reconstruction. Department of Urban Development and Building Construction under the Ministry of Physical Planning and Construction is implementing the programme

12. Surveying and Mapping work of lakes of Kaski district

To finalize the area of the lakes of the Kaski district and to find out the encroachment if any. Surveying and mapping works of the lakes was carried out by Survey Department .The lakes namely Fewa,Begnas, Rupa,Maidi, Dipang, Khaste, Kamal pokhari , Gunde and Neureni were surveyed and studied with the help of existing maps and documents like cadastral plan, orthophoto and maps prepared by department of Urban Development and Building Construction.. The Survey team has already submitted its reports to Pokhara Valley Town Development Committee.

13. Preparation of profiles and topographical maps.

As per request of Ministry of Culture, Tourism and Civil Aviation, Tourism Industry Division, Survey Department prepared profiles of mountain peaks higher than 5500 meters and topographical maps of Khumbu area of Mahalangur Mountain Range at the scale of 1:7500 and1:125000. Similarly field works for the preparation of above said maps of Phoksundo lake area of Kanjiroba Mountain Range was carried out.

14. Preparation of topographic maps for JPO-SKSKI

As per the Memorandum of Understanding between urvey Department and Joint Project Office- Saptakoshi-Sunkoshi Investigation, preparation of small-scale topographic maps by photogrammetric method and large scale maps by field survey method is under progress.

Effects of Urbanization on River morphometry: A case study for Nag River Urban Watershed using Geomatics Approach

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Key Words: Urban watershed, Basin, Drainage, River channel, Remote sensing

Abstract

Urbanization is responsible for the unexpected environmental degradation, which in turn has resulted in resource scarcity and damage to the towns and cities surroundings. Besides urbanization, the successive economic activities also exert tremendous pressure on the available limited natural resources. Especially in developing countries such as India, heavy urbanization has converted vast stretches of agricultural lands into built-up area, roads and other impervious surfaces, which obstructs water to get absorbed into the surface (UNEP 2000)

It is estimated that 75% of pollution loads of all the rivers in India is due to urban wastewater. Nagpur is one of the fastest growing urban city with multitude of problems cropping up over the period of time. The severity of the problem can be understood by the fact that growing urbanization has changed the morphometry of Nag River. In this case study for Nag River urban watershed, remote sensing & GIS technologies are utilized to understand the impacts of growing urbanization on the river morphometry.

Introduction

The study area is a part of Nag River watershed which lies between 21°07'- 21°10' N and 78°59'- 79°10' E. The study area covers the Nag River flowing from its origin in the eastern side of Ambazari Lake to Punapur village till it meets Pili River. For most of the course, the river traverses through Nagpur city urban area. (Nagpur Gazetteer)

For this case study, Nag river urban watershed has been selected, since the term "urban watershed" comes into picture. While studies on rural watersheds has been well taken care in many researches in the past, very less work has been done on urban watershed in Indian context. In such scenario of the growing urbanization in Indian cities, the water resources (surface & ground water) are facing the maximum pressure resulting in either water scarcity in summers or flooding due to heavy rainfall.

Also the factors affecting the urban watershed are precisely man-made features apart from other factors such as population increase, concrete encroachment of land, population pressure on existing resources, garbage dump in rivers (river pollution) etc. Turning of rivers into nallahs (heavily polluted streams) is affecting the watershed at micro-level, which indeed affects the sub-watershed of the river (Naomi et. al.). Nag river watershed is one such dynamic urban watershed, which has undergone a dramatic change in its morphometric characteristics in last few decades. It offers a good study environment to understand all the parameters & factors affecting an urban watershed in Indian context.

Methodology

Indian Remote sensing (IRS-1C) data is mainly used for the study, which is having a spatial resolution of 23.5 m for LISS III image (Fig. I) & 5.8m resolution for PAN image. Apart from this, requisite Survey of India (SOI) toposheets on the scale of 1:50,000 were used to prepare the base map of the study area.

Survey of India (SOI) toposheets & IRS-1C (LISS III & PAN) satellite images were georeferenced with UTM – WGS 84 (zone 44) projection and the required Nag river urban watershed was extracted based on the drainage pattern along with its tributaries and the contours.

Features extraction for contours, drainage pattern etc. was carried out from Survey of India (SOI) toposheets (1976). Then data fusion was performed on IRS – 1C (2003)

LISS III & PAN images to get a better high resolution image from which features of interest such as drainage pattern of Nag river & its tributaries were extracted. Finally a drainage analysis with emphasis on comparative study was carried out to understand the impacts of growing urbanization on the morphometry of Nag River.

Drainage analysis

The Nag river urban watershed area forms a part of Godavari river basin and Kanhan river sub basin, while topographically the area in general is gently sloping. The streams of the Nag River urban watershed area are dendritic to sub dendritic in pattern and are originating in western part of the area.

Morphometry

Development of drainage is the result of climate, lithology, structure and geomorphic processes. Occurrence of ground water and its recharge also depend on these factors. Defining the basin or watershed in quantitative term also help in understanding their functional relationship with runoff.

Basin order and stream order

The order of basin is the order of its highest-order stream. The Nag river urban watershed basin is of fourth order. For ordering the various streams in the basin, Horton - Strahler ordering scheme has been adapted. The orders of various streams and their lengths are computed and summarized in table I.

Number of streams and their orders

The number of stream channels of each order is expressed by a mathematical relation known as Horton's law of channels numbers, in which numbers of streams channels of each order from an inverse geometric sequence with order number.

Nw = R b (W- w)……………. (1)

or log Nw = Wlog Rb- wlog Rb……… (2)

or log Nw = a- bw…….(3)

In which a = w log Rb

B= log Rb

Nw = numbers of streams of order w

W= order of the basin

w= order of the basin

Rb = bifurcation ratio

And

Rb = Nw/ N (w+1)…………. (4)

This fourth order basin has a drainage area of 76.11 sq. Km. Fourth order represents the highest order of the stream in the basin. Ordering of basin shows that there is 1- fourth order stream, 3 - third order stream, 14- second order streams and 55-first order streams. Following relationship has been established for the basin:

Log Nw= 2.590-0.652 w (Where, Nw is number of streams of order w)

Bifurcation ratio (Rb)

The number of streams in each order is counted for the basin and bifurcation ratio, a relationship between the number of streams of one order to that of the number of streams in the lower order are computed.

According to Strahler (1952) the value of bifurcation ratio, higher than five, indicates structural control over the drainage network. In 1976, the average values of bifurcation ratio (Rb) for Nag river urban watershed fourth order basin was 5.46, which indicates complete structural control of the fracture zone over the Nag river drainage network. While in 2003, the average value of the bifurcation ratio (Rb) for Nag river urban watershed is 4.29, which indicates that only some portions of the major streams are controlled by the lineaments / fractures.

The change in bifurcation ratio (Rb) may be attributed to the growing urbanization, population pressure and lessening of existing land cover in the Nag river urban watershed. This average value of bifurcation ratio (Rb) indicates that on an average, there are about 4.29 times as much number of streams of any given order as that of the next higher order.

Length ratio

Length ratio is the ratio of the mean length of the stream of the next lower order. The variation in the values of the length ratio, for different stream orders within a basin indicates the relative permeability of the surface contributing to the drainage network of the basin.

The length ratio for Nag river urban basin has been calculated and presented in table III, which shows the length ratio for the Nag river urban basin for first, second, third and fourth order basin. It is evident from the values for Nag river urban watershed basin (1976) that the length ratio for the third order stream is higher than the length ratio for the streams of the other order. While the values for Nag river urban watershed basin (2003) indicate that the length ratio for the fourth order stream is higher than the length ratio for the streams of the other order. This fact indicates the permeable nature of the geological formation through which the third order / fourth order streams flow.

Similarly, when the length ratio of Nag river lower and upper basin were compared for 1976 & 2003, it is observed that very high length ratio 7.24 was noticed for the III order stream of Nag river lower basin (1976) as compared to 4.06 in 2003 which indicates that III order stream of Nag river lower basin was flowing through more permeable strata than of the III order stream of 2003 basin.

It is also seen from the table III that the average length of III order stream of Nag river lower basin is longer (9.5 Km - 1976) than the average length of III order stream of the lower basin (4.41 Km – 2003). Similarly, the average length of III order stream of Nag river upper basin is longer (4.14 Km - 1976) than the average length of III order stream of the upper basin (1.95 Km – 2003).

Drainage density [Dd]

Drainage density is defined as the total stream length cumulated for all orders in a basin to the total area of the basin. The drainage density is the measure of the texture of the drainage basin. Lithology, infiltration capacity, vegetative cover, climate, runoff etc. are the major controlling factor of the drainage density.

In bedrock areas, drainage textures and patterns depend among other factors, on the lithologic character of underlying rock and their structural disposition. Fine textured (high density) drainage over flat areas may lead to the inference that the underlying strata are impermeable and favorable for high runoff and erosion, thereby indicating poor infiltration possibilities.

The drainage density for the Nag river urban basin has been calculated and presented in table III, which shows that the drainage density values of Nag River Urban basin was high (1.12 km/km2 –1976), while it reduced to moderate (0.95 km/km2 –2003) which indicates its medium texture. Tendency of ground water contribution to the stream flow decreases with the increasing drainage density. The high value of drainage density in the study area for Nag river basin (1976) indicates moderate permeability and moderate relief for the area, while the moderate value for 2003 indicates more permeable zone.

Form factor [Ff]

The form factor is the ratio of basin area to the square of basin length. The form factor for the Nag river urban basin has been calculated and presented in table III, which indicates that the value for the Nag river upper basin has varied from 0.22 (1976) to 0.23 (2003), while the value for the lower basin has varied from 0.19 (1976) to 0.20 (2003) and the form factor for the entire basin has been found to be 0.183.

Shape factor

Shape factor is the ratio of basin length to the basin area. A square drainage basin would have a shape factor [Sf] =1, whereas the long narrow drainage basin would have a shape factor [Sf]>1. If a basin is long and narrow, then it will take longer for water to travel from basin extremities to the outlet. A compact basin is more likely to be covered by the area of maximum rainfall intensity of local streams.

The shape factor for the Nag river urban basin has been calculated and presented in table III, which indicates that the value for the Nag river upper basin has varied from 4.45 (1976) to 4.34 (2003), while the value for the lower basin has varied from 5.25 (1976) to 4.91 (2003) and the shape factor for the entire basin has been found to be 5.46, which indicates an almost compact elongated basin.

Circularity ratio [Rc]

The circularity ratio of basin is to the area of a circle having the same perimeter. The circularity ratio for the Nag river urban basin has been calculated and presented in table III that indicates that the values for circularity ratio vary from 0.41 to 0.51. The circularity ratio for the entire basin is found to be 0.41.

Elongation ratio [Re]

Elongation ratio is the ratio between the diameters of the circle having same area as that of the basin to the maximum length of the basin. The values of elongation ratio calculated for Nag river basin are tabulated in table III, which shows the variation from 0.49 (1976) to 0.51 (2003) for the Nag river lower basin, while it varies from 0.53 (1976) to 0.54 (2003) for the upper basin and the elongation ratio for the entire basin has been found to be 0.48. The values for circularity ratio and elongation ratio are more equal for lower basin and upper basin; this indicates the seasonal tend towards elongated shape.

Compaction coefficient

Compactness coefficient for a drainage basin is the ratio of basin perimeter to the perimeter of circle of basin area.

The compactness coefficient for the Nag river basin has been calculated and presented in table III, which shows that the values for compactness coefficient vary from 1.57 (1976) to 1.58 (2003) for the Nag river lower basin, while it varies from 1.40 (1976) to 1.41 (2003) for the upper basin and the same is found to be 1.57 for the entire basin.

Constant of channel maintenance [C]

The constant of channel maintenance [C] is the inverse of drainage density. In general, the constant of channel maintenance increases with the size of the basin. The constant of channel maintenance for the Nag river basin has been calculated and presented in table III, which indicates that the constant of channel maintenance for the entire basin has varied from 0.9 (1976) to 1.05 (2003).

The comparative values for Nag river basin indicates that 1.05 sq. Km (2003) area is required to support one km length of stream as against 0.9 Sq. Km. (1976) respectively. The relatively higher value of constant of channel maintenance for Nag river basin (1.05 Sq. Km) indicates more permeable geological strata.

Stream frequency [F]

Stream frequency is the ratio of the total number of stream of all orders with in a given basin to the area of the basin. The stream frequency for the Nag river basin has been calculated and presented in table III, which indicates that the stream frequency ratio for the entire Nag river basin has changed from 0.94 (1976) to 0.96 (2003). The lower stream frequency for Nag river basin (0.96 / km2) indicates a gentle gradient and more permeable surface.

Length of overland flow [Lg]

As the rain falls on a drainage-basin surface, it flows down the slope towards a channel; the maximum length of this surface flow is called the "length of overland flow". The average length of overland flow is approximately one-half the average distance between stream channels. Since drainage density is the function of infiltration characteristics of drainage basin, it must be the length of overland flow.

The length of overland flow for the Nag river basin has been calculated and presented in table III, which indicates that the values for the entire Nag river basin has changed from 0.45 (1976) to 0.52 (2003). This value indicates slope of the channels and surrounding area is gentler in this basin.

Results & Conclusions

The cities grow with the migration of population from rural surroundings in search of fulfilling their food and other domestic needs, resulting major stress on the infrastructure. Hence their settlement and water supply in urban area is always one of the major concerns to the local civic authorities. Also, due to growing pressures and the complexities involved, little attention is paid during the city planning and respective management processes. (Sharifi 2002)

From the drainage analysis performed, It can be concluded that the morphometry of Nag River has been substantially altered in last 27 years; the major points of concern are the decrease in upper basin & lower basin area of Nag river, which in turn has resulted in the reduction of Nag river stream length by approx. 12 Km (Table II). Also, it has been observed that the ill-planned urban sprawl of Nagpur city has almost changed the Nag river basin and the sub-basins have changed most of the river morphometric properties.

Finally it can be concluded that Urbanization has caused an irreversible impact on Nag river natural drainage pattern and its flow impacted by the urban development. It is assumed that within the next few decades, more than 50% of India's population would be living in urban areas. Quality of life of majority of India's population depends on the existing environment within the cities. If development progresses in a planned manner, the adverse impacts on population and river properties can be minimized.

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Table I Drainage Characteristics of Nag River Urban Watershed

River Basin area	Order of stream	Total no. of streams (N)	Bifurcation ratio (Rb)	Total stream length (Km)	Average stream length Km	Length ratio (Rl)
Nag River (1976)	I II III IV	55 14 2 1	3.92 7.00 - - (Av. 5.46)	40.97 18.56 13.65 11.83	0.744 1.325 6.825 11.83	- 1.78 5.15 1.73 (Av. 2.89)
Nag River (2003)	I II III IV	55 14 3 1	3.92 4.66 - - (Av. 4.29)	29.0 17.2 8.42 17.81	0.527 1.228 2.806 17.81	- 2.33 2.285 6.347 (Av. 3.65)

Table II showing the Morphometric changes in the Nag River urban watershed, Nagpur during 1976 and 2003

Morphometric Parameters	1976	2003
Upper Basin Area (Sq. Km.)	13.66	13.48
Lower Basin Area (Sq. Km.)	21.65	20.44
Total Stream Length (Km)	85.01	72.43
Bifurcation ratio	05.46	04.29
Drainage Density	1.12	0.95
Constant of Channel Maintenance	0.90	1.05
Stream Frequency	0.94	0.96
Length of Overland Flow	0.45	0.52

Table III Drainage Characteristics of the Nag river urban sub-basins (1976 – 2003)

Basin area	Sub Basin	Total no. Stream (L) Km	Area of Sub basin Km2	Total stream length (Km)	Drainage density Dd = L/a (km/km2)	Elongation ratio	Form factor Ff = A/LW2	Shape factor FS= LW2/A	Circularity factor Rc=12.57 A/02	Compact less coeff. cc=0.2821 p/0.5 A	Const. of Chan-nmaint.	Stream freq. F=N/A (per km2)	Length of over land flow (km) Lg = ½ Dd
Nag 1976	Lower	41	21.65	40.5	1.90	0.49	0.19	5.25	0.41	1.57	0.53	1.90	0.95
	Upper	19	13.66	21.52	1.60	0.53	0.22	4.45	0.51	1.40	0.62	1.39	0.80
	Entire	72	76.11	85.01	1.12	0.48	0.183	5.46	0.41	1.57	0.90	0.94	0.45
Nag 2003	Lower	45	20.44	38.84	1.90	0.51	0.20	4.91	0.40	1.58	0.53	2.20	0.95
	Upper	15	13.48	17.85	1.30	0.54	0.23	4.34	0.51	1.41	0.77	1.11	0.65
	Entire	73	76.11	72.43	0.95	0.48	0.183	5.46	0.41	1.57	1.05	0.96	0.52

LISS - III Image showing Nag River Urban Watershed (2003)

IRS - 1C Satellite Image

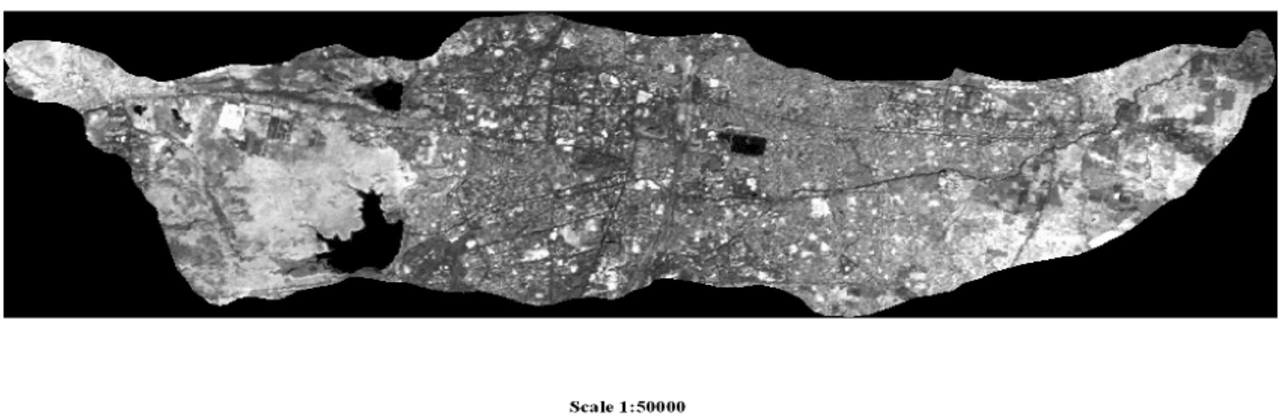

Fig I – Nag River Urban Watershed through IRS-1C LISS III Satellite Image

Obituary

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

1. *Late Mr. Mishri Lal Mandal - Survey Inspector*
2. *Late Mr. Bal Krishna Neupane - Accountant*
3. *Late Mr. Ganesh Kumar Bhandari - Amin*
4. *Late Mr. Bekharam Maharjan - Amin*
5. *Late Mr. Tej Narayan Chaudhary - Amin*
6. *Late Mr. Gyan Bahadur Khadka - Office Helper*
7. *Late Mrs. Manju Mandal - Office Helper*

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

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

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

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

Length of manuscript: Manuscript should be limited to 6 pages.
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Minor headings should be flushed with the left margin in Times New Roman "10" Bold font and with Upper and lower casings.

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Geomatics Engineering Education in Nepal

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Introduction

The training in engineering profession was started in Nepal about five decades back. Even though formal education in engineering profession started with BE in Civil Engineering in Tribhuvan University in 1978, the growth of engineering education has been since 1994 in both government and outside the government system. Kathmandu University started undergraduate program in Electrical & Electronics, Computer and Mechanical Engineering in 1994. It has been pioneer in starting these courses in Nepal and always providing students new career opportunities in the fields, which needs huge investment, physical resources and expert faculties. There are 28 institutions approved by Nepal Engineering Council (NEC) offering undergraduate level courses in 13 engineering disciplines in Nepal with annual intake capacity of 4297. Nepalese engineers are educated from more than 20 countries and 430 universities around the world. More than 9000 engineers in 42 different disciplines have registered to practice in Nepal and there are quite a many who are practicing without registration. But even this number is not enough for development of the country. The acceleration of economic growth cannot be achieved without engineering.

Government of Nepal is mainly responsible for surveying and mapping. The 50 years of periodic planning process in Nepal has witnessed the growth of Survey Department as a Cadastral Survey office to National Mapping Agency (NMA) to the hub of National Geographic Information Infrastructure (NGII) in Nepal (Chhatkuli, 2007). There could be the gap between the qualities of human resource needed to cope with the future challenges with existing human resource development mechanism. On the other hand, there may not be any more monopoly of government in mapping and geo-information sector. The previous influence of government at both strategic and operational levels has diminished, although there is still strong case for a strategic national government role in Spatial Data Infrastructure through coordination (Rajabifrad et al 2006). Realizing such future challenge, Kathmandu University and Land Management Training Center (LMTC) has collaboratively initiated and started new program Bachelor in Geomatics Engineering since August 2007 to produce internationally competent human resource.

Engineering Education at Kathmandu University

Kathmandu University (KU) was established in November 1991 as an autonomous, non-profit, non-government, public institution through private initiative. KU is committed to develop leaders in professional areas through quality education with the vision "To become a world-class university devoted to bringing knowledge and technology to the service of mankind". It is running more than 50 different academic programs from certificate level to PhD through six different schools. KU has produced 4906 undergraduate and 1017 graduate level specialized manpower until 2007.

School of Engineering at KU was established in 1994. It is offering BE in Mechanical Engineering program, Electrical & Electronics Engineering program and Computer Engineering program with 48 intake in each discipline annually. The graduate program in engineering was started in 2001. Until 2007, KU has produced 33 graduate and 833 undergraduate level engineers in these three engineering profession.

The universities in Nepal are offering undergraduate and graduate programs in engineering. Council for Technical Education and Vocational Training (CTEVT) offers most of the skill oriented training programs. Technical Education is always expensive, but the quality of the program cannot be compromised and diluted, because engineering profession is responsible for health and safety of society. Hence the curriculum of the program should be formulated in such a way that the program should be able to prepare engineers to meet the present requirement, ready to face challenges that may appear in future and should be of internationally acceptable standard. For this reason KU has adopted following procedure for finalizing its curriculum:

- Meta analysis of courses of same or similar program offered by universities and institutions around the world
- Organizing Curriculum Development Workshop by involving experts in the field of education, industry, business and other related area.
- By incorporating topics demanded by employer and market.

The engineering program of Kathmandu University is always focusing to produce engineers with one or more of the following qualities:

- Engineers who can make use of ultra modern technologies to become highly skilled manpower
- Engineer who can make use of natural resources efficiently and economically, especially in the rural communities of Nepal to become excellent social servant
- Engineers who can best manage human and material resource in production and service industry to become highly successful manager
- Engineers who can be creative in the profession and business and become entrepreneur to provide employment to many others
- Engineers who can develop new technology and system for the service of mankind and become leader in the society

Each of the above mentioned activities are equally important especially in case of Nepal. The country has developed confidence in producing such human resource in technical area and reduced dependence with other country. To achieve this, all the engineering program of Kathmandu University incorporates knowledge of basic sciences, engineering sciences, social sciences, management, practical technical skill, creativity, language proficiency and professional practice.

Geomatics Engineering

The technologies in the engineering discipline are developing rapidly. Even though traditional engineering disciplines are very essential for infrastructure development, the specialized area of engineering is also equally important for comfort, safety, accuracy and reliability. When population density was low, the importance of land was not that high because land was basically used for agriculture. Similarly prior to development of modern communication and transport facility, the knowledge of every part of the globe was not of much interest because of accessibility problem. But in today's modern life every human activity is associated with geo information and measurement science.

Geomatics Engineering is rapidly developing discipline. This is a term which is not found even in modern dictionaries. Geomatics is new term which incorporates the traditional "Surveying" along with other aspects of spatial data management. The spatial information, which is information that is referred based on location, is the primary factor for viewing and analyzing wide range of data. The development of information technology, digital data processing techniques and mapping technology has revolutionized the land surveying profession. The spatial information produced by this profession is vital for planning and decision making not only for government level, but also in community level and business society. Hence the profession of land surveying is converted and expanded to the profession of Geomatics Engineers.

Geomatics Engineers apply engineering principles to create spatial information and use relational data involving measurement science. Geomatics Engineers are special information engineers who manage local, regional, national and global spatial data. Even in Nepal, prior to seventies, land measurement was carried out by chain survey. It has been already changed now and Department of Survey has already established the National Geo Information Institute (NGII) and created huge digital resources in the country. Nepalese surveying professionals have to design, develop and operate system for collecting and analyzing spatial information about the mountains, land, natural resources and manmade infrastructures.

Both traditional and new disciplines of science and technology such as geodesy, cartography, digital mapping, remote sensing, photogrammetry, image visualization, geographic information system (GIS), global positioning system (GPS), computer aided design and drafting (CADD), land information system (LIS), land information management and so on fall under this discipline of Geomatics Engineering. KU was providing education in GIS to computer engineers since 1994 on technological perspective, but now with this new education program, the things will be looked in to application perspective. With the launching of Geomatics Engineering, there will be synergic effect in geomatics and informatics program of Kathmandu University.

The overall course structure of Geomatics Engineering is shown in figure 1. More than 40% of the courses are on Geomatics Engineering and among 16% practical oriented courses, it is mostly related to Geomatics Engineering. The foundation of geomatics engineers are prepared strong with 15% courses in basic science and 18% courses are interdisciplinary engineering courses, which prepares them to cope with all other engineering challenges and make them comfortable to work with other engineering team. Geomatics Engineers in no way should be inferior to the existing Senior Surveyor. Hence there is strong field survey training of total 18 weeks (which is equivalent to full 1 semester load) in five parts in the program.

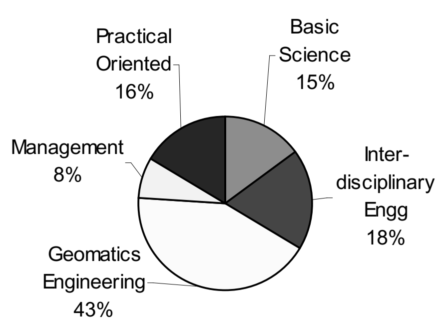

Figure: 1

Challenges and Opportunities

There are only 4 survey engineers who have registered in Nepal Engineering Council. Land Management Training Center (former Survey Training Center) under Ministry of Land Reforms and Management has so far produced about 5000 survey professionals of different levels since its establishment in 1968. School of Geomatics and Himalayan College of Geomatic Engineering and Land Resource Management has also initiated programs in related field in private sector. Mainly survey professionals of Nepal are getting higher degree from abroad. In such situation, Land Management Training Center and Kathmandu University has joined hand to initiate quality education in undergraduate and graduate level in this field in Nepal itself.

Several universities around the world have Geomatics Engineering Departments and offering courses in Geomatics. Conventionally this curriculum is administered by Civil Engineering in most of the universities and also considered as specialized area of Civil Engineering. The Ministry of Land Reforms and Management realized the need of professional with better skill and knowledge in the survey field and requested Kathmandu University to support them to change Senior Surveyor Training (16 months course after BSc) to academic engineering degree. Kathmandu University and Land Management Training Center in Dhulikhel are neighboring institutions. These two institutes have now lunched joint program in BE in Geomatics Engineering since August 2007. Government of Nepal is providing financial and human resource support for this program through Ministry of Land Reforms and Management for 7 years (at least 4 batches). The physical and laboratory resource of the center will be used for teaching this course while resources of Kathmandu University will be used for basic science and engineering courses. The experts from government, private consulting companies, INGOs and other institutes have contributed to design the courses. This course will have common engineering pattern of Kathmandu University, which includes courses of basic science, engineering knowledge & skills, managerial competency and specialized knowledge in the subject area. This is a joint effort in the country of two pioneer institutes KU and LMTC to produce highly skilled professionals. The engineers produced from this program can get job in government, infrastructure development projects (such as roads, irrigation, hydropower and housing), NGO/INGOs, development agencies and consulting firms. There is also growing demand of this profession in international job market. Moreover it is believed that these engineers will create opportunity for them by themselves.

This program is one of the unique programs in South Asian region. Kathmandu University has started bringing international students in Nepal for higher education. This could be one area where we can bring the international students for higher education because we have a nature that gives all the challenges for survey and mapping starting from Terai to Himalayas.

If information technology industry cannot develop in faster pace in the country, that could be hurdle for speedy growth of Geomatics Engineering. Since it is first ever program in the country, it takes time to prepare Survey and Mapping professional for changing need of Geomatics Engineering.

Student attraction

There is a great response from the student community for this newly offered engineering program. Out of the 10 undergraduate programs offered by Kathmandu University in science and engineering, Geomatics Engineering was second highest demanded program and it was a first priority among engineering program (Figure 2). Out of the 917 applicants, 372 candidates have shown interest in Geomatics Engineering for the total 24 seats available. The distribution of interest of priority for this program is shown in figure 3. Students admitted in this program have got good academic records. This is an opportunity for survey professionals in the country to nurture this young talented group and prepare them for upcoming challenges.

Overall female to male student ratio in Kathmandu University is 40:60, but this trend is not encouraging for gender balance in engineering program. There is a same reflection in total applicant of the geomatics program as 10:90, but there is only 1 girl student who got admission in a group of 24 students. Hence there should be effort for promoting this program in under privileged sections of the society.

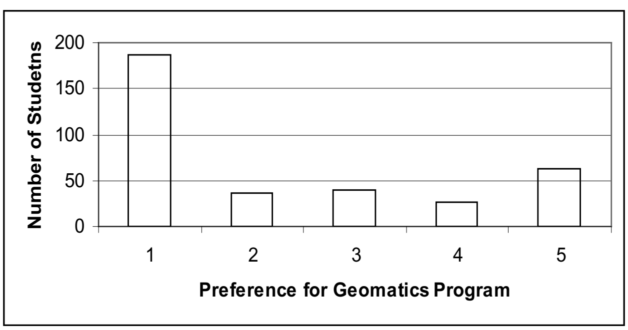

Figure: 2

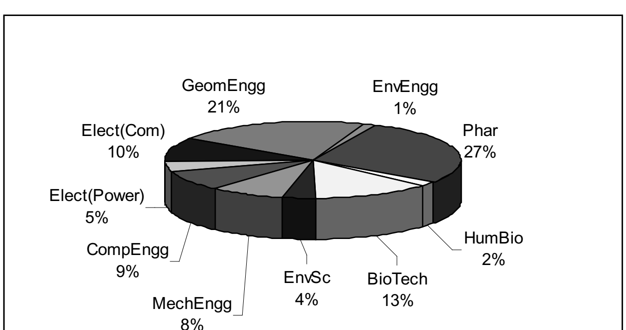

Figure: 3

Conclusion

This new innovative joint academic program of Kathmandu University and Land Management Training Center is leapfrog step of public private partnership in higher education. This program will create many new opportunities for Nepalese in the future and contributes for scientific geo-information system in the country. There is a great appreciation of all sectors of society for this novel endeavor, but it is a responsibility of the professional working in the field to make it world class and make it successful. There will not be any compromise in quality in any corner of the program. Hence it needs incubation care for some time. There is a great interest of Nepalese youth in the program. This is not only due to financial subsidy in the program, but Nepalese student, nowadays is taking more risk for new, challenging and creative things rather than conventional activities. It could be great opportunity for Nepalese youth to establish themselves in the field of geo-information and geo-science.

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Institutional and Legal Aspects in Land Disputes: the Context of Nepalese Cadastral Surveying

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Key Words: Cadastral Surveying, Land Administration and Management, Institutional Aspect, Legal Aspect, Land dispute

Abstract

Cadastral Surveying is the foundation of land administration and management activities in Nepal. The country has nationwide coverage of cadastral surveying achieved by conducting systematic cadastral surveying from 1964 to 1997. Cadastral re-surveying has been initiated since 1994. Some of the cases of land disputes that exist in Nepalese society are due to inadequacy of cadastral surveying activities in various aspects, institutional and legal aspects are two of them. Some weaknesses of existing institutional set up and legal framework that are influencing the attempts to resolve the disputes such as limited authorities to the organisation involving in systematic cadastral surveying, lacking proper coordination among the district level stakeholder organisations, lacking proper mechanism for bridging the incompleteness of cadastral surveys conducted by commissions/committees, lacking comprehensive legal documents, ambiguous legal provisions, etc have been pointed out in the paper.

1. Background

As the agriculture sector deserves a major contributor of the national economy, land is the most important asset for Nepalese people. The value of land is increasing day by day. With the increase in land value, landowners are seriously concerned over the boundaries of land they own and various kinds of land disputes are seen in the society. Most of the cases of land disputes come across while dealing with land business. The disputes have affected the efficacy of the land administration and management activities of the country. If the reasons of disputes are not identified in time, future will be more problematic.

Most of the cases of land disputes that exist in Nepalese society are resolved on the basis of cadastral maps and documents prepared by cadastral surveying. It has been experienced that some of the cases are due to inferiorities of cadastral surveying activities in various aspects. Institutional and legal aspects are the main concerns of the paper. The main objective of the paper is to present some weaknesses of institutional and legal aspects of Cadastral Surveying in Nepal, which are behind the cases of land disputes in the society.

2. Institutional Aspect of Nepalese Cadastral Surveying

2.1 Institutional Arrangement

Ministry of Land Reform and Management (MoLRM) is the responsible ministry for cadastral surveying and land administration & management activities in the country. Survey Department (DoS) and Department of Land Reform and Management (DoLRM) are the major departments having an involvement with cadastral surveying activities.

DoS, the National Mapping Organization (NMO) of Nepal, is responsible for carrying out cadastral surveying in the country since its establishment in 1957. There are two kinds of organisations working for cadastral surveying at district / local level: Survey Goshwara (Survey Party) (SG) and Survey Office (SO) under DoS. SG is responsible for carrying out systematic cadastral surveying whereas SO is responsible for updating cadastral maps and supporting land administration and management activities in the corresponding district. There are 9 SGs and 83 SOs throughout the country. SGs are mobile in nature, i.e. after completion of cadastral surveying in a district shift to another district, whereas SOs are permanent offices.

DoLRM is the department responsible for executing land administration and management activities in the country through Land Revenue Offices (LROs) and Land Reform Offices at district level. There are 83 LROs throughout the country that are supported by SOs at corresponding district.

In the mean time, several commission/committees constituted at different times for land distribution, establishing new settlements, and for other many reasons conducted cadastral surveys, sporadic in nature, on their own but with the involvement of technical manpower from DoS. Following section explains cadastral surveying conducted by SGs, SOs and Commissions:

2.2 Cadastral Surveying Activities

Cadastral Surveying by SGs

SGs prepare cadastral maps and related documents such as field books, land ownership registration books, and land ownership registration certificates, by conducting systematic cadastral surveying. Ownership on every parcel of the land is registered during the surveying. After the registration, a landowner is provided a land ownership registration certificate.

After the completion of cadastral surveying in a specified area, Land Ownership Register Certificates are handed over to respective landowner(s). Cadastral Maps and Field Books are handed over to Survey Office (SO) in the district. Similarly, the Land Ownership Register Books, Mishils, decision books and documents related to unresolved cases (if any) are handed over to Land Revenue Office (LRO).

Cadastral Surveying by SOs

SOs provide technical assistance to LROs for land administration and management activities within a district. The main responsibility of SOs is to update the Cadastral Maps prepared by SGs and other authorities (if available). Updating of fragmentation of a parcel, updating utility services mainly road network on cadastral maps, preparation of parcel maps etc are the technical works under the responsibility of SOs. Similarly, laying out of parcel boundaries on the ground based on cadastral maps, minor corrections to cadastral maps during land transaction are other responsibilities of SOs.

Cadastral Surveying by Commissions/Committees

Government constituted various political level commissions/committees in the past to deal with land issues such as distributing lands to land less people, establishing new settlements / resettlements, developing land etc. Sukumbasi Samasya Samadhan Aayog (Commission for Resolving Problems with Landless People), Basti Vikash Aayog (Commission for Town Development), Jhora Aayog (Commission for Jhora Land), Ban Sudhridhikaran Aayog (Commission of Strengthening Forests), Rara Rastriya Nikunj Basobas Byabastha Samiti (Committee for Managing Resettlement for the displaced families of Rara National Park)etc. are some of the examples of such commissions. These commissions/committees performed cadastral surveys around the area specified by the government, in the other words sporadic cadastral surveys, and prepared all the documents same as those by SGs. The process of handing over of the maps and documents is also similar to that of SGs.

LROs in Cadastral Surveying

The major responsibility of LROs is to facilitate land administration and management activities in the district. It has to deal with the unresolved matters handed over by SGs. LROs can make corrections to minor technical errors (if any) on the cadastral maps and conduct cadastral surveys of unmapped areas, if required, with the agreement from DoS.

2.3 Weaknesses of Institutional Aspect

Various cases of land disputes are seen during cadastral surveying or resurveying and land transaction. As discussed above, SGs, LROs and SOs are the main organisations at district level to look after the cadastral surveying and land administration & management activities. The cases of land disputes are dealt from these offices. Following are some major weaknesses of existing institutional setup:

1 Limited authorities to district level organisations involving in cadastral surveying activities, especially SGs, influence the effort for resolving some of the disputes. For example, SGs are not given following authorities:

   I. Corrections of errors on existing maps even though there exist evidences of errors

   II. Dealing with the cases left from commissions/ committees as mentioned in the above sections

   III. Establishing the actual location of public lands on newer map no matter where the location has been mentioned on the existing maps, in case of errors

IV. Full autonomy to register the unregistered land having sufficient proof of ownership

2. Lack of proper coordination among district level organisations involving in cadastral surveying, land administration and management, especially between SGs and LROs, is influencing effectiveness of cadastral resurveying activities.

   I. Customers say LRO officials are not in the favor of cadastral resurveying

   II. The publications issued from DoLRM are contradictory with that issued by DoS. There is a statement published on the website of DoLRM "The major issue in the Act (Land Survey & Measurement Act, 1961) is the provision of re-survey. This provision does not clearly state that the LRO should compulsorily accept the new records generated through re survey (http://www.landdepartment.gov.np/LAWS&ACTS.htm)". This statement has strong contradiction with provision of the act that after the submission of documents to LRO by SGs from cadastral resurveying, existing documents will automatically be cancelled.

   IV. By the provision of the act, LRO must provide all the documents related to landownership and transaction taken place of the concerned area to SGs during cadastral resurveying. This provision is further elaborated in the working manual issued by DoLRM as the record of transactions taken place should be sent to SG daily or weekly. In practice, it is never seen implemented in district level.

3. Sporadic cadastral surveying carried out by different commissions/committees to distribute land in the past has some incompleteness in documentation and processes. For example some people are provided land ownership certificate but no land to occupy, some have been allocated lands but the registration is incomplete, in some cases allocated land and occupation is quite different. Due to this reason, many people are suffering from various kinds of disputes. There is a lack of proper mechanism for bridging the incompleteness of sporadic cadastral surveys conducted by various commissions/committees in the past.

3. Legal Aspect of Nepalese Cadastral Surveying

3.1 Legal Framework

Land administration and management activities are governed by various laws and regulations in Nepal. About sixty acts and regulations have addressed land administration and management matters. Since land administration and management activities are followed by cadastral surveying activities, the surveying has affiliation with these acts and regulations in one way or another. Following acts, regulations, technical circulars and directives have major influence in cadastral surveying activities in Nepal.

Land (Survey & Measurement) Act, 1963 and Regulations, 2001

Most of the Cadastral Surveying activities are governed by Land (Survey and Measurement) Act, enacted in 1963, and corresponding regulations, enacted in 2001, in Nepal. Survey Department is given the major responsibility of carrying out cadastral surveys in the country. The Act states that the land records prepared by the survey are authentic. Once the records are handed over to the LROs and SOs, the existing records should be automatically replaced by the new ones and subsequent land administration should be based on the new records. So, the act has made provision for re-survey for updating the records and make corrections of errors of previous survey, if any exist (Paudyal, 2005). Corresponding regulations prescribe the procedures of implementation of the Act. (Adopted from Bhatta, 2005)

Land Revenue Act, 1977 and Regulations, 1979

Land Revenue Act, enacted in 1977, is the main act to carry out land administration including maintenance and updating records, collection of land revenue and settlement of the disputes after completion of survey and handing over of the records to LRO by the SGs. The act covers corrections of survey records, updating the records when transfer of ownership is held. It also authorizes LRO to correct the mistakes of Survey and register the land as a Chhut Darta. Corresponding regulations, enacted in 1979, prescribe the procedures of implementation of the act.

Working Manual of SOs and SGs, 2003

DoS has issued several technical circulars, directives and working manuals for SOs and SGs to carryout cadastral surveying in the country. These documents further elaborate the acts and regulations making the provisions easier to materialize. Important guidelines have been given to the officials involving in the activities of cadastral surveying. These are compiled in a book as Working Manual of SOs and SGS in 2003.

Land Administration Directives, 2001 and Land Administration Manuals

Land Administration Directives issued by DoLRM in 2001 includes directives for land administration activities carried out from LROs. This directive mentions the methods and processes to deal with cadastral surveys conducted by SGs and SOs. DoLRM has also issued Land Administration Manuals in three parts. These manuals provide step by step approach to deal with land administration activities.

3.3 Weaknesses of Legal Aspect

It has been experienced that available legal provisions, as mentioned above, are not in the state to address all the issues of the disputes. Even same is the case for the departmental circulars, working manuals and other publications. Some major examples of the weaknesses can be listed as follows:

3. Ambiguities and complexities in legal provisions influence the effective implementation of legal measures in reality. Some of them having major influences are as follows:

    10. Article 7 (1) of Land (Survey and Measurement) Act states that newer value of area of parcel should be registered during resurveying. It means the law has realized that existing maps might have errors or differences in occupation but it is not mentioned anywhere explicitly.

    11. Article 7(2) of the act prohibits the same case if the land adjoins any public or government land. This provision contradicts the realization of errors in previous maps

    12. The provision of Haal Sawik Bhidaune (matching the present situation with the existing maps and documents) in Land (Survey and Measurement) Act, on the other hand, contradicts the realization of the errors in existing maps

    13. There is a provision of registering unregistered land during cadastral resurveying, but it requires representation from many other different offices. Representatives from other offices are nonprofessionals and cannot contribute professionally in decision making. The provision only delays the process.

    14. In practice, the incompleteness of SGs (since SGs are mobile offices and sometimes incomplete cases could be submitted to LROs before shifting another district) are dealt by corresponding LROs in the district with the technical assistance of SOs but the provision is not addressed in any of the related acts

    15. There are some durations for notification to call for registration and for other reasons, but the duration are not practically feasible due to the nature of cadastral resurveying

1. There is a lack of comprehensive land law addressing all the issues of land disputes

2. There is no any legal provision to deal with the technical errors such as overlaps and gaps in existing cadastral maps, wrong mapping of public lands etc

4. Conclusions and Recommendations

4.1 Conclusions

Survey Goshwaras, Land Revenue Offices and Survey Offices are the organisations at district level to deal with cadastral surveying and land administration & management activities. Sometimes the district or regional level wings of the commissions/committees constituted by the government also deal with land related activities under their scope. About sixty acts or regulations govern these land related activities in the country. Land (Survey and Measurement) Act and corresponding regulations, and Land Revenue Act and corresponding regulations are widely used acts and regulations to deal with these activities along with some departmental circulars, working manuals and directives.

Since, land is the most important asset for Nepalese people its value is increasing day by day. With the increase in land value various cases of disputes with land boundaries and ownership over a land parcel are seen in the society. Cadastral resurveying has experienced many errors in existing cadastral surveys and incompleteness with the surveys conducted by commissions and committees time to time. Mismatching of cadastral maps with actual occupancy is one of the major factors causing land disputes. Although the piece of land surveyed during the original surveying is still there, the disputes come due to mismatching of the records and maps prepared by cadastral surveys. There are so many other examples of such cases of land disputes.

Thus, weaknesses in various aspects of cadastral surveying deserve some reason of land disputes that exist in the society. The two major aspects; institutional and legal aspects have been dealt in this paper. Weaknesses of existing institutional set up and legal framework are greatly influencing the attempts to resolve land disputes. Limited authorities to the organisation involving in systematic cadastral surveying, lacking proper coordination among the district level stakeholder organisations such as SGs, SOs and LROs, lacking proper mechanism for bridging the incompleteness of cadastral surveys conducted by commissions/committees, etc are some of the major weaknesses of institutional aspect of cadastral surveying in Nepal. Similarly, lacking comprehensive legal documents, ambiguous legal provisions, incomplete working manuals, lacking circulars on technically sensitive issues etc are some of the major weaknesses of its legal aspect.

4.2 Recommendations

A few recommendations have been listed as follows:

a) It is experienced that existing organisational structure formulated decades back cannot meet the customers' satisfaction with service delivery. Thus, timely organisational reengineering is a must.

b) District level organisations involving in cadastral surveying and land administration/management activities are lacking proper coordination as it ought to be, especially between SGs and LROs. Thus, a mechanism for establishing proper coordination among stakeholder organisations must be developed and enforced from the ministry level.

c) Sporadic cadastral surveying carried out by different commissions/committees has incompleteness in documentation and processes in some cases remained after the termination of its tenure. Thus, either SGs or if SG is not established in the district LRO and SO must be given the responsibility with full authority to deal with the situation.

d) Most of the cases of land disputes during cadastral resurveying are due to the provision verifying new maps and documents with respect to existing maps and documents, so called Haal Sawik Bhidaune (matching present real situation on the ground with existing maps and documents), as per the Land (Survey & Measurement) Act, 1961. Such ambiguities in legal provisions must be amended and explicitly defined provisions should be provided to the professionals involving in the cadastral surveying and land administration activities.

e) Various laws and acts govern land related issues. It has been experienced that in some cases the laws and acts contradict with each other. Organisations having similar status have dissimilarity in authority to deal with similar issues. Thus, a comprehensive integrated land law must be enacted and district level organisations should be given full authority to deal with land matters.

f) Cadastral resurveying is a must to overcome the weaknesses of existing cadastral surveying but the present approach of cadastral resurveying cannot meet the expectations. Thus, it must be conducted with modern technology and practical legal provisions.

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Licentiate Surveyor System in Nepal

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Nepal entered into licentiate surveyor system on 4 February 2008. Nepal Government Survey Department provided "Surveying & Mapping License" for the first time to twenty seven eligible Surveyors amidst a function. So this is a historic event for the land surveyors of Nepal and land-mark for the Department of Surveys as well.

If we recall the history of land surveying and surveyor's name in Nepal, parcel estimation with eye examination survey work was started in 1623 AD. Later on it was improved to measuring by bamboo rod. At that time the designation 'Chhyatrakar' was given for those who would measure open land and 'Takshhyakar' for built-up area. In due course, chain survey measurement system with parcel identification was started in 1852. And the Surveyor was named as 'Dangol.' They use to measure the land with the help of Chain. During 1906 military took over the work of land surveying. They started to work with the help of Trough Compass. So they were named as 'Compassay.' First Plane Table surveying was introduced in Bhaktapur in 1923, and the surveyor's name was changed to 'Amin.' They were helped by Chainman in the field for land surveying work. The name Amin was retained out for a long period, even after the implementation of revolutionary Land Reform Programme in Nepal in 1964. At that time cadastral survey system was improved and the supervisor was named as Settlement Officer. After the implementation of geodetic control point system in 1970 and establishment of topographical survey branch in 1972, various names had been emerged for the surveyors; such as Basic Surveyor, Assistant Surveyor, Surveyor, Inspector, Team Leader, Field Computer, Signalman, EDM Operator, Cartographer, Photogrammetrist, Aerial Photographer, GPS Operator etc. The supervisors were named as Survey Officer, Senior Survey Officer, Chief Survey Officer, Deputy Director General, Director General etc. These names are existed in these days as well. In short, basically they all belong to the designation of 'Surveyors'.

Who is a Surveyor?

It is necessary to know who is a surveyor and what does he do? A Surveyor caries out the survey and measurement of land and related objects. He uses to draw and establish land related data on paper and digital form as well. In the changing context of the world with the development of modern scientific technique, improved equipment and instrument; surveyor must have broader activities in relation to land surveying, measurement and creation of land data. In fact, surveyors are fact finders and providers of opinion and advice because they collect, process and establish data, which are generated from the actual field work.

The code of conduct provided by the Survey Department along with the license says- 'Licentiate Surveyors' are those, who have obtained license (permission) under the Article 26 of Land (Survey & Measurement) Regulations- 2001. At the same time, the Regulation has defined as- 'License' should be understood as letter of permission to work for survey and mapping in accordance with the Article 26 of the Regulations.

The International Federation of Surveyors (FIG) has defined- "A surveyor is a professional person with the academic qualifications and technical expertise to practice the science of measurement, to assemble and assess land and geographic related information; to use that information for the purpose of planning and implementing the efficient administration of the land, the sea and structures thereon; and to instigate the advancement and development of such practices." Practice of the surveyor's profession may involve one or more of the allocated activities which may occur either on, above or below the surface of the land or the sea and may be carried out in association with other professionals. In the application of these activities surveyors take into account the relevant legal, economic, environmental and social aspects affecting each project.

Licensing system

Licensing of the professionals is not a new phenomenon in the world. The first regulation of this type was contained in the code of laws of Hammurahi of Babylon in the eighteen century BC. But the code was something like 'eye for an eye and tooth for a tooth.' For example, a builder constructed a house that collapsed and killed owner; the builder would be killed. If the collapse caused the death of the owner's son, the builder's son would be killed and so on.

Regarding the licenses to the Surveyors and Engineers, it was started in 1907 in Wyoming. George Washington and Abraham Lincoln of the United States of America had possessed Surveyor's Licenses. Today surveying professionals of the developed countries of the world must obtain licenses before they practice land surveying and mapping. Singapore, Malaysia, Sri Lanka, Japan etc in the continent of Asia has introduced the system of licensing / registration of the surveyors. Now Nepal is also a country of licentiate surveyors. However, Nepal had started to issue license for the Lawyers on 29 October 1956 and Medical Doctors in 1964

Elements of a surveyor

It may be relevant to mention the elements of a surveyor in the context of licensed surveyor system. Surveyors and professional people have four basic elements i.e. education, organization, experience and exclusion. Education means obtaining of formal school degree and the completion of as many surveying courses as possible. Also it can be self-education and continuing professional development (CPD) for improvement of personal qualifications and skills by handling tasks and duties through a lifelong process of learning.

Organization means participation in a professional organization and membership of professional Associations, such as Nepal Institution of Chartered Surveyors, Nepal Surveyors Association, Royal Institution of Chartered Surveyors etc. Membership of such organizations may lead the surveyors towards obtaining the recognition and status of a true professional man. Experience is obtained over the years, undertaking specific tasks and it will be as a gradual transformation of knowledge with the solution of problems.

Exclusion is regarded as to avoid, unfit and unworthy activities which are restricted by the code of ethics or code of professional conduct. One has to bear in mind that there is always a possibility to be expelled from the registered licensed surveyor, if he/she had unethical behaviour and incompetence on the code of conduct.

In the bygone days land surveying was generally said to include the determination of area of tract of land, the surveying needed for preparing descriptions of land establishing or re-establishing land boundaries and the preparation of plots for land tracts and sub-divisions. In course of time with the development of new technology and equipment.

Licensing in Nepal

Licentiate survey system in Nepal is a need according to the pace of time. Because so many modern techniques and activities on surveying, mapping and creation of digital database are not untouchable to Nepal in the global perspective. And Nepalese mapping and geo-informatics system must have been adopted in relation to other countries, especially the SAARC nations. On the other hand, maps and digital data concerning to it, must be accurate, exact, standard, reliable and up-to-date. Licentiate system may help to develop further the mapping activities and establishment of digital database in Nepal according to the norms and standard set by the government.

The other fact is that in the developing world, especially the third world countries, government organizations may not cover all the developmental activities to be carried out, as per increasing demand of the society. In this context, the government organizations set forth the norms, standard and specifications and private sectors work accordingly. And government agencies supervise the quality of work. So it is a kind of co-operation and compliment to each other to develop the overall standard of the nation. This is applicable also in the field of mapping for development.

In this perspective, Survey Department has issued the surveying and mapping license on the recommendation of the Assessment Committee, formed under the Rule 27 of Land (Survey & Measurement) Regulations- 2001. It is mentioned in the recommendation that it should have to carry out the mapping and updating of parcels, engineering surveying, topographic surveying and mapping (except base maps of Nepal) and thematic surveying and mapping related activities by the Licentiate Surveyor. It has been mentioned the conditions of the Land (Survey & Measurement) Act-1963 and its Regulations-2001, while Survey Department provided the license. These terms and conditions are the code of conduct to the Licentiate Surveyors of Nepal.

Code of conduct

A professional surveyor must follow the code of conduct to make the mapping profession respectful, disciplined, reliable, and trust worthy. It is necessary to fit the Nepalese surveyor professionals into national and international level as per universally accepted standard in the context of increasing globalization and borderless opportunities. At the same time, it should be based on the statement of ethical principle and model code of professional conduct of International Federation of Surveyors (FIG). In the context of all these basic principles, some of the important conditions as 'code of conduct' provided along with the license (certificate) by Survey Department are as follows:

Ethical principles

1. Honesty and integrity:

- Surveyors must cultivate professional obligations to society and promote the surveying profession to clients and public.
- Measures accurately, record and interpret all data based on facts and figures with caution.
- Standard must be maintained within the limit of permissible error. Surveyors must clarify to the client, the possible percentage of correctness of his work.

2. Independence:

- Surveyors must work hard in relation to existing laws. Work must be carried out with legal submission and full dedication.
- He must be diligent, impartial, unquestionable and competent in his work, though no one can be perfect one hundred percent. He should not incline to any person or institution. Impartial and unbiased advice must be provided to the client or employer.
- He maintains the highest standard of honesty and integrity in ensuring that the information and data he provides are true and complete.

3. Care and competence:

- Surveyors work should be consistent in relation to knowledge and skill. Expertise should be utilized for the development of community.
- He should not accept assignment those are outside the scope of his professional competency.

4. Duty:

- Surveyor maintains confidentiality about private information of his current and former clients / employers / the public, unless to make disclosure by the law or client's permission.
- He avoids conflicts of interests and recognizes the interest of the public.
- Attention should be given to environmental aspect for all activities.
- Public interest should be identified in the context of services provided to the clients and employers.
- He must conduct work with due attention to the rights of all clients with the maximum capability.

Professional code of conduct

1. Generally, the licentiate surveyor must:

- Exercise impartial, independent and professional judgment.
- Not to accept assignment those are outside the scope of his professional competency.
- He must increase skill and knowledge with the continuity of professional development.
- He may employ the expertise of others when his knowledge and ability are inadequate for addressing specific issues.

2. Surveyor as an employer:

- Surveyors must be responsible on the work done by sub-ordinates.
- He must help to employees who are working under him, for their technical and professional development.
- Working environment and reasonable remuneration must be ensured for the employers.
- He should generate the sense of responsibility of surveying professionals, in addition to the honesty and reliability of employees.

3. When dealing with clients:

- Surveyors must not to show professional weakness.

- He should pre-inform to the customers, if there may be the possibility of disputes and conflicts.
- He must be careful with doubtful person or organization.
- He does not receive remuneration for one project from multiple sources without the knowledge of the parties involved.
- He maintains the highest honesty and trust worthiness, with whom they come into contact, directly or indirectly.

4. While providing professional services:

- Remuneration must be fixed on the basis of technical complication, level of responsibility and liability of services.
- Unofficial fees should not be imposed on account of the services provided.
- Detail breakdown of the fee should be provided, if the client requests.
- No maps, report and document should be certified, except it is prepared directly under own supervision and direction.

5. Surveyor as a member of professional institution:

- Licentiate surveyor must not employ who are under qualification.
- If he has some information on illegal activity done by others, he has to furnish that information to the professional institutions.
- No certification should be done to those, who are below standard in academic qualification, experience and character.
- He must enhance survey professionalism to all clients, customers and general people.

6. As a professional practioner:

- Surveyors must not express misleading statements in advertisement and commercial media.
- He must not disturb the prestige of surveying professionals directly or indirectly.
- He must not interfere and displace the work of other surveyors, who are in agreement with other customers.
- Branch offices should not be opened without the direction and management of responsible surveyors.

7. Surveyor as a resource manager:

- Environmental context should be addressed with sufficient understanding, hard working and honesty.
- He must have knowledge on various aspects of environment and principle of sustainable development.
- If the project has an effect on environmental impact, it must include its assessment, planning and management.
- Encouragement should be provided, if the exercises to environment conservation are in favour of the welfare of society.

Formation of institution

Nepal Institution of Chartered Surveyors (NICS) has been formed on 4 February 2008. It has been registered officially in the Government District Administration Office, Kathmandu on 9 May 2008. It is an institution of licensed surveyors of Nepal who have obtained license under the Article 11 (E) of Land (Survey & Measurement) Act- 1963. This institution has been registered for the well being of Chartered Surveyors, to make homogeneous in their works and to protect and expand their professional rights and welfare. NICS is dedicated and determined to follow up the code of conduct, norms, standard and specification set by the concerned government department and organization. However, main objectives of NICS are as follows:

1. To work for the professional rights and welfare in accordance with the professional ethical principle and code of conduct.
2. To help to attend the allocated accuracy of the work for all types of survey and maps.
3. Be ready for the services of nation and people.
4. To help to update and certify as necessary, the survey and maps prepared by various agencies and organizations.
5. To help to prepare maps and data in co-operation with Survey Department, various government and non-government organizations.
6. To help to perform accurate mapping works, for government, non-government and private organizations and agencies.
7. To extend help for the valuation of land and housing.
8. To assist to prepare cadastral, thematic, topographic,

engineering maps (except base maps) for the planning and evaluation of new programmes and housing development projects.

9. To help to generate employment and to create the condition of self employment.
10. To perform and to make performed activities for the welfare of the members of NICS.
11. To organize various seminar, conference, symposium and publish research papers.
12. To work jointly with national and international organizations, who have similar nature and objectives and obtain their membership, as necessary.

Last item

Each and every qualified surveyor should have been desirous to be a Licentiate Surveyor. Because he will be identified as legally appropriate person to perform the duty. Next, registration provides a person appreciated as a professional in the community. His work will be recognized as per standard set by the concerned government authorities. In fact, registration raises the status of a surveyor as a true professional. As a result, licentiate surveyor may be offered the job rather than an unregistered one. In this perspective, government departments and organizations should encourage the surveyor to be licentiated, so that they may provide services to the client, customer and general people in a legal and scientific manner with standard format. In addition, licentiate surveyor must hold the membership of Nepal Institution of Chartered Surveyors for the professional rights, welfare and duty. If the professionals be united, their voice for their welfare will be heard by the concerned authorities.

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5. Boundary of Nepal (in vernacular), Buddhi Narayan Shrestha, Bhumichitra Co. Kathmandu, 2000.

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Price of Aerial Photograph and Map Transparency

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

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

Price of Digital Topographic Data Layers

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

(A) Nepalese Researchers, Students, Government of Nepal Organizations, Non-Government Organization (Non-profit), Government of Nepal Affilated Institutions.

(B) Nepalese Private Company (Consultant, Contractors)

(C) Foreign Organizations (Consultants, Contractors)

Price of SOTER Data	Whole Nepal	NRs : 2000.00

Professional Organizations of Geoinformatics in Nepal

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Introduction

The Government of Nepal visualized a concept for building a new Nepal with good governance, and conceptualization of such thoughts needs relevant and reliable geo-information, and proper analysis of information is a key element to develop and design programmes for supporting the ideas. Geo-information can be made available through Geoinformatics field that encompasses the wider range of subjects such as Surveying and Mapping (including Remote Sensing, Photogrammetry, Geodesy, etc.), Geo Information Science (including Geography, Geology, etc.) and other related fields. Analysis of information requires efficient tools and techniques and the professionals involved in Geoinformatics field could recommend appropriate technologies and could extract fundamental information necessary to design a system.

The professionals of Geoinformatics realized that they need a common platform for their particular field, other than their working place for sharing, disseminating and enhancing knowledge among the professionals and the related persons for supporting activities of national development. Government is also looking forward the organizations for collecting suggestions, advices, and criticism for improvement on the programmes that has to be implementing for the betterment of the public. So, the Government has made provision to register professional organizations. Gradually, professionals of particular fields started registering the professional society or association with specific objectives. So far there are more than ten professional organizations in Geoinformatics have been registered. The overall performance of the organizations are commendable though the professionals involve in the organizations itself are not satisfied with the results and achievements and looking forward to improve their activities. They are also facing problems for the sustainability of the organization.

Professional organizations are more concerned with the advancement and technological development in their corresponding fields. It can be observed that the impact from such changes in many cases, orient the concerned organizations in the production line to restructuring the organization, reengineering the traditional system and launching human resource development programmes towards effective service delivery and efficient management. In such situation, line agencies have to face unavoidable constraints such as advocacy of new system, need of capacity building, management of financial resources, etc. Professional organizations can to some extent play roles to address these issues for benchmarking the modern tools and techniques.

Professional Organizations of Geoinformatics

Many professional organizations have been established mainly to secure and promote the Geoinformatics profession, to facilitate regular dissemination of new ideas and technology and to play an advisory role in formulating policies and programmes in their corresponding domain. Each organization has their own vision, mission, objectives, ways, and means for promoting activities. However, the common approaches are conducting seminars/workshops, publication of journals, etc. Although there are many professional organizations in Geoinformatics, brief information for the following professional organizations only are enunciated:

1. Nepal Geographical Society (NGS)
2. Nepal Engineering Association (NEA)
3. Nepal Geological Society (NGS)
4. Nepal Surveyor Society (NSS)
5. Nepal Surveyor's Association (NESA)
6. Nepal Remote Sensing and Photogrammetric Society (NRSPS)
7. Nepal Geographic Information System Society (NGISS)

1. Nepal Geographical Society (NGS)

Nepal Geographical Society was established in 1961 AD and perhaps the oldest professional organization in the field of Geoinformatics. The society aims for collecting and disseminating geographical knowledge and information sharing through research discussions, lectures, conferences, exhibitions and publication of journals. The society has begun to exchange its publication with Bangladesh Geographical Society since 2000 AD. Some of the major activities conducted during 2006-2007 are as follows:

- A week long exhibition of books, reports and documents contributed by the Late Dr. Harka Gurung
- Publication of proceedings of the National Conference on "Geography in Nepal: Reflections on Mountain Environment and Human Activities"
- Jagat Bahadur Singh Budhathoki Scholarship awarded to Shyam Prasad Lamichhane who scored highest marks in M.A. in 2004-2005 batch of Humanities Faculty of Tribhuvan University.

2. Nepal Engineer's Association (NEA)

Nepal Engineer's Association (NEA) was established in 1962 AD. The association aims to support development process by the application of engineering science and technologies. It increases interaction, goodwill and cooperation among the engineers in Nepal and abroad and it works towards protection of their professional rights. The major activities of the association are to publish journals, manuals, articles and newsletter on various fields of engineering, to organize conferences, workshops and talk programmes, and to enhance safeguards of professional rights of engineers. NEA is the member of World Federation of Engineering Organization (WFEO) and established Federation of Engineering Institute of South and Centre Asia (FEISCA). Some of the programmes conducted in 2007 are as follows:

- Seminar on "Building Code Introduction" held in Pokhara and Hetaunda on March 21, 2007 and May 11, 2007 respectively
- "10th National Convention of Engineers" in conjunction with "Engineering & Development EXPO 2007" held in Kathmandu on April 11-13, 2007.

3. Nepal Geological Society

Nepal Geological Society was established on April 15, 1980. The society aims to fulfill a role to help to develop a better networking of the scientists of this region and overseas and foster an atmosphere for a more effective regional and international scientific cooperation in the field of researches in the Himalayan earth sciences. The main activities of the society consists of regular publication of the Journal and the bulletins, organization of special lectures by national and international geoscientists and other professionals and organization of national and international seminars, workshops and symposium on geosciences, natural disaster, and related fields. The Society is also the country member of the International Association for Engineering Geology and the Environment (IAEG) and member of the Nepal National Committee, International Decade for Natural Disaster Reduction (IDNDR 1990-2000). The society is also involving in the Asian Disaster Reduction and Response Network (ADRRN) and Disaster Preparedness Network (DP-NET) to exchange of ideas and information as well as sharing of resources among various organizations. Some of the main activities of the society organized in 2007 are as follows:

- Fifth Nepal Geological Congress on November 26-27, 2007 at Kathmandu
- A programme to observe ISDR Day 2007 on October 10, 2007
- Publication of Journal of Nepal Geological Society; Volume 35.

4. Nepal Surveyor Society (NSS)

It is unfortunate to say that Nepal Surveyor Society (NSS) has remained inactive for a long period. However in its initial period of time, it conducted seminars and talk programmes on the then burning issues and also published quarterly news bulletin and an annual journal. This society was also affiliated with FIG.

5. Nepal Surveyor's Association (NESA)

Nepal Surveyor's Association (NESA) was established on March 28, 1991. NESA aims to perform activities to preserve the integrity, secure the professional rights, enhance dignity and develop career of surveyors. The association has declared 18th day of the month of Bhadra as per the Nepalese calendar which lies in the first week of September as a Surveyor's Day and each year celebrates this day with observing varieties of programmes. To name few activities they are as follows:

- Blood Donation
- Sapling Plantation
- Journal Publication (in 3 years of interval)
- Main function arrangement where speeches are delivered by number of invited dignitaries.

6. Nepal Remote Sensing and Photogrammetric Society (NRSPS)

Nepal Remote Sensing and Photogrammetric Society (NRSPS) was established on April 12, 1991. NRSPS aims to promote the remote sensing and photogrammetry technology in all aspects of national development. The main activities of the society are networking with related agencies and institutions, and conducting public awareness and workshops, seminars and lecture programmes, etc. The Society was in a state of inactiveness for a long period in the past but it has been shaken up since few years back, however it has not gain its momentum as per expectations. NRSPS is one of the member organizations of International Society for Photogrammetry and Remote Sensing, (ISPRS) and Asia Pacific Regional Space Agency Forum (APRSAF). It had conducted following programmes in 2007:

- Awareness programme on Application of Space Technology for the instructors and trainee of Land Management Training Centre at Dhulikhel on February 1, 2007.
- Seminar on Space Technology for National Development at Lalitpur on April 6, 2007.

7. Nepal Geographical Information System Society (NGISS)

Nepal Geographical Information System Society (NGISS) was established on July 23, 1995. NGISS is more focused on the GIS technologies which can contribute towards developing framework for state restructuring and realigning development priorities in the Nepalese context. In addition, NGISS will also assume advocacy rules putting forth the need to avoid duplication of efforts, developing standards and ensuring commitment for data sharing and tailoring GIS application to meet local level development challenges. The main activities of the society consists of regularly publishing annual news bulletin, organizing talk programmes, workshops, seminars, conducts training program on GIS as well as hosting GIS and related product exhibition shows. The Society conducted the following programme in 2007:

- National Workshop on Geographical Information System and Remote Sensing Application focusing the Role of Planners and Decision Makers at Lalitpur on October 7, 2007.
- Training on ArcGIS software environment from November 12-16, 2007.
- Seminar on GI-Science Application in Nepal at Lalitpur on November 14, 2007.

Development of Technology and Challenges to Adopt

Advancement in computer technology along with the development of space technology has presented the modern world with vast opportunities for extraction and analysis of required information for numerous fields. So the existing system or hardware components become obsolete due to non-compatibility of the new technology and not possible to update or upgrade such components, in many cases, due to non-availability of the required support from the market. Consequently, it is the need and necessity to apply new technology for growth, development and sustenance for each organization which is affected by such development which has been considered as one of the major challenges for adaptability. On the other hand, majority of the professionals are always one step behind the newer technologies because only a few professionals used to get opportunity to update their knowledge either through further training or attending national and international conferences and seminars or studying available literatures. However, availability of web and internet service facilitates the professionals considerably to update and enhance their knowledge.

Capacity building is also considered as a challenging task to an organization. Capacity building can be defined as a system to build ability of professionals working in the organization and the organization itself to perform functions efficiently, effectively and sustainable way. Necessity of capacity building is guided by the technological development so it is a continuous process in which assessment, relevance and analysis of the required capacity should be clarified beforehand to support the new technology and initiation should be made to fulfill the need. Some of the initiatives to be carried out by the organizations for capacity building are as follows:

- Assess the importance, relevance and impact for adopting the new system
- Advocate the decision makers to adopt the system
- Formulate policy to support the technology

- Manage required infrastructure for functioning the system
- Encourage professionals to apply the system
- Enhance knowledge and skill required to the professionals
- Promote and create awareness of the system to other related group of professionals and to the stakeholders

Constraints in the Application of the New Technology

Information on availability of a new technology can be obtained through different media such as:

- Surfing web sites in internet system
- Participating in conference and seminar or studying its proceedings
- Reading publications such as brochure, booklet, bulletin, etc. from the related organization
- Studying the articles from national and international journals/magazines
- Visiting the related organizations
- Viewing advertisement on International Journals
- Communicating with the local agents of the concerned companies
- Organizing talk programme with renowned expert(s)
- Consultating with officials/students just completed the higher degree course or training
- Etc.

Although the government policies seemingly encourage for applying the new system when necessary, however, it remains inadequate to use the full potential of the system. Some of the constraints in the development and application of the technology are listed below:

- Lack of recognized platform to analyze and develop the system to improve access, sharing, integrated and use of the products
- Lack of proper education and awareness in the field of new technology
- Lack of proper human resources and expertise
- Lack of financial support
- Lack of coordination among the users resulting duplication of works and non-uniformity of the products

Sustainability of Professional Organizations

Once the professional organization is registered, one of the major problems is to sustain the organization, which is governed by several factors. Some could be listed as follows:

- Less participation from the members
- Difficult in managing financial resources
- Communication gap between the professional organization and government organizations
- Lack of administrative auditing from the concerned organization

The executive body of the professional organization has overall responsibilities for identifying appropriate programmes, managing financial resources, encouraging members for participation in the activities of the organization and communicating with the governmental organizations. Therefore the executive body should take the following initiations for sustainability:

- Prepare annual work plan viewing the users requirement and need assessment
- Communicate regularly with the concerned organizations for reporting the achievements and their feed back
- Implement programmes as scheduled for regularizing the participation of the members
- Develop appropriate strategies and implement for fund raising
- Publicize the programmes, results, achievements, etc. through appropriate media for attracting the concerned organizations

As per the prevailing Act and rules and regulations, the professional organization needs to renew its validity for each fiscal year. The professional organization should apply to District Administration Office to renew the organization. From the past experience it shows that the validity will be renewed as per the existing rules and regulations. Furthermore, there is no provision for financial support to the organization from the government side. So, in order to justify the renewal of the organization, a governmental body should develop a mechanism for reviewing the annual work programme, regular monitoring the work progress, and evaluation of achievements and also provision should me made for partial financial support to the professional organization based on the viability and appropriateness of the proposed programmes. This will definitely bind the organizations to implement appropriate programmes for supporting to achieve the targets set by the government. This will further tend towards sustaining the organizations.

Role of Professional Organizations

Attachment between the professional organizations and the profession are inevitable because the professional organization could evaluate as a good organization only when the officials of the organization are active and more professional. So in order to maintain this relationship and to face the challenges and to overcome the constraints as mentioned above, the contribution of professional organizations could be as follows:

- Conducting awareness programme on the recent development of the technology so that the maximum number of organizations working under production line could apply for their corresponding activities.
- Helping training programmes and refresher courses to develop appropriate human resource required for the organization.
- Supporting the government to overcome the duplication of investment in the creation of framework data and encourage concentrating more on the creation of value added data for respective use.
- Suggesting appropriate policies, laws and regulations for effective implementation of the technology.
- Pressurizing the government to establish and adopt appropriate policies, acts, rules and regulations to ease to adopt the suitable technologies and to sustain the system.
- Participating to develop norms, standards, etc. of the system to ensure interoperability and also to facilitate the sharing of information at local, national and global levels.

While the Government of Nepal visualized a concept of building a new Nepal and at the same time people has very high expectations for their prosperous life which are recognized as very challenging tasks considering the present economical status, therefore, attempt should be made from all the related sectors to achieve the ultimate goal of the Government keeping in view of achieving zero poverty, prosperous life standard, overall economy growth of the country, etc. Globally, it has already been demonstrated that professionals from Geoinformatics field has capabilities in handling development activities of the Government effectively and efficiently even with optimal utilization of resources and available technologies. Hence, professionals involving in professional organizations should feel responsibility to contribute for the national development with vision, commitment, dedication and devotion for fostering the economy of the country utilizing available resources, knowledge and technology.

Concluding Remarks

The study showed that all the professional organizations of Geoinformatics field are serving as a platform for sharing ideas, knowledge and experiences in their corresponding fields through almost similar ways such as conducting seminar, talk programme and training, publication of bulletin or journal. They launched their programmes in order to help for planning national development activities, natural resource management, environmental conservation, creating awareness on technological development, etc. This will certainly lead to good governance of the country. However, the professional organizations should widen its scope to play role as specified and the professionals should contribute for building new Nepal. At the same time, Government also should design mechanism to monitor and support the activities of the professional organizations for their sustenance.

Acknowledgement

The author would like to gratefully acknowledge to all the professional organizations, which had kindly provided the relevant information for this article and highly appreciate Mr. Narayan Prasad Regmi for taking pains to collect the information from those organizations.

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2. *Narayan Prasad Regmi: Developing Strategies for Improving Cadastral Survey in Support of Reduction of Land Disputes in Nepal: Individual Final Assignment Report; ITC, The Netherlands; 2007*
3. *Rabin K. Sharma: Survey Profession and Professional Organizations in Nepalese Context, ISPRS 2008*
4. *Sudarshan Karki and Rabin K. Sharma: Space Technology Applications in Nepal (Opportunities and Challenges); Seminar on Space Technology Applications and Recent Developments in Geo-Spatial Products, August 17, 2005*

Participation in international events by the officials of Survey Department

- Mr.Toya Nath Baral, The then Director General
  GEOID Nepal and modernization of height system of Nepal
  19-25 Shrawan 2064 (August 4-10, 2007)
  Denmark

- Mr.Toya Nath Baral, The then Director General
  Research collaboration with Stuttgart University
  26-31 Shrawan 2064 (August 11-16, 2007)
  Stuttgart ,Germany

- Professional Education
  Mr.Naba Raj Subedi, Survey Officer
  Mr. Krishna Prasad Sapkota, Survey Officer
  Mr.Shiva Prasad Lamsal, Survey Officer
  Mr.Keshab Raj Lekhek, Survey Officer
  Mr, Ramesh Gyawali, Survey Officer
  Mr. Gajendra Prasad Shrestha, Surveyor
  1 year from September 2007, ITC, The Netherlands

- Mini-Project Training titled " Flood Risk Assessment of Kamala River using GIS and Remote Sensing "
  Shijan Dhakal, Survey Officer
  Bhadra 2064 - Falgun 2064 (September 2007-February 2008)
  Asian Institute of Technology. Bangkok, Thailand

- UN/Austria/ESA Symposium on Space Applications to support the Plan of Implementation of the World Summit on Sustainable Development
  Mr. Raja Ram Chhatkuli, Deputy Director General a.i.
  23-28 Bhadra 2064 (9-14 September 2007)
  Graz, Austria

- GEO-IV Plenary and Ministerial Summit
  Mr. Raja Ram Chhatkuli, Deputy Director General a.i.
  10-17 Marga 2064 (26 November-3 December 2007)
  Cape Town, South Africa

- Short course in Remote Sensing (Specialization on digital image processing)
  Mr. Manoj Prakash Singh, Surveyor
  23 Paush- 17 Falgun 2064 (7 January- 29 February 2008)
  Indian Institute of Remote Sensing
  Dehradun, India

- Mr.Toya Nath Baral, The then Director General
  GEOSS, APRSAF Symposium
  26 -30 Paush 2064 (10-14 January 2007)
  Tokyo, Japan

- Mr. Nagendra Jha, Chief Survey Officer
  The second GEOSS Asia Pacific Symposium
  02-04 Baishakh 2065 (14-16 April 2008)
  Tokyo, Japan

- Mr. Durgendra Man Kayastha, Project Incharge NGIIP
  First JPTM for Sentinel Asia STEP 2
  23-24 Jestha 2065 (5-6 June 2008)
  Kobe, Japan

Calendar of International Workshop/Seminar/Conference

ISPRS 2008
Silk Road for Information from Imagery
Beijing, China
03-11 July, 2008
E: loc@isprs2008-beijing.org
W: www.isprs2008-beijing.org

14th Permanent Committee on GIS Infrastructure for Asia and the pacific (PCGIAP)
19-22 August 2008
Kuala Lumpur, Malaysia
E: see@pcgiap.org
W: www.pcgiap.org/

Map Asia 2008
Kuala Lumpur, Malaysia
26-28 August 2008
E: info@mapasia.org
W: www.mapasia.org

7th International conference on ASIA GIS 2008
Busna Korea
26-27 September 2008
E: suh@pknu.ac.kr
W: www.asiagis2008.com/

4th Asian Space Conference
Taipei
01-03 October 2008
E: asc2008tw@nspo.org.tw
W: www.nspo.org.tw/ ASC 2008/

Collobrative Mapping and Space Technology
Gandhinagar, Gujrat, India
4-6 November 2008
E: yprana@sac.isro.gov.in

29th Asian Conference on Remote Sensing (ACRS)
Colombo, Srilanka
10-14 November 2008
E: acrs@sltnet.lk

International Symposium on Global Navigation Satellite System
Berlin, Germany
11-14 November 2008
E: gerd.rosenthal@senstadt.berlin.de
W:www.unoosa/org/oosa/en/SAP/gnss/ieg.html

Geoexpo 2008
Shanghai China
02-04 December 2008
E: victor.van.essen@reed business.nl
W: www.chinageo-expo.com

15th APRSAF
Hanoi Vietnam
10-12 December 2008
E: secretariat@aprsaf.org
W: www.aprsaf.org

Map World Forum 2009
Hyderebad, India
10-13 February 2009
E: info@mapworldforum.org
W: www. mapworldforum.org/

FIG XXXII General Assembly and FIG Working Week
Eilat Israel
3 - 8 May 2009
E: fig@fig.net
W: www.fig.net/fig2009

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

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

The Role of NGII in Disaster Management and Mitigation Program

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Abstract

Disaster is a sudden, accidental event that causes many deaths and injuries. Spatial data and related technologies such as Geographical Information System (GIS), Global Positioning System (GPS), remote sensing, have proven to be crucial for disaster management in such a way that without spatial data, one can not expect effective and efficient disaster management Although spatial data can facilitate disaster management, there are substantial problems with collection, access, dissemination and usage of required spatial data for disaster management. If each of the involved organizations in disaster management community collects some part of required spatial data for disaster response during their everyday business and emergency situation, required spatial data will be available to all participants.

Sharing information between involved parties in order to facilitate coordinated disaster response operations is another challenge in disaster management. This includes the development of a prototype web-based system which can facilitate sharing, access and use of data in disaster management and especially disaster response. Geospatial data are the initial input for GIS and Emergency Response Modeling and Simulation Systems. In an emergency situation, different organizations become involved in disaster response.

Survey Department, along with several other departments of Government of Nepal, jointly conducted several studies related to different types of disasters and their impacts. Survey Department has taken a lead in the creation of a National Geographic Information Infrastructure (NGII) in Nepal to share Geographic information. The mission of the programme is to strengthen planning and resources management through the development of geographic information infrastructure for the access of Geographic and attribute data for planning and decision making. Access to metadata information for all available geographic and related data could only assist in such initiatives.

Introduction

Disaster, a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources (ISDR, 2003)

Most disasters also result in significant property damage. Common natural causes of disasters include earthquakes, floods, hurricanes and typhoons, and tornadoes. Tsunamis (known as tidal waves), volcanic eruptions, wildfires, and landslides and avalanches rank among the other natural forces that sometimes create disasters.

Not all disasters are produced by the forces of nature. Many modern-day disasters involve accidents aboard passenger-carrying airplanes, ships, or railroads. Other "man-made" disasters can be traced to the collapse of buildings, bridges, tunnels, and mines, as well as to explosions and fires unintentionally triggered by humans.

Disasters interrupt the societies by claiming lives, creating victims, and destroying infrastructures and houses. By striking disasters, funds and budgets that have been assigned for development purposes are diverted to responding to disaster and recovering the quality of life to its normal. Disasters have also negative impacts on environment as they affect natural resources. Basic concept of GDI is "Information should not only exist" rather users should know about its existence, usefulness, and way to access it. Without spatial data, one can not expect effective and efficient disaster management.

With this in mind, appropriate management on disasters can contribute to reducing its negative impacts on development activities. With other talk by facilitating disaster management, achievement of sustainable development can be facilitated for nations and societies. It has already been proven that spatial data can considerably facilitate disaster management because most of the required information for disaster management has spatial nature

It is suggested that Geospatial Data Infrastructure (GDI) as an initiative in spatial data management can be an appropriate framework and a web-based system can be an appropriate tool for resolving current problems with spatial data. In other words, using GDI as a framework and a web-based system as a tool disaster management can be facilitated which contributes to facilitating achievement of sustainable development.

Resolving the problem with data for Disaster Management

Different organizations (such as Fire, Medical and police departments; Red Cross Society; and Utility Companies) collaborate in disaster management activities due to diversity of disaster response operations. Inter-organizational coordination of disaster response operations and controlling the emergency situation is generally conducted through Emergency Operation Center (EOC) where the representatives of involved organizations are gathered. Due to dynamic nature of emergency situation, required data for disaster response should be collected regularly in order to be available for decision-makers. This is achieved through partnership and collaboration between organizations in production and updating spatial datasets. If each of the involved organizations in disaster management community collects some part of required spatial data for disaster response during their everyday business and emergency situation, required spatial data will be available to all participants (Mansourian et al, 2004 and Rajabifard et al 2004). The required datasets should also be accessible for decision-makers (involved organizations and EOC) to be utilized for planning and decision-making purposes. This is achieved if collected data by each of the participants in data collection to be shared to wider disaster management community.

In addition, the required datasets need to be easily integratable with each other and interoperable with decision-makers' systems for real-time use. This is achieved by utilization of appropriate standards and specifications for data collection and sharing.

The NGII concepts seeks to support the sharing and optimal use of data in the national context by means of a set of standards, such as national spatial reference system, a national topographic template, a national elevation model, other standardized spatial data set of national scope like geographical names, administrative boundaries, etc and certain thematic data sets like soils, hydrology, vegetation, population, etc and metadata standards, to describe in a consistent way each of the NGII holdings. A GDI is therefore encompasses the networked geospatial databases and data handling facilities, the complex institutional, organizational, technological, human and economic resources that interact with one another and underpin the design, implementation facilitating the sharing, access to, and responsible use of geospatial data at an affordable cost. With this in mind, Geospatial Data Infrastructure (GDI) can be used as an appropriate framework that facilitates the availability, access and usage of spatial data for disaster management. The role of spatial information and related technologies in disaster management has been well-known worldwide. One of the challenges concerned with such a role is access to and usage of reliable, accurate and up-to-date spatial information for disaster management. This is a very important aspect to disaster response as timely, up-to-date and accurate spatial information describing the current situation is paramount to successfully responding to an emergency. This includes information about available resources, access to roads and damaged areas, required resources, required responding operations, etc., and should be available and accessible for use in a short period of time. Sharing information between involved parties in order to facilitate coordinated disaster response operations is another challenge in disaster management.

Disaster management

Disaster management is a cycle of activities (Figure 1) beginning with *mitigating* the vulnerability and negative impacts of disasters, *preparedness* in responding to operations, *responding* and providing relief in emergency situations such as search and rescue, fire fighting, etc., and aiding in *recovery* which can include physical reconstruction and the ability to return quality of life to a community after a disaster. The employment of recent advances in spatial data management and Geomatic engineering technologies in disaster management, including Information Communication and Technology (ICT), Geographical Information Systems (GIS), Remote

Sensing (RS), and Global Positioning System (GPS), has considerably improved disaster management through facilitating data capture, integration and analysis. The integration of such technologies with each other and with other technologies such as decision support systems (DSS), the world-wide-web and simulators has created more effective disaster management. Spatial data and GIS have proven crucial in preparing for, mitigating, detecting, responding to, and recovering from natural and technological disasters (Amdahel, 2002). Without spatial data one cannot expect effective and efficient disaster management, as spatial data are the initial input for GIS and Emergency Response Modeling and Simulation Systems (ERMSSs). On the other hand studies have revealed that there are substantial problems in the way in which disaster-related spatial data are gathered, displayed, accessed, and disseminated (SNDR, 2002).

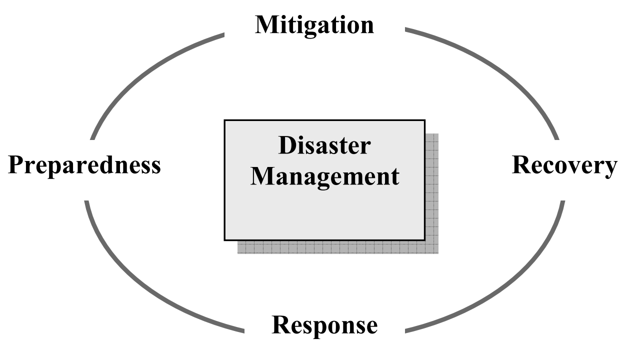

Figure-1

The response to the September 11 emergency situation was an example of the wide utilization of spatial information and related technologies in effective and efficient disaster response. It also highlighted different issues regarding access to spatial information as well as the applicability of available information in systems, as reported by Donohue (2002) and Letham (2001).

Providing information for disaster response

In an emergency situation, different organizations become involved in disaster response. Agencies such as fire-fighters, red-cross, medical emergency departments and police departments undertake emergency response within their everyday activities. Other organizations like utility companies however are only called upon in certain emergency situations. These agencies, organizations and departments must be prepared to provide training and other required resources such as spatial data when the need arises.

These organizations are logically the producer and updater of datasets during their everyday business and during an emergency situation. If the results of such data production and updating efforts are physically recorded in appropriate databases, the required data/information for disaster response is always available to the producer. If this information is shared and exchanged, then datasets are accessible to the wider emergency management community. In order for this data exchange to occur however, appropriate data standards and interoperability models need to be implemented by stakeholders so that information can be utilized within different systems. This brings the concept of partnerships in spatial data production and sharing to the fore.

The responsibility of maintaining information should be shared between different organizations based on:

- appropriate and accepted policies;
- appropriate standards for the production of data;
- the training of people to work with these datasets;
- the establishment of appropriate network and software tools for exchanging and sharing information/data; and
- appropriate policies for accessing and using data/ information

These components can aid and contribute to the development of a proper disaster response environment.

There is a need for an appropriate framework which recognizes the relationships between each component including the effect that the components have on each other, external factors affecting each component, as well as the internal elements of each component. For example regarding policies, it is necessary to understand what policies are required, who the policy makers are, what internal or external factors affect policy making, the effect that the polices have on the other components,

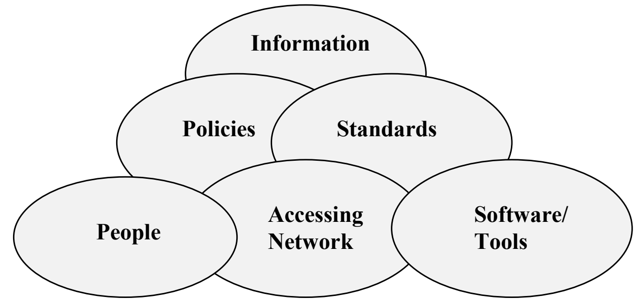

Figure - 2

Figure 2, describes the required components as discussed above for having spatial information ready for access and use.

Role of NGII/GDI in disaster management

Geospatial Information is information concerning objects or phenomenon that are directly or indirectly associated with a location relative to the Earth. (www.iso.org). Survey Department, NEPAL a national mapping organization (NMO), should gradually change its role of providing surveying and mapping services in the country to assuming a lead role in regulating the national mapping activities including development of environment for meaningful sharing of geospatial information at large ie, from production to regulating and coordination agency (Kayastha 2003 b).

The growing need to organize data across different disciplines and organizations and also the need to create multi-participant, decision-supported environments has resulted in the concept of Geospatial Data Infrastructure (GDI). GDI is an initiative intended to create an environment that will enable a wide variety of users to access, retrieve and disseminate spatial data and information in an easy and secure way. In principle, GDIs allow the sharing of data, which is extremely useful, as it enables users to save resources, time and effort when trying to acquire new datasets by avoiding duplication of expenses associated with generation and maintenance of data and their integration with other datasets. GDI is also an integrated, multi-leveled hierarchy of interconnected GDIs based on collaboration and partnerships among different stakeholders. With this in mind, many countries are developing GDIs to better manage and utilize their spatial data assets by taking a perspective that starts at a local level and proceeds through state, national and regional levels to the global level. These activities have resulted in different models being suggested for facilitating GDI development. As illustrated in Figure 3, an GDI encompasses the policies, access networks and data handling facilities (based on the available technologies), standards, and human resources necessary for the effective collection, management, access, delivery and utilization of spatial data for a specific community.

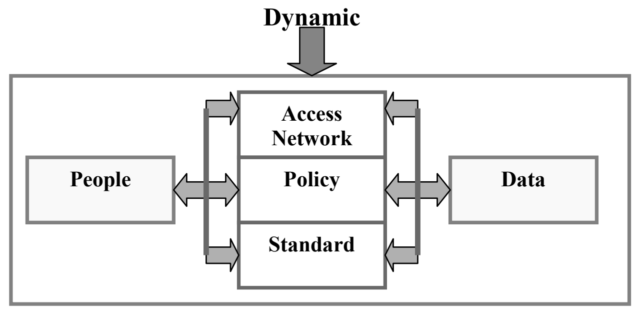

Figure 3: GDI Components

Viewing the core components of GDIs, Rajabifard *et al.* (2002) suggested that different categories of components can be formed based on the different nature of their interactions within the GDI framework. Considering the important and fundamental role between people and data as one category, a second category can be considered consisting of the main technological components: the access networks, policy and standards. The nature of these two categories are very dynamic due to the changes occurring in communities (people) and their needs, as well as their ongoing requirement for different sets of data. Additionally, with the rapidity with which technology develops, the need for the mediation of rights, restrictions and responsibilities between people and data are also constantly subject to change. This suggests an integrated GDI cannot be composed of spatial data, value-added services and end-users alone, but instead involves other important issues regarding interoperability, policies and networks. According to this view, anyone (data users through producers) wishing to access datasets must utilize the technological components.

Therefore, it is proposed that GDI as an information infrastructure can be an appropriate framework in bringing the disaster response components together and facilitating decision-making for disaster management as illustrated in Figure 4. By designing an GDI model for a disaster management community, and by utilizing relevant information and communication technologies (ICT) in disaster management, it is possible to have better decision-making and increase the efficiencies and effectiveness of all level of disaster management activities from mitigation to preparedness, response and recovery phases.

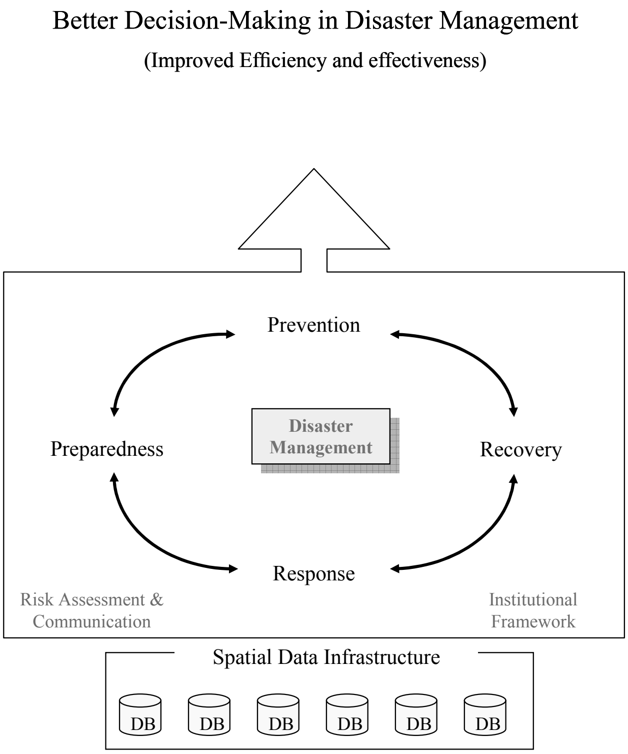

Figure 4: GDI to Facilitate Disaster Management

CONCLUSION

Spatial information and information communication technologies are the important elements in disaster management which has been well-known worldwide.

Not a single agency can collect, update, hold and disseminate data. With this in mind, the paper first addressed the role of GDI as a framework for facilitating disaster management. The NGII platform under development in Nepal is one such platform for interagency networking and data sharing. It is argued that the design and implementation of an GDI model as a framework and consideration of GDI development factors and issues can assist the disaster management agencies in such a way that they improve the quality of their decision-makings and increase their effectiveness as well as efficiencies in all level of disaster management activities from mitigation to preparedness, response and recovery phases. The result of such quality decision-making in disaster management then can directly contribute to the sustainable development of the community in terms of social, economical and environmental development. NGII, Survey Department should also take leading role to address the nation's important issues like supporting on disaster mitigation and management activity.

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