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CSO Mr. Ganesh Prasad Bhatta, a Member of Nepalese Delegation Led by the Secretary of the MOLRM, Mr. Lok Darshan Regmi at
Korean Cadastral Survey Corporation, High Level Geospatial Forum,
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Director General of Survey Department Mr. Madhu Sudan Adhikari presenting the paper on 'Cadastre of Nepal' at World Cadastre Summit Congress & Exhibition, 2015 held at Istanbul Turkey from April 20-24, 2015

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Survey Officer taking GPS observation near Swayambhunath Stupa few days after Earthquake of April 25, 2015 to assess the shift of Kathmandu Valley.

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After accomplishment of certain academic level, normally we join some professional organization and do some project works related to our profession. After some time we acquire some skill in performing specific type(s) of work(s). With these academic knowledge and practical skill in mind we may have/develop our future vision to further our profession. We all know one man does not make a team, and without a team work no organization can achieve its goals in an efficient way. It is not necessary that a group of people makes a team. Each member of a team should have certain level of knowledge and skill which can be shared to enhance the team performance. Among many others, a periodic journal is an effective and efficient means of knowledge sharing.

Realizing the value of knowledge sharing, Survey Department has been publishing its journal "Nepalese Journal on Geoinformatics" for last thirteen years. In last thirteen issues more than 100 articles in a variety of themes related to geoinformation have been published. I would like to express sincere thanks to all those incredible authors for their contributions and members of Advisory Councils and Editorial Boards of all those issues of the journal for their persistent efforts to publish the journal.

At this point, I am very much thankful to the Survey Department for entrusting me with the responsibility of the Editor-in-Chief for the fourteenth issue of the journal. Following the advice and suggestions of Advisory Council, we, the members of Editorial Board have been able to bring forth the fourteenth issue of the journal.

I believe that, we all can benefit from the development of the thinking and sharing knowledge in the field of geoinformation. We have made a good start with a strong tradition of writing and publishing case studies in our journals. We need to continue to improve upon our ability to reflect on what we are doing as we are doing it – this is essential for practicing professionals.

There are many challenges in the field of research works. Lack of appropriate data, hardware and software for research, consistant methodology et cetera are not creating conducive environment for research. Most of the times we do not seriously think about what should we be observing, measuring and asking questions about? What constitutes improvement? When is an improvement in one part of a complex system meaningful in the dynamics of the whole system? Yet these conceptual approaches present significant difficulties in designing research – identifying suitable questions, identifying and capturing the complexity of the interactions between large numbers of variables, etc. Despite these constraints, embracing the question of research has much to offer us. To better understand some of the phenomena we observe in practice, we need to improve our language and try to present the results in a way which is simple to understand for the readers. For these benefits we need to engage in a dialogue within our professional field. This Journal is a part of that process.

On behalf of all the members of the Editorial Board, I would like to express sincere thanks to all contributing authors, members of Advisory Council and all others who have contributed for the publication of this issue of the journal. Last but not the least, I feel privileged and honored to work as the Editor-in-Chief.

2072 Jeth,
Kathmandu

Suresh Man Shrestha,
Editor-in-Chief

Forewords

I am very much delighted to write a few words of introduction to the fourteenth issue of 'Nepalese Journal on Geoinformatics'. The journal has been published at a very important time – there is clearly an upsurge of interest in ICT based solutions in our professional field. And this journal has been one of the platforms for sharing professional knowledge among us.

Being a National Mapping Authority, Survey Department has generated a huge amount of nationwide geographical information related to our land, one of the basic sources of our livelihood. With the developments of technologies in the field of geoinformation and to cater ever growing demands of the geoinformation users, Survey Department must update its geoinformation in its possession. And dare to change itself to be in par with the modern technology.

Survey Department is going to adopt a new set of transformation parameters to interchange its geoinformation in traditional ellipsoid, Everest-1830 with modern WGS84 system. This is going to be a great achievement for the users of our geoinformation and GPS based technology. Chief Survey Officer Mr. N. Manandhar has put a lot of effort in this regard and his article will be of great value for our department.

There are a lot of issues to be understood about how we use geoinformation. Implicit in our work are many aspects of the scientific method as it is actually practiced in the laboratory. Increasing our scientific literacy level can improve our ability to think about our work. Articles by Mr. Sharma Rabin K., Mr. Bajracharya Birendra, Ms. Shrestha Shobha, PhD, Mr. Ghimire Subash, Mr. Dangol Susheel, Mr. Maharjan Hira G. are very good examples in this regard.

Starting this fiscal year, Nepal and India have resumed their boundary field works. Experience shared by Mr. Sharma Prabhakar on boundary survey works is surely going to be of great help for the surveyors involved in Nepal-India border field works.

The Earthquake of Baishakh 12, 2072 (April 25, 2015) shook almost all central part of Nepal, killed thousands of people, made thousands of people homeless, damaged/destroyed physical infrastructures including houses and put lives of nepali people in a very difficult situation at this point of our history. Destruction of historic monuments, specially in Kathmandu Valley, has been a very bitter truth. But, as many others, the staff of Survey Department stood determined to assist the rescue works of initiated by our government. We published geoinformation useful for rescue works. This information can be downloaded from www.dos.gov.np and www.ngiip.gov.np for free. Similarly our staff are busy in making maps, performing research regarding the possible shift of earthquake hit area and many are deputed to earthquake hit districts to assist rescue works. I am very proud to be the Director General of such devoted staff with professional obsession.

Very special thanks go to the members of the Editorial Board who brought out this issue of journal within a very short time period. I highly appreciate the effort of all the authors of the articles for sharing their knowledge. Finally, to conclude, I wholeheartedly invite and encourage new professionals to contribute to the noble cause of this journal in future.

Mr. Madhusudan Adhikari,
Director General,
Survey Department,
Jeth, 2072

BYE-BYE EQ2015,11:56AM

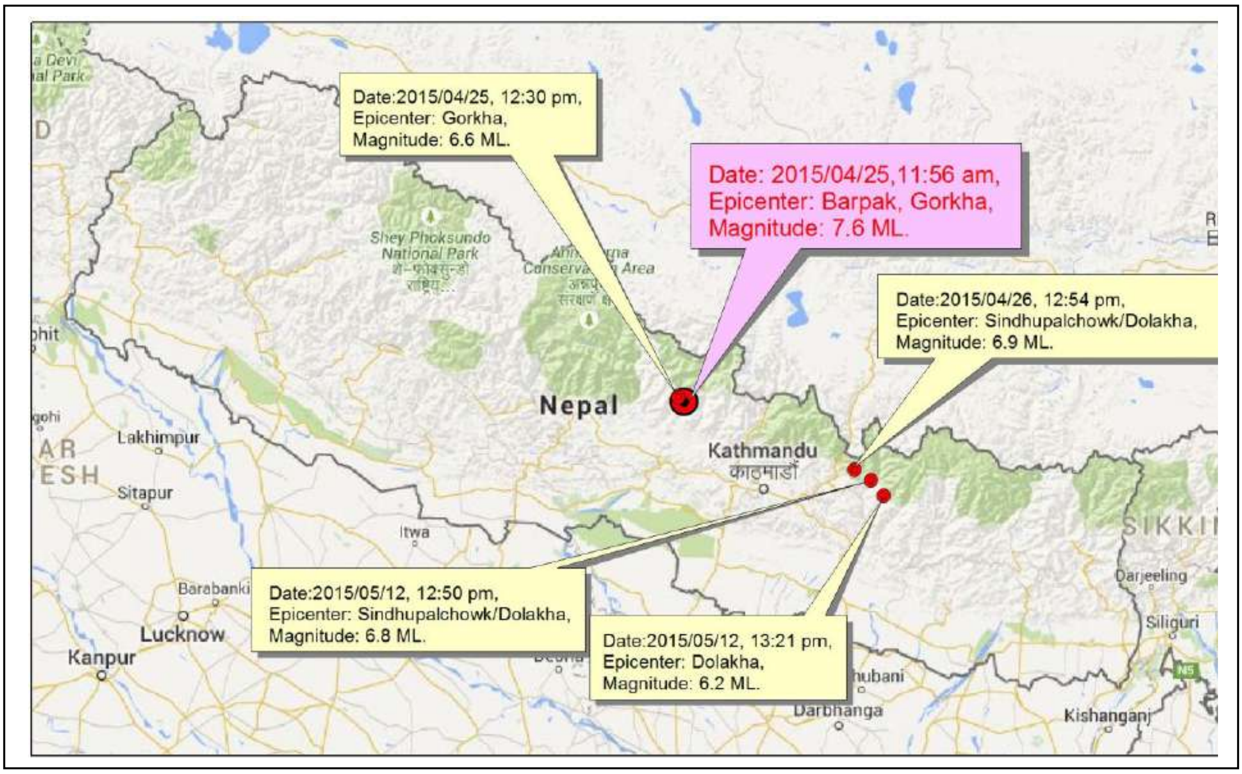
Kalyan Gopal Shrestha
DDG, Topographical Survey Branch,
Survey Department

A huge earthquake with the magnitude of 7.6 ML which occurred at 11:56 NST on 25th April 2015 shook Nepal killing more than 8,800 people, injuring more than 22,000 people, leaving hundreds of thousands of people homeless and leveling houses and centuries old architectural structures. The quake's epicenter was at Barpak village in Gorkha district, 80 kilometers northwest of Kathmandu, and it had a depth of only 15 kilometers, which is considered shallow in geological terms. The shallower the quake the more destructive power it carries. It also triggered an avalanche on Mt. Everest which is believed to have killed at least 10 climbers. It was the worst natural disaster to strike Nepal since the 1934 Nepal - Bihar Earthquake.

Repeated aftershocks for more than a month terrified Nepalese people and resulted landslides in Gorkha, Rasuwa, Sindhupalchok, Dolakha districts and some other places with casualties. Steep slopes in the area are also prone to avalanches like the one that the aftershock triggered on Mt. Everest .

A second major aftershock occurred on 12 May 2015 at 12:50 with a magnitude of 6.8. The epicenter was near the Chinese border between the capital of Kathmandu and Mt. Everest. More than hundred people were killed and thousands were injured by this aftershock. Hundreds of aftershocks greater than magnitude of 4 were felt since April 25, 2015.

1. WHY ARE WE AFFECTED:



The quake with a preliminary struck before noon and was most severely felt in the capital as well as the densely populated Kathmandu Valley. A major aftershock of magnitude 6.9 occurred on 26 April 2015 at 12:55 NST, with epicenter located about 17 km south of Kodari, Nepal and smaller aftershocks continued to ripple through the region for hours.

The devastation is more severe in the mountains near the epicenter, and in the surrounding districts.

Everyone knew Nepal lies in a earthquake prone zone. There have been a number of significant earthquakes in Nepal in the last centuries. April 25, 2015 earthquake is believed to be occurred as the result of the Northward under thrusting of Indian Plate beneath Eurasian Plate. A number of events of M6 or larger have had occurred over the past century. One, a M 6.9 earthquake in August 1988, with epicenter 240 km to the southeast of the April 25 event, caused close to 1500 deaths. The largest, an

M 8.3 event known as the 1934 Nepal - Bihar earthquake, struck at 2.30PM on 15 January 1934 in a similar location to the 1988 event. It severely damaged Kathmandu valley, and is thought to have caused around 10,600 deaths.

Millions of years ago, the Indian continent collided into Southern Tibet. The Indian continent is driven under Tibet, pushing lightweight sediments upwards and thus the formation of the Himalayas. Nepal is resting on these colliding tectonic plates: Eurasian(Tibetan) plate and Indian plate, which are still moving towards each other by 2 meters per century. This movement creates pressure within the Earth, which builds up and can only be released through earthquakes. Thus earthquakes happen very often in Nepal. Based on the seismic record since 1255, earthquakes of magnitude greater than 8 occurred on average once every 80 years.

The latest earthquake was not "unexpected", everybody knew it was coming sooner or later, experts had warned of the danger to the people of Kathmandu for decades. Since Kathmandu and the surrounding valley sit on an ancient dried-up lake bed with very, very soft soil, and the soft soil amplified seismic motion, death toll in Nepal on that black Saturday was practically inevitable given the tectonics, the local geology that made the shaking worse and the lax discipline in the construction of buildings that could not withstand the shaking. The earthquake occurred to the northwest of Kathmandu at a relatively shallow depth of about 15 kms, which caused greater shaking at the surface lasted for about 2 minutes, but at magnitude 7.6, it released less energy than the 1934 quake.

Seismologists have done a preliminary analysis of April 25, 2015 earthquake. Subsequent ruptures along the fault set off the number of aftershocks. This means a lot of the tectonic tension beneath Central Nepal has now been released possibly postponing a mega-earthquake for now. However, according to the Geologists, we are not in a position to ignore the possibility for an even bigger one in western Nepal. And a M8.5 earthquake in western Nepal will shake Kathmandu up even more than the M7.6 on April 25, 2015.

Earthquakes have tectonic origins and we call them 'natural disasters', The trouble in Nepal is that there is not enough research on risks. Kathmandu is prone to severe shaking even during minor quakes because the city is built on clay and sediment of a previous lake, and is also prone to liquefaction.

2. CONTRIBUTION OF SURVEY DEPARTMENT:

According to scientists, the devastating earthquake and aftershocks as large as magnitude 6 that struck on April 25, 2015 and on following days could have caused permanent changes of the Earth's surface. As part of the earthquake process, Earth's surface could have deformed as earthquake faults accumulate strain and slip or slowly creep over time. Survey Department(SD) use GPS to monitor this movement by measuring the precise position (within 5mm or less) of stations near active faults relative to each other. We compare the results with those of the previous observation results derived by occupying the same stations to determine the movement's magnitude and directions. By determining how the stations have moved we calculate ground deformation.

In the aftermath of earthquakes of April 25, 2015, Survey Department in it's capacity as National Mapping Agency carried out investigations based on Global Positioning System(GPS) field survey preliminarily in and around the capital city of Kathmandu in order to investigate the movement and change of elevation caused by the earthquake. Five stations surrounding Kathmandu valley: Nagarkot of Bhaktapur, Lakhe danda of Bungamati, Swayambhu of Kathmandu, Kumari of Nuwakot, Phulchoki hill of Lalitpur were selected as sample points. The analysis on surveyed data reveals that earthquake shifted Nagarkot by 1.82 m southwest, Phulchoki by 0.92m southwest. Likewise Bungmati, Swayambhu and Kumari shifted by 0.99 m south, 1.64 m southwest and 1.71 m southwest respectively. Regarding the Ellipsoidal elevation Nagarkot, Phulchoki, Bungmati, Swayambhu and Kumari found to be elevated by 1.158 m, 0.63 m, 0.77 m, 0.98 m and 1.093 m respectively.

The rigorous calculations were done linking with the observation data in 13 Continuously Operating Reference Stations (CORS) distributed in Hongkong, Lhasa, Bangalore, Hyderabad, Kazakastan, Oman, Mongolia. Thus calculated Post - earthquake coordinate values were compared with the Pre - earthquake corresponding coordinates compliant with International Terrestrial Reference Frame 2008 adopted by International GNSS Service (IGS). The primary result of the research was unveiled to the public in a Press meet.

The hundreds of aftershocks continued even after this unveiling of the result. The positions of National Geodetic Network have been suffered from the great earthquake. Therefore, a complete revival of the Network is a must. Survey Department must develop an immediate update to the reference positions of control points to publish a new set of recalculated coordinates. Since Nepal lies in the boundary of Indian and Tibetan plates, the accumulated strains and crustal deformations caused by plate subduction will more or less continue in future too. Thus, SD should introduce dynamic/semi-dynamic correction method to solve major problem with revision of survey results, that is, how to manage relation between static geodetic datum and actually moving positions of reference points and how to reduce the total cost for revision in future.

SD has made the provision of allowing free download of Topographic data of the earthquake affected area which includes 17 districts and can be downloaded from http://www.ngiip.gov.np. The data on the web includes Transportation, Hydrography, VDC boundary and Place name. The data can be used freely for earthquake disaster analysis purpose only by the organization who are working for disaster rescue and mapping activities of the disaster occurred due to the recent earthquake of April 25, 2015.

The department has also published Post Disaster web map to support the relief efforts. Most of these maps are focused on the 11 most affected districts.

Apart from these, the department has also published an interactive web map at http://www.ngiip.gov.np/EARTHQUAKE2072/Earthquake.html where one can see the number of deaths, injured etc and the department is updating this interactive web map as far as possible.

Within less than a month, we have felt more than 250 incidents of earthquake of magnitude 4+. It is more than enough! So enough is enough. On behalf of all nepalese let us say BYE – BYE Earthquake 2015.

See you never again!

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A REVIEW OF GEODETIC DATUMS OF NEPAL AND TRANSFORMATION PARAMETERS FOR WGS84 TO GEODETIC DATUM OF NEPAL

Niraj Manandhar

Keywords: WGS84, Everest 1830, ENTMP, WNTMP, Transformation Parameter, Datum, GPS.

Abstract: *In Nepal there exist different coordinate systems based on different geodetic datum. The existence of these datum and coordinate systems are poorly known. In this literature the geodetic datum that is in existence in one way or other are illustrated and discussed. The next common problem encountered by users is the availability of authentic precise transformation parameter between National geodetic datum and World Geodetic Datum 1984 (WGS84) ; global datum used by global positioning system (GPS). There can exist a considerable difference in the position between local and the global system and the difference could be of several hundred meters.*

Based on the availability of data three sets of transformation parameters has been determined. The tests have been carried out to evaluate the accuracy of the transformation parameter in this region. The transformation parameter is recommended to transform the topographical data base of scale 1: 3500 and smaller. The accuracy of the transformation parameters are specified and can be used accordingly. This study will ultimately provide standardization and ease in transforming the coordinates from global datum (WGS84) to national geodetic datum of Nepal and vice versa.

1. INTRODUCTION:

The national and regional surveying and mapping works are all based on one single framework of geodetic control which is considered as a primary network of the country. The importance of the geodetic frame work for the country is beyond justification and is applied in almost all development works of the country such as defense, satellite lunching, missiles projecting etc, construction of major infrastructures of the country (dams, roads, sewerage system, irrigation, hydropower stations etc).

The concept of the position defined by co-ordinate system is the most essential part in the process of map-making and to the performance of the spatial search and analysis of geographic information. In order to plot the geographical feature on the map it is necessary to define the position of points on the features with respect to a common frame of reference or the co-ordinate system in other words.

In the other hand all the observations and measurements for accurate mapping are carried out on the physical surface of the earth where as computations and representation of the earth surface into paper in the form of map requires mathematical figure of the earth. In order words there has to have some relationship between the mathematical earth (ellipsoid) and the physical earth (geoid). In the geodetic terms we need to define best fitting ellipsoid and geoid. The best fitting ellipsoid is that particular ellipsoid which best fits the spread of the earth surface of a particular country. Therefore there are different ellipsoids of different country and hence different countries have different origin and different datum defined by certain parameters.

2. GEODETIC DATUM:

Precise positioning of points on the surface of the earth is one of the fundamental goal of geodesy . In order to define such point a starting point with respect to the reference system and a reference ellipsoid is necessary. The primary or the first order network is defined by means of well defined three-dimensional reference system of co-ordinates related to the earth fixed reference system. Such a reference system is defined by the dimension of the reference ellipsoid in terms of five parameters such as semi-major axis 'a' and flattening 'f' and its position represented by regional X, Y, Z or φ, λ, h system specifying the orientation with respect to the global system, hence with respect to earth or geoid.

Usually the centre of the ellipsoid does not coincide with the earth's centre of mass but that axis is made parallel to the earth's axis of rotation with a pre assumption that global Xg, Yg, Zg rectangular co-ordinate system, has the origin which lies on the earth's centre of mass and a Z axis coinciding with the mean rotating axis of the earth, X - axis passing through the mean of the Greenwich Meridian. The Y - axis as defined by the plane which is perpendicular to X and Z - axis (Torge, 1991, pl 38).

3. NATIONAL GEODETIC DATUM (NEPAL DATUM):

In Nepal different geodetic datums have been used in different times for mapping purpose. The table 1 below shows the difference between them.

Table 1: Comparison of datums of Nepal

Datum	India	MODUK	ENTMP	WGS84
Source	Sources of India	MODUK	ENMP project report	SDN & University of Colorado
Ref. Spheroid	Everest 1830	Everest 1830	Everest 1830	WGS84
a (semi-major axis)	20922931.80 ft.	6 377 276.345 m	6 377 276.345 m	6 378 137.00 m
1/f (flattening)	300.8017	300.8017	300.8017	298.2572235
Origin latitude (θ)	24^0 07' 11".26 N	27^0 41' 31".04 N	27^0 41' 32".956 N	27^0 41' 33".778 N
Origin Longitude (λ)	77^0 39' 17".576 E	85^0 31' 20".23 E	85^0 31' 24".941 E	85^0 31' 16".384 E
Deflection of (ξ) in meridian	-0".29	-37".03	-37".03	-
Deflection in P. vertical	2".28	-21".57	21".57	-
Separation (N)	0	0	0	-

From the Table 1 it is obvious that there exists four different sets of co-ordinates on four different datum. The transformation parameters between these datum has to be established.

4. GPS OBSERVATION IN NEPAL:

In co-operation with University of Colorado and Massachusetts Institute of technology established the precise Global Positioning System (GPS) Geodetic network throughout the country.

The objective of establishing precise GPS geodetic network was:

- To provide a precise control grid for the geodetic survey throughout the country and
- To establish large scale strain grid to measure the north-south shortening, east-west extension and quantifying the uplift of the terrain across the Himalayan collision zone (Bilham & Jackson, 1991)

The best co-ordinate values in WGS 84 reference system for station related to Nagarkot were determined from a network solution of all stations. The network consist of 28 precise GPS controls.

5. ENTMP AND WNTMP GPS OBSERVATION:

The Eastern Nepal Topographical Mapping Project ENTMP & Western Nepal Topographic Mapping Project WNTMP was launched in order to produce new topographical map series of the country.

Geodetic controls over the project area was established by using the static relative GPS survey. In ENTMP a total of 101 stations were established and observed, the network consisting of 29 primary stations and 72 secondary stations. Instruments used for this field survey were Astech LD-XII GPS receivers. These instruments are 12 channel and dual frequency receivers.

In case of Western Nepal the ground control survey was carried out in two parts. First part was completed during January- April 1996 and second part during September – November 1996. During the first part 62 and during the second part 65 ground control GPS – stations were monumented premarked and observed. Among them 51 were the primary stations and 76 were the secondary stations.

One session per day was observed using four to eight GPS satellites. The length of the observation session was 180 minutes in the primary network. Carrier phase observation of GPS satellites were processed using L2 corrected L1 phase measurements and double differences phase observations. Astech Inc's

Geodetic post-processing software (GPPS), version 4.4.01 was used for the data processing. The adjustment of the network was done by using in FILNET (version 3.0.00) adjustment program.

One sigma accuracy of the baselines in the Network is better than 1-5 ppm.

6. DATUM TRANSFORMATION PARAMETERS:

The present study is focused on the estimation of transformation parameters between Everest and WGS-84 in order to transform the digital data of the topographical maps or the ground control points (GCP).

The topographical mapping project was launched in order to update the topographical maps of the country. The topographical maps of Nepal are prepared and published in two parts. One of the Eastern Nepal and other of the Western Nepal. In both cases geodetic control was done by GPS/GNSS survey. As the main aim of the project was to provide control for the topographical mapping, it was felt important to transform GPS control from WGS84 to local datum. It was found that the distribution of common points has a good network geometry for transformation. Hence for the derivation of the seven parameter transformation controls considered from ENTMP and WNTMP was given considerable weight.

Similarly, in the process of the determination of the transformation parameter of WNTMP, 22 collocated points (the common points between the reference frame i.e. WGS-84 and Everest 1830) first order points based on Nepal datum were used.

In the computation of transformation parameter 3-dimentional coordinates based on WGS-84 were taken as the controls established by WNTMP and ENTMP. This network consists of all together 80 primary stations and 148 secondary stations. A total of 33 primary GPS points were common stations in first order geodetic network of Nepal. These 33 stations are used for the derivation of the transformation parameter. 33 stations of first order network of Nepal based on Nepal datum were obtained from appendix (1) report of Ministry of Defense United Kingdom (MODUK). The Bursa-Wolf method was used to estimate the transformation parameter.

The values of the transformation (WGS-84 to Everest1830) parameters are as follows:

Table 2

Parameters	Estimated Values
Translation in X axis(m)	124.3813
Translation in Y axis (m)	-521.6700
Translation in Z axis (m)	-764.5137
Rotation in X axis (Sec)	-17.1488
Rotation in Y axis (Sec)	8.11536
Rotation in Z axis (Sec)	-11.1842
Scale factor (ppm)	2.1105

In order to test the accuracy of the transformation parameter given in table 2 the second and third order coordinates in WGS-84 were transformed to Nepal datum. Then the transformed coordinates were compared with existing second and third order coordinates of the same points.

As in the previous test, the deviations between same particular points were quantified by computing the distance using the set of coordinates of the same points. Maximum and minimum difference between X and Y co-ordinates were computed along with distance between two points. The results are tabulated in table 3.

The variations in the second and third order Transformed coordinates and National coordinates are presented below:

Table 3

	Difference in X coordinates(ΔX)	Difference in Y coordinates(ΔY)	Distance between the points
Maximum Value in (m)	1.0717	2.7447	**2.7737**
Minimun Value in (m)	-0.5733	-1.828	0.077912
Average			0.872848

Referring table 3 the average deviation between the transformed points are found to be 0.872 m therefore this parameter can be used in the map of scale 1: 3500 or smaller.

The values of the transformation (Everest1830 to WGS-84) parameters are as follows:

Table 4

Parameters	Estimated Values
Translation in X axis(m)	-124.3813
Translation in Y axis (m)	521.6700
Translation in Z axis (m)	764.5137
Rotation in X axis (Sec)	17.1488
Rotation in Y axis (Sec)	-8.11536
Rotation in Z axis (Sec)	11.1842
Scale factor (ppm)	-2.1105

Comparison of Transformed coordinates from Everest Spheroid to WGS 84 Ellipsoid using parameters of table 4 is shown in table 5.

Table 5

Station Name		Everest Spheroid Coordinate	WGS 84 Coordinate	Transformed Coordinate from Everest to WGS 84 Using Parameter
Siranchok	Lat.	28 05 01.38	28 05 02.58	28 05 02.592
	Lon.	84 36 11.00	84 36 2.719	84 36 02.715
Chaure dada	Lat.	27 26 27.85	27 26 29.28	27 26 29.293
	Lon.	84 48 44.45	84 48 36.117	84 48 36.129
Dhaje	Lat.	26 51 56.88	26 51 58.66	26 51 58.70
	Lon.	84 36 11.00	84 36 2.719	84 36 02.760
Laure Dada	Lat.	27 22 19.7400	27 22 21.33	27 22 21.365
	Lon.	86 55 20.7600	86 55 11.43	86 55 11.422
Biratnagar	Lat.	26 29 00.94	26 29 02.846	26 29 02.891
	Lon.	87 16 01.17	87 15 51.742	87 15 51.764

7. CONCLUSION AND RECOMMENDATION:

It has been felt essential that the integration of the coordinates of first, second, third, and lower order triangulation points in National Geodetic datum is essential to bring homogeneity in co-ordinate system of country.

The relationship between Nepal datum and WGS-84 co-ordinates is of immense requirement in present context. In order to bring the uniformity and consistency in coordinate conversion it is very important to determine reliable transformation parameters.

Transformation parameter which has been determined is recommended to use as a National Transformation Parameter of the whole country. These parameters can be used for scales 1: 3500 and smaller.

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CONNECTING SPACE TO VILLAGE: SERVIR HIMALAYA AT WORK FOR BRINGING EARTH OBSERVATION TO SOCIETAL BENEFITS

B. Bajracharya, MSR Murthy

Keywords: SERVIR, Earth observation, Gospatial Information, Satellite image

Abstract: Earth observation plays an important role in understanding earth as a system by providing repetitive and consistent view throughout the globe for regular assessment and monitoring. There are a number of initiatives working globally to facilitate and promote the earth observation applications. SERVIR is one such global initiative evolved through partnership between USAID and NASA with an overarching goal to improve environmental management and resilience to climate change. SERVIR-Himalaya is being implemented by ICIMOD to provide integrated and innovative geospatial solutions for generation and dissemination of information and knowledge resources on mountain environments in the Hindu Kush Himalaya region. The SERVIR applications are focused on the broad thematic areas which are also subset of the societal benefit areas of Global Earth Observation (GEO), namely - agriculture and food security, ecosystems and sustainable landscapes, and disaster risk management. Some of its applications in Nepal include agriculture drought monitoring; land cover dynamics; biomass estimation at local and national scales; climate change vulnerability to forest ecosystems; multi-scale disaster risk assessment; and forest fire detection and monitoring. Access to these applications and data are facilitated through ICIMOD's Mountain Geoportal and Regional Database System. Regional and national training and workshops, on-the-job training, internships and exchange programs and technical backstopping are key capacity building components to enhance the capacity of national institutions in the regional member countries. These efforts are also seen as receiving feedback on the science applications, identify additional needs, and increase synergy by exploring opportunities for collaboration.

1. INTRODUCTION:

1.1. Earth Observation in the Global Context

Importance of earth observation to understand earth as a system has been increasingly recognized by the global scientific communities and professionals. Earth observation plays a major role in the assessment of our environment by providing repetitive and consistent view throughout the globe. The increasing concerns of climate change impacts in recent decades have emphasized the importance of earth observation applications in the areas such as climate modelling, assessment of snow and glaciers, agriculture monitoring and disaster risk reduction. A number of initiatives have been working globally to facilitate and promote the earth observation applications. The Global Climate Observation System (GCOS) provides for comprehensive observations for research and for detecting and attributing climate change to support the United Nations Framework Convention on Climate Change (UNFCCC) through harmonized national observation systems to avoid both gaps and redundancies in Earth observation programs (Lewis et al 2010). GCOS works towards ensuring free and unrestricted availability of climate and related data for informed decision making. The Committee on Earth Observation Satellites (CEOS), is another principal body for coordinating Earth observation among national civil space programs. It also supports the Group on Earth Observation (GEO), an operational body established in 2005 to provide "a single, comprehensive and sustained system for Earth Observation." GEO, with a permanent secretariat in Geneva, is a voluntary partnership of governments and international organizations that provides a framework for coordinated strategies and investments (GEO 2013). GEO is the body that coordinates and sets up the architecture for the "system of systems" (GEOSS) to ensure complete coverage and compatibility of data. Nepal has been a member nation of GEO since the beginning.

The release of the entire Landsat archive to all users at no cost has been a major contribution to the Geospatial community. Since the Landsat images were made free by the National Aeronautics and Space Administration (NASA) and the United States

Geological Survey (USGS) in December 2008, over 19 million scenes have been downloaded till August 2014 (USGS 2014). Another encouraging step was the announcement by the White House on 23 September 2014 during the United Nations Heads of State Climate Summit in New York regarding the release the high-resolution (30mx30m) images of Shuttle Radar Topography Mission (SRTM) globally. The availability of high resolution Digital Elevation Model (DEM) will help in better analysis of the mountain environments like Nepal.

The visualization using high resolution images, geographic data including 3D terrain in Google Earth has revolutionized the way people use Geographic information. Browsing digital geographic information over the web (geobrowsing) has led to development of innovative applications to explore data geographically, and visualise overlaid information provided by diverse contributors. Integration of geobrowsers such as Google Earth and Google Map through application programming interfaces (APIs) has popularized the use of map for serving all sorts of information. Similarly, introduction of smartphones with map based applications and GPS has brought GIS into fingertips of common people. There is a huge potential for mobile applications in view of 88% mobile penetration in Nepal (NTA, 2015).

The more open policies on earth observation and wider access and affordability of consumer products enabling use of spatial information has brought in new paradigm in GIS application development and use.

2. THE SERVIR INITIATIVE

2.1. SERVIR-Himalaya: connecting space to village

SERVIR is a regional visualisation and monitoring system that integrates earth observations such as satellite imagery and forecast models together with in situ data and other knowledge for timely decision-making. SERVIR evolved through a 'non-traditional' partnership between USAID (United States Agency for International Development) and NASA to make earth observation data, decision-support tools for interpreting the data, and online mapping capability. SERVIR places a strong emphasis on partnerships to support the access to and availability of earth observations, spatial analysis, and visualisation.

The first SERVIR regional operational facility – for the Latin America and the Caribbean region – was established in 2005 at the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC). A second SERVIR regional operational facility – for East Africa – was initiated in 2008 at the Regional Center for Mapping of Resources for Development (RCMRD) in Nairobi, Kenya. SERVIR-Himalaya was initiated in late 2010 with ICIMOD, with its focus in the Hindu Kush Himalaya region. SERVIR Himalaya is implemented through ICIMODs regional program Mountain Environment Regional Information System (MENRIS). Very recently, a new hub SERVIR Lower Mekong has been formally launched in November 2014.

The overarching purpose of the SERVIR-Himalaya is to improve environmental decision-making in the Hindu Kush-Himalaya (HKH) region through dissemination and analysis of earth observation information. Stakeholders for this kind of information range from decision-makers at the regional level addressing transboundary issues, to national governments, scientists, students, the general public, donors, and development practitioners.

3. PRIORITY AREAS AND THEMES

Driven by the SERVIR's motto 'Connecting Space to Village', SERVIR-Himalaya works as a regional resource centre in the HKH region. The activities of SERVIR-Himalaya are designed from the perspective of *Supply* (tools, technologies and methods offered by the available Earth observation and Geospatial information systems) and *Demand* (information gaps, user needs, and creating enabling environments).

Based on the findings of series of needs assessment workshops and also considering ICIMOD's priority areas and GEO societal benefit areas, SERVIR Himalaya has focused on the broader themes of Agriculture and food security, Ecosystems, Cryosphere, Disaster, and Air quality. For each of these themes, assessment of major issues, key stakeholders in the countries, on-going initiatives, gaps and opportunities were carried out. Based on this, a number of Science applications are being developed. These include development of methodologies, customized information systems and web based tools for query and interactive visualization by the target audience. It also works on creating enabling environments through capacity building, creating platforms for access and sharing of data, and wider engagement of users beyond the scientific communities during the process of development and dissemination of SERVIR applications.

4. SERVIR APPLICATIONS IN NEPAL

SERVIR science applications are designed to address the gaps and needs identified in the national and regional context. Some of the ongoing applications in Nepal are presented here.

4.1. Satellite based Agriculture Drought Warning System (Nepal)

Over the last few decades the Himalayan region is experiencing high degree of spatial and temporal climate variability affecting crop production. SERVIR Himalaya is developing satellite based agriculture drought monitoring system to support sub-district level planners and decision makers in Nepal. Over the last year, the crop calendars, crop intensity and area under major crops like rice, wheat and maize are delineated using multi temporal Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data of 250 m resolution. The crop phenology patterns over the last decade was analysed using fortnightly MODIS 250m satellite data. Using this decadal response patterns as a base, fortnightly Normalised Difference Vegetation Index (NDVI) based in season crop growth anomaly maps are generated. Integration of information on seasonal vegetation performance and climate-based drought indicators are used to produce a timely and spatially-detailed drought monitoring information products. Additional datasets (e.g. historical climate and crop production patterns, real-time field based climate and crop data, knowledge of cropping practice, satellite based Moisture based Vegetation Index, Land Surface Temperature (LST), CHIRPS Rainfall data) are being integrated into the system using empirical modeling approaches.

4.2. Land cover dynamics of Nepal

Assessment and monitoring of land cover dynamics are essential for the sustainable management of natural resources, environmental protection, biodiversity conservation, and developing sustainable livelihoods, particularly for the rural communities. Under SERVIR, land cover data for 1990, 2000 and 2010 have been derived from Landsat images using object based image analysis. The legend is developed in consultation with national partners using Land Cover Classification System (LCCS) from FAO/UNEP.

The data are served through an interactive web-based application (Figure 1) which provides user friendly tools for generating statistics to understand the change processes and to support the informed decisions. User are able to access the land cover statistics for the whole country or a selected district. The area of each land cover type can be viewed for all three years together or separately, with the option to make charts on a selected set of classes only. Change map is generated for each class showing the areas of gain or loss while the conversion to or from other classes can be seen on the chart.

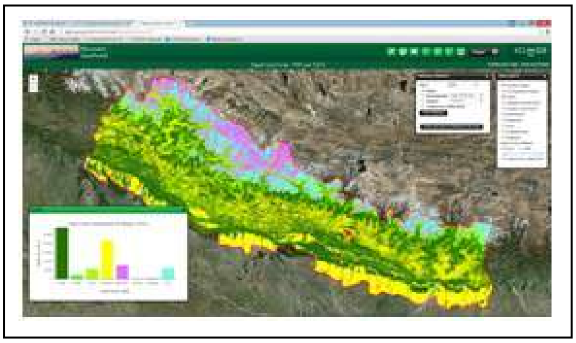

Figure 1. Interactive application for visualization of Nepal land Cover data

4.3. Biomass estimation using multi-resolution satellite data at sub-national level

Agriculture, Forest and Other Land Use (AFOLU) system offers a critical basis for creating and safeguarding more climate-resilient communities in Nepal. This has called for reliable baseline assessment of forest biomass and its monitoring strategies at multiple scales to ensure optimal supply – demand resource scenario and also leverage carbon mitigation benefits through mechanisms like Clean Development Mechanism (CDM) and REDD+. The work includes estimation of biomass using multi resolution satellite data and ground information at watershed level. The work has been carried out with community forestry user groups in the three watersheds, one each in Chitwan, Gorkha and Dolakha districts. The methodology has been up-scaled to apply at district level and national levels. A web enabled monitoring system to support mechanisms liked REDD Monitoring, reporting and verification (MRV) is being developed.

4.4. Multi-scale disaster risk assessment and decision support system for DRR (Nepal)

Disaster risk reduction (DRR) efforts needs understanding both as combined effects of multiple disasters and also at individual disaster. However, the requirement of degree and type of understanding varies as a function of scale at which DRR management options are operated. A framework consisting of broad information on multiple disasters at national level and detailed information on specific disasters at vulnerable zones would help better preparedness towards disaster risk management. A multilevel hazard and risk analysis system is being developed through wider stakeholder consultation. A decision support system is also being developed by integrating the data and information to aid in decision making for managing flood hazard and associated risk in Nepal.

4.5. Forest Fire Detection & Monitoring

Forest fire is a big concern in many countries including Nepal due to its adverse ecological and economic effects. A need for reliable and time effective information on fire is realized to be important as part of forest fire management. In view of its synoptic and high repetitive coverage, satellite data is found quite useful in fire detection and monitoring, and burnt area assessment on near real time basis. MODIS sensor on board Terra and Aqua satellites of NASA is extensively used for the purpose across the globe. SERVIR Himalaya has developed a forest fire detection and monitoring system for Nepal. The work is being carried out in close collaboration with the Department of Forest. The system carries out automated data acquisition, processing, reporting, and feedback on fire location. It provides location information on active fires present during the satellite's twice-daily overpasses. The system automatically adds important information to these data such as administrative unit (i.e., district, VDC, etc.), protected area identification, land cover type, elevation, and slope. The system then sends email notifications and SMS text about active fires to the subscribers which includes district forest officers, park managers and other relevant stakeholders (Figure 2).

Figure 2. SMS message received from the Forest Fire monitoring application

In addition, an interactive mapping application allows visualization of active fire locations on any given day along with district level fire count statistics.

5. REACHING THE COMMUNITIES

5.1. Capacity Building

Strengthening national and regional capacity to enable the use of earth observation information and geospatial tools for developmental decision-making is the major focus of SERVIR-Himalaya. There is a need to increase awareness and extend SERVIR benefits to ministries and/or national agencies for sustainable use of SERVIR's products and services and foster data sharing and exchange among the multi-sectoral agencies. In this regard, SERVIR has been carrying out various capacity building activities and developing national geospatial portals.

SERVIR-Himalaya conducts customized trainings on its science applications targeted the relevant institutions in the regional countries. The trainings are targeted to participants from different government and non-government agencies, universities and academic institutions. Focused opportunities are provided through on-the-job training to relevant institutions for in-depth skills developed in specific applications. SERVIR Himalaya has been regularly organizing Youth Forum targeting the fresh graduates and young professionals to increase awareness on earth observation application to climate change issues. In collaboration with NASA Develop program, it also provides internships to the students from the region to work on relevant thematic issues.

5.2. Mountain GeoPortal

All the science applications and related data are made accessible to the users through ICIMOD's Mountain Geoportal (Figure 3).

Figure 3. Mountain Geoportal (http://geoportal.icimod.org)

All the science applications are served through the Geoportal with necessary tutorials to access the information and tools. Users can use the web based tools for interactive query and visualization of information in different application areas. Metadata of all the data are also made available through quick and advanced search tools. The data are served through ICIMOD's Regional Database System which allows metadata search and downloads. Another feature of the Geoportal is the story maps which integrate geospatial information with related photographs, statistics and text for easy understanding by the users.

SERVIR-Himalaya is consolidating its efforts in Nepal to provide geospatial information services by developing national Geospatial Portals and facilitate the availability and sharing of geo-information. National Geospatial Portals are implemented for coordinated development and delivery of national geospatial services for improved decision-making. These efforts are also seen as a catalytic in complementing national SDI components by building synergies with relevant national programs and initiatives to facilitate data standardization, sharing and exchange. Ultimately it will help create ownership and grow geospatial information services in Nepal.

6. CONCLUSION

Over the past decade, ICIMOD, together with national and international partners, has promoted the use of GIS and earth observation applications at multiple scales to support its mission and strategic priorities. These regional priorities are closely interlinked, and improved understanding of the interrelationships between different components is a key challenge. Reliable and timely information on environment and society is critical for such improved understanding of the status, changes and inter-linkages. The emerging initiatives at the global, regional and national fronts and advancements in geospatial technologies has greatly changed the scenario in the user landscape. The easy access to spatial information through mobile devices has mainstreamed the use of spatial information by the common people and has given birth to many applications that are useful in daily life. The new concepts such as GeoDesign to bring geographic analysis into the design process where initial design sketches are instantly vetted for suitability against a myriad of database layers describing a variety of physical and social factors for the spatial extent has opened up enormous opportunities for application developers and decision makers (ESRI 2010). The mobile technologies has also made it possible for materializing the concepts of Citizen Science where the systematic collection and analysis of data and development of technologies are done through public participation.

While Earth observation has proven its usefulness in a wide range of application areas, it is important to consider the context and scale of operation for them to create a real impact. For example, the application on agriculture monitoring is focusing at country level while the forest fire application is implemented at national scales with information dissemination to the local level. The above ground biomass estimation is looking at the watershed level which is now up-scaled at district and national levels. At the watershed level, the primary target group is Community Forestry User Groups while at the national level the line ministry and departments are the primary users.

Another important aspect is to look at the temporal resolution. The forest fire application provides data four times a day while the information on agriculture is carried out fortnightly. Information on forest biomass and land cover are updated over a year to five year period. The temporal resolution is dictated by frequency of satellite data and the variability of the theme.

ICIMOD through its SERVIR Himalaya initiative is striving towards benefiting from these opportunities to make real difference to the people in the HKH. The science applications, trainings and user engagements at various levels are targeted to develop enabling environment in the region where spatial information on all the issues are available to the users and informed decisions are made on the basis of these analyses.

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PARTICIPATION IN THE INTERNATIONAL EVENTS BY THE OFFICIALS OF SURVEY DEPARTMENT

Sushil Narsingh Rajbhandari, Kamal Ghimire, Anil Marasini, Susheel Dangol, Narayan Regmi, Ramesh Gyawali, Dhruba Aryal,
Observation Tour of Quasi Judicial Organization in Bhutan,
14 - 17 February, 2014,
Bhutan.

Madhu Sudan Adhikari,
Director General,
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20 - 24 August, 2014,
Jakarta, Indonesia.

Ganesh Prasad Bhatta,
Deputy Director General,
High Level Geospatial Forum,
24-28 August, 2014
Seol, Korea.

Ramesh Gyawali,
Chief Survey Officer,
Land Policy Instrument (Land Readjustment and Land Based Financing Course),
22 - 31 October, 2014,
South Korea.

CSO Mr. Sushil Narsingh Rajbhandari,
Study Visit and 6th International Summer School 2014, in Phnompenh, Cambodia,
November 8 - 18, 2014.

Madhu Sudan Adhikari, Director General,
Ganesh Prasad Bhatta, Deputy Director General,
South Asia Geospatial Forum,
9 - 12 February, 2015,
Hyderabad, India.

Ganesh Prasad Bhatta,
Deputy Director General,
Study visit to land related government agencies,
1-4 April, 2015
Colombo, Sri Lanka.

Madhu Sudan Adhikari,
Director General,
World Cadastre Summit,
20 - 24 April, 2015,
Istanbul, Turkey.

Survey Officers Ms. Shanti Baba Bajracharya, Ms. Shanti Basnet, Section Officer Ms. Ganga Subedi and Surveyor Ms. Rupa Dotel,
Empowering Women Working in the Land Information and Management Sector,
Perth, Australia,
May 11 – June 5, 2015

EDUCATION AND RESEARCH ENHANCEMENT IN LAND ADMINISTRATION SECTOR AT KATHMANDU UNIVERSITY

Mr. Subash Ghimire

Keywords: Education, Research, Land Administration, Kathmandu University

Abstract: *This paper aims to strengthen the existing education and research in Land Administration and draw attention of all national and international Land Administration community for their contributions to promote education and research in Land Administration in developing countries such as Nepal. This paper also deals with the challenges and opportunities in collaborative efforts made by KU and LMTC to become a leader in this sector. The cost effective and reliable information is necessary for effective public service delivery. The economic growth of any country involves the effective service delivery. This requires highly skilled and knowledgeable human resources and output oriented research. To make land administration education, a leader course in Nepal and also within the region in the future, KU has to overcome many challenges. Some challenges may be addressed in the national level but some require collaborations and cooperation from international level. Finally, Education and research in Land Administration sector helps to develop quality land administrational professionals which in turn may incorporate the entire South Asia region as a potential Land Administration market. KU is committed to develop a centre of excellence in Land Administration sector by providing quality education and research.*

1. INTRODUCTION:

Land Administration is a discipline that integrates different land issues from different disciplines such as legal, social, economic, technical, planning, management and so on. The strengthening of Land administration system is at high agenda of Nepal government.The sufficient number of efficient land professionals is required to fulfil this mission. However, there exist major gaps in providing education in all other aspects of land administration and management. Moreover, in the scenario of federalism of the state, the country needs to develop strong land professionals. It is very important to develop land professionals for the effective implementation of recently formulated land use policy. It is well known fact that today the Geomatics and Land Administration field has become very important as it is the program which deals with land. In context of Nepal, land issues are very critical and service delivery in land is poor. Therefore, the production of qualified human resources in this field is very important. Besides understanding the need of higher education in the land administration sectors due to lack of skilled and professional human resources, there is necessity to conduct joint program for enhancing research and education in land administration sector.

Several Universities in United States, Europe and India are offering courses in Land Administration, Surveying, mapping and Geomatics Engineering. In this context, Land Management Training Center (LMTC) and Kathmandu University(KU) have already started the BE Geomatics Engineering in 2007 and successfully running under the framework of Memorandum of understanding (MOU). KU and LMTC also share the physical boundary and resources to promote Geomatics Engineering and Land Administration courses. This course supports the further strengthening of the collaboration between KU and LMTC.

Kathmandu University (KU) was established in November 1991 as an autonomous, non for profit, non-government, dedicated to maintain high standards of academic excellence, public institution through private initiative. The university 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 committed not only to develop leaders in professional areas through quality education but also develop as a centre of excellence. Long term presence of the university is also intended to benefit the local communities in terms of development of small scale business and community services.

Under the University there are seven schools: School of Engineering, School of Management, School of Science, School of Arts, School of Medical Sciences, School of Education and School of Law. Departments are headed by school. Currently, Geomatics Engineering lies under the Department of

Civil and Geomatics Engineering within the umbrella of School of Engineering of Kathmandu University.

Mainly LMTC under the Ministry of Land Reform and Management is established to produce the skilful surveying, mapping and land administration and management professionals through trainings within the country. LMTC is offering two types of regular courses and several short courses; Basic Survey course and Senior and Junior Survey course. Similarly, School of Geomatics which was established in 1999 in affiliation to council for technical education and training (CTEVT) is a private institution providing education in the field of surveying and mapping. Since its establishment, the school has been working at human resource development in the field of surveying and spatial information application at different levels. It is offering Diploma in Survey Engineering, TSLC in Survey Engineering (surveyor), and Short term and tailored made course on surveying/mapping, GIS, GPS and Land Information-system.

2. OBJECTIVES OF GEOMATICS PROGRAM:

The main objectives of Geomatics program at KU are as follows

- To produce undergraduate and graduate level highly skilled andqualified professionals in the field of land Administration and management.
- To conduct and promote research and development activities in the field of land administration/ management.

3. STATUS OF UNDERGRADUATE GEOMATICS ENGINEERING:

The undergraduate Geomatics engineering program was started in August 2007. Total 102 students are graduated as Geomatics Engineers and most of them are already employed in various government and non-government institutions.

The first MOU between KU and LMTC under the framework of which, the Geomatics program had been started was completed in 2011 and a second MOU is completed with the intake of 2014 batch. Under first completed MOU, Ministry of Land Reforms and Management have provided financial support for 7 years for four batches. In this case 75% of total fee is waived for 24 students. Similarly, under the framework of second MoU, the 2011, 2012, 2013 and 2014 batch students are enrolled in the course. The Ministry of Land Reform and Management is providing scholarships under various categories to number of students. In the new MOU, a 100% tuition fee is waived for two students from government employee in the engineering services under survey group category, a 50% fee is waived for eight students from four Development Regions except the central regions of Nepal and 33% of tuition fee is waived for 10 students passing the Kathmandu University Common Admission Test (KU-CAT) entrance exam on merit basis.

4. EXISTING PHYSICAL FACILITIES:

The library facilities and sports facilities are available at KU and LMTC. The survey equipments, computer lab for remote Sensing and Geodesy are available at LMTC. Similarly, computer Lab for computer programming, GIS lab and conference lab for provision for e-learning are available at KU. The course syllabus of BE Geomatics Engineering program is consistently revised by the Subject Committee/Faculty board and academic council of KU with due consideration of feedback from students and stakeholders including industries every year. This engineering program have strong component of field survey training equivalent to 4.5 months in 4 years program and internship of one and half months.

5. GRADUATE PROGRAM IN LAND ADMINISTRATION:

KU has also started two year's master degree program in 2013 in Land Administration in collaboration with LMTC and is successfully running at KU. The main aim of starting the master in land Administration course is to produce graduate level highly skilled and qualified professionals in the field of land Administration and to conduct and promote research and development activities in the field of land administration and management. The market study was carried out in 2010 and implementation plan was drafted in 2011 to start the master program. Land administration program at KU consists of multidisciplinary courses so that the intake will be from multidisciplinary background. The Government of Nepal has approved 100% scholarship to 10 candidates for government employee up to four batches. The financial aid is also available to selective full paying students in the form of graduate teaching assistantships as per the requirement of the Department.

The 2013 batch students are in final semester and are carrying out the Master research focussing on various land issues. The Memorandum of Understanding (MOU) between Kathmandu University, School of Engineering, Nepal and University of Twente, Faculty of Geo-Information Science and Earth Observation, the Netherlands had alreadybeen signed to run the Land Administration program.

6. RESEARCH ENHANCEMENT:

KU has given priority in the following areas of research in Geomatics Engineering. They are remote sensing, digital image processing, Geographic Information System, physical Geodesy, Photogrammetry: Analytical, Digital and Closs

Range, GPS Surveys: Static, Differential and Real Time, Computer Cartography, Mobile Mapping, Land Administration and management. In this context, KU has carrying out the research project titled Strengthening Geospatial Capacity building at Kathmandu University in collaboration with ICIMOD and includes following activities.

Activity1: Extending exchange program and internship opportunities on five selected projects and publishing story map through ArcGIS online. This activity is successfully completed.

Activity2: Development of geo-enabled web and mobile applications and services through a consortium of likeminded department, centres and institutions (Web-GIS based disaster impact and need assessment)

Activity3: Advance research using remote sensing data (Burnt Area Mapping Automation for the Landsat Using Python)

Similarly, the Geomatics Engineering program is also carrying out the next project in collaboration with ICIMOD titled Estimation of above ground forest biomass and carbon stock using UAV images. In collaboration with OXFAM, Geomatics Engineering program successfully completed project on hydro –geological mapping of aquifers.

7. PROSPECTS OF THE PROGRAM:

KU has set vision for Geomatics program "To become centre of excellence by providing quality education and research for leadership in the Land sector with joint cooperation with government and other collaborating organisations"

Therefore, vision is categorized into short term and long term. The short term vision is to continue the Geomatics Program with quality output. The long term vision was to head towards research oriented Master and PhD courses. Geomatics Engineering program in KU and LMTC has set following future plan to fulfil its vision:

- To start Diploma in Geomatics Engineering to produce operational level skilled human resources.
- To start B. Tech (Ed) in Surveying.
- To start MS by research in Land Administration and management.
- To enrol more PhD candidates in the field of Land administration and management.
- To emphasize the research projects in Land Administration and management.
- To strengthen and develop the intern opportunity for Geomatics Engineering students in related industries.
- To establish Geo Spatial Lab.
- To Establish CORS station within KU in collaboration with University of Tokyo.
- To carry out more research projects in collaboration with collaborating organisations.

8. MAJOR CHALLENGES:

The major challenges of undergraduate Geomatics Engineering and Master Program in Land Administration in Kathmandu University are highlighted as follows.

- Infrastructure development
    - Physical facilities
    - Hardware and software

- Delivery of course
    - Faculty expansion
      Visiting experts (national/international)
      Transfer of LMTC officials
    - Knowledge exchange programs

- Enhancing private/ private and private/ public understanding and support at both national and international level for running the program.
- Expansion of further higher education and job market .
- Sustainability of the program.

9. OPPORTUNITIES:

There is an ample of opportunities for KU to become a centre of excellence in Land Administration Sector. Institutions like UT/ITC, ICIMOD, private and government agencies are willing to support KU to achieve its goal. KU has expectations for expert advice from national and international land administration community.

10. CONCLUSION:

The land issues are critical and service delivery in land is poor in many developing countries. Therefore, development of qualified human resources in the field of Land Administration and management become necessary. Land administration and Geomatics Engineering has become emerging field as it directly deals with surveying, mapping and land management. KU in collaboration with LMTC is playing crucial role for it. To become a centre of excellence in Nepal and also within the region in the future, KU has to grab the opportunities and overcome the challenges. Some of the above mentioned challenges could be addressed in national level but some requires cooperation and collaboration from the international level. Therefore, it is essential to draw attention of all national and international land administration and management community for their contributions to promote education and research in land administration sector in developing countries such as Nepal.

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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 this department will always remember the contribution they have made during their service period in this department.

1. Nanda Kumar Mandal, Surveyor, Survey Office, Siraha, 2071/05/15.
2. Narayan Prasad Bhattarai, Surveyor, Survey Office, Chitwan, 2071/10/29.
3. Ganga Ram Katuwal, Surveyor, Survey Department, 2071/12/24.
4. Dil Bahadur Magar, Surveyor, Survey Office, Sindhupalchok, 2071/10/30.
5. Sushil Mandal, Surveyor, Survey Office, Rupandehi, 2071/11/03.

Survey Department and family.

PRICE OF MAPS

S.No.	Description	Scale	Coverage	No. of sheets	Price per sheet (NRs)
1.	Topo Maps	1:25 000	Terai and mid mountain region of Nepal	590	150
2.	Topo Maps	1:50 000	HIgh Mountain and Himalayan region of Nepal	116	150
3.	Land Utilization maps	1:50 000	Whole Nepal	266	40
4.	Land Capibility maps	1:50 000	Whole Nepal	266	40
5.	Land System maps	1:50 000	Whole Nepal	266	40
6.	Geological maps	1:125 000	Whole Nepal	82	40
7.	Districts maps Nepali	1:125 000	Whole Nepal	76	50
8.	Zonal maps (Nepali)	1:250 000	Whole Nepal	15	50
9.	Region maps (Nepali)	1:500 000	Whole Nepal	5	50
10.	Nepal (English)	1:500 000	Whole Nepal	3	50
11.	Nepal Map (Nepali)	1:1000 000	Nepal	1	50
12.	Nepal Map (Nepali)	1:2000 000	Nepal	1	15
13.	Nepal Map (English)	1:1000 000	Nepal	1	50
14.	Nepal Map (English)	1:2000 000	Nepal	1	15
15.	Physiographic Map	1:2000 000	Nepal	1	15
16.	Photo Map			1	150
17.	Wall Map (loosesheet)		Nepal	1 set	50
18.	VDC/Municipality Maps (Colour)		Whole Nepal	4181	50
19	VDC/Municipality Maps A4 Size		Whole Nepal	4181	5
20.	VDC/Municipality Maps A3 Size		Whole Nepal	4181	10
21.	Orthophoto Map		Urban Area (1:5000) and Semi Urban Area (1:10000)	-	1 000
22.	Outlined Administrative Map A4 size		Nepal	1	5

PRICE OF CO-ORDINATES OF CONTROL POINTS

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

FLOOD HAZARD MAPPING AND VULNERABILITY ANALYSIS OF BISHNUMATI RIVER, NEPAL

Susheel Dangol, Arnob Bormudoi

Keywords: Flood, Hazard, Vulnerability, Bishnumati River, HEC-RAS, HEC-GeoRAS

Abstract: *Flood is one of the striking water induced disaster that hits most of the part of the world. In Nepal also it is one of the serious disasters which affect the human lives and huge amount of property. The increase of population and squatter settlements of landless people living at the bank of the river has tremendous pressure in encroachment of flood plain making them vulnerable to the flood damage. The study describes the technical approach of probable flood vulnerability and flood hazard analysis. Bishnumati catchment was taken as area of study. One dimension model of HEC-RAS with HEC-GeoRAS interface in co-ordination with ArcGIS was applied for the analysis. Analysis shows that the flood area increases with flood intensity. Higher flood depth increases and lower flood depth decreases with increase in intensity of flood. Inundation of huge area of urban land indicates that in future human lives are more prone to flood disaster. Thus, the study may help in future planning and management for future probable disaster.*

1. INTRODUCTION:

Water induced disasters of varying intensity and magnitude affect various parts of Nepal regularly. The principal triggering factor is the monsoonal rainfall which is mostly confined between June and September every year (Chalise, *et. al.* 1995). About 80% of annual rainfall occurs during monsoon season and thus, extreme floods during monsoon season occur due to this concentrated spells of heavy rainfall (Shakya, 1998).

The draining of natural wetlands and the spread of towns across the countryside and many other human interventions has reduced infiltration leading to more frequent and higher floods (Shakya, et. al., 2006). Such changes are also observed in the Kathmandu Valley. Based on reported floods in Kathmandu valley (Table 1), it can be said that the valley is susceptible to severe floods. Hence proper flood forecasting and awareness system is quite necessary in order to minimize the probable loss due to floods.

In most of the urban cities of Nepal, floodings are due to the combination of extreme rainfall and urbanization. However, issue of urban flooding was highlighted when Katmandu got flooded in 2002 with total human death of 27. Most of the rivers were flooded with huge loss of property. The major cause of the flooding was the constriction of river channel for the human settlement.

Flood forecasting and warning is one of the most important non structural measures in comprehensive flood loss prevention and management (Lin, 1995). Thus flood forecasting is very important for efficient means of minimizing flood damage and loss of life. It should be an integral part of flood control system and must deserve prominent place in the national flood policy (Singh and Singh, 1988).

Among various non structural measures needed for disaster mitigation, hazard mapping is one of the important nonstructural measures (Mahato, et. al., 1996). Land flood hazard areas can be delineated based on hydrologic studies for selected flood peak magnitudes and topographic information (Joshi, 1987).

2. STUDY AREA:

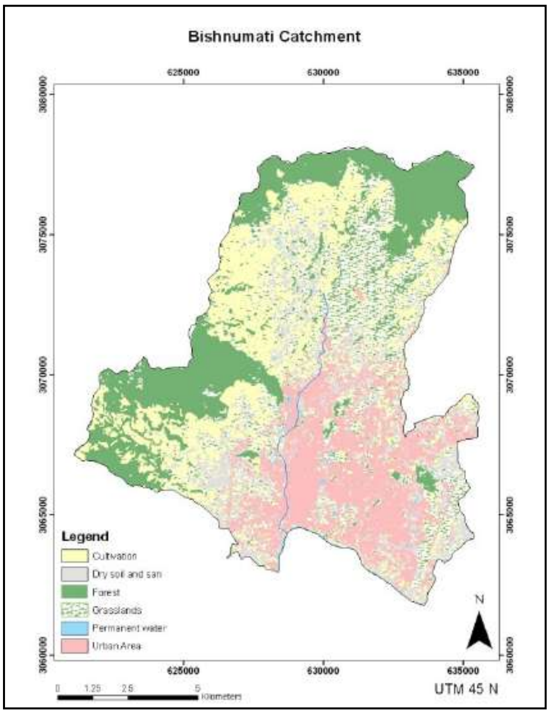


Figure 1: Land use map of study area (from ALOS Avnir-2)

Bishnumati catchment with the outlet at confluence of Bishnumati and Bagmati river of Kathmandu is taken as the study area. The the upstream of the catchment consist of cultivation and forest area and the downstream is more densly populated. Further, the channel of the river is modified by differnt artifical levees, which effects the flow of water in the river. Since the northen face of the valley receives more intense rainfall, there is the probability of flood disaster due to human intervention in the natural flow of river channel. Due to this reason, the catchment was selected as study area.

3. OBJECTIVES:

The main objective of this study study is to estimate flood hazard mapping in a GIS environment. The specific objective of this study includes:

- Flood frequency analysis
- Flood vulnerability mapping

4. DATA USED:

The data used in this study are-

Hydrologic data-

- DEM generated from free ASTER image in the Bishumati River Catchment. Spatial resolution 30x30 m.
- Daily maximum river discharge data for the upstream and the downstream gauge stations for a period of 30 years collected from Department of Hydrology and Meteorology.

Satellite data-

- ALOS AVNIR2 image of the study area of December 14, 2008

GIS data – (from survey department)

- Municipal boundary
- Road Network
- River Network
- Building Footprints

Other data-

- Population Census data per village level 2001 from Central Bureau of Statistics
- Cross sections along the river channel created by the HEC-geoRAS

5. METHODOLOGY:

1d flood model HEC RAS V4.0 has been used for calculation of one-dimensional water surface elevations/profiles for flood level prediction for different return periods. HEC-geoRAS has been used as an interface between HEC-RAS and the GIS environment. Stream lines were generated from the ASTER DEM using HEC-Geo HMS. This stream line was given as one of the input to the 1D model HEC RAS. Frequency analysis was carried out on the peak annual discharge data at the upstream as well at the downstream gauge station. The values obtained from Gumbell distribution was chosen as the hydraulic parameter for input to HEC RAS. The land use map was utilized for assigning Manning's roughness coefficient values to the model input.

Table 1: Manning's roughness coefficient for different land use.

S. No.	Land use type	Manning's Coefficient
1	Cultivation	0.035
2	Built-up area	0.015
3	Forest	0.15
4	Dry soil and Sand	0.029
5	Permanent water	0.04

This manning's n value was assigned as taken from HEC RAS hydraulic reference manual (2002) for different land use types within the study area (Table 1). Geometric data editing was carried out in HEC RAS to fit the surveyed cross sections to the model. Table 2 shows the values obtained from the frequency analysis of the 30 years discharges at the upstream and downstream.

Table 2: Discharge values for different return periods.

S.No.	Return Period	Discharge (m3/s)	
		Upstream	Downstream
1	10-year	3	456
2	20-year	4	531
3	50-year	4	628
4	100-year	5	701

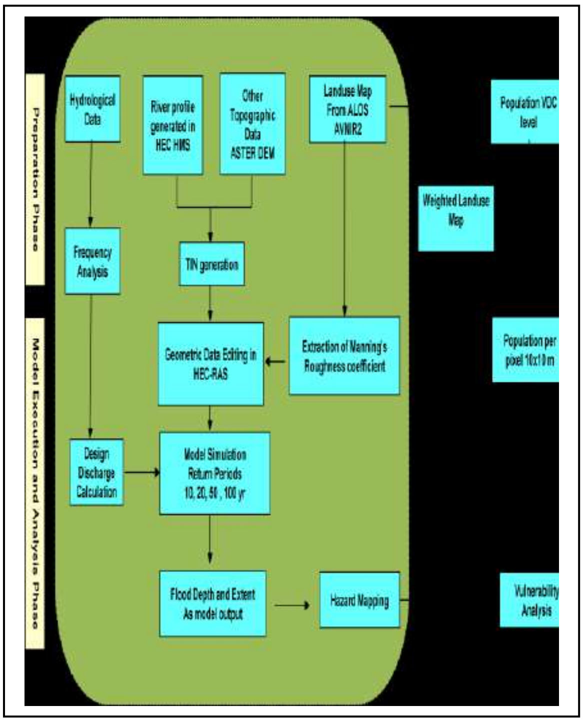


Figure 2: Methodology.

Post processing included creating maps of inundation in the GIS platform and the vulnerability analysis. Vulnerability analysis was done on investigate the physical vulnerability of the population and the landuse to the floods.

For this, the population was distributes in the study area according to the weightage given to the landuse. Three maps of depth, population density and landuse were used to make the final vulnerability map after assigning proper weighatage.

6. RESULTS AND DISCUSSION:

The inundation map shows the variation in flood depth over the flood plain. The inundation maps provide qualitative picture of the depth and aerial extent of inundation coverage.

7. FLOOD VULNERABILITY

The flood vulnerability maps for the area were prepared by intersecting the land use map of the floodplain with the flood area polygon for each of the flood event being modeled. The assessment of the flood area shows that most of vulnerable area lies on the urban land which shows the considerable impact of flooding on the human beings. Another effected area includes cultivation area.

Table 3: Land use vulnerability for different return periods.

Land use class	Area in Hectares			
	10 yr	20 yrs	50 yr	100 yr
Cultivation	22.3	23.8	25.4	26.4
Dry soil and sand	46.6	48.6	51.0	52.7
Forest	0.4	0.4	0.6	0.7
Grassland	13.2	14.0	15.1	16.2
Urban area	153.2	163.2	176.7	185.7
Total	235.5	250.7	268.8	281.6

Similarly tabel 4 shows the total buildings vulnerable due to different frequency of floods.

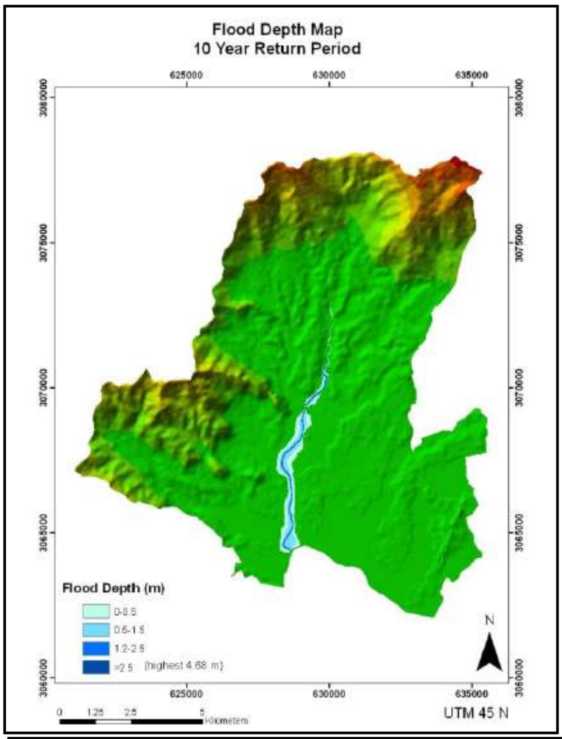
Table 4: Total buildings vulnerable to the flood.

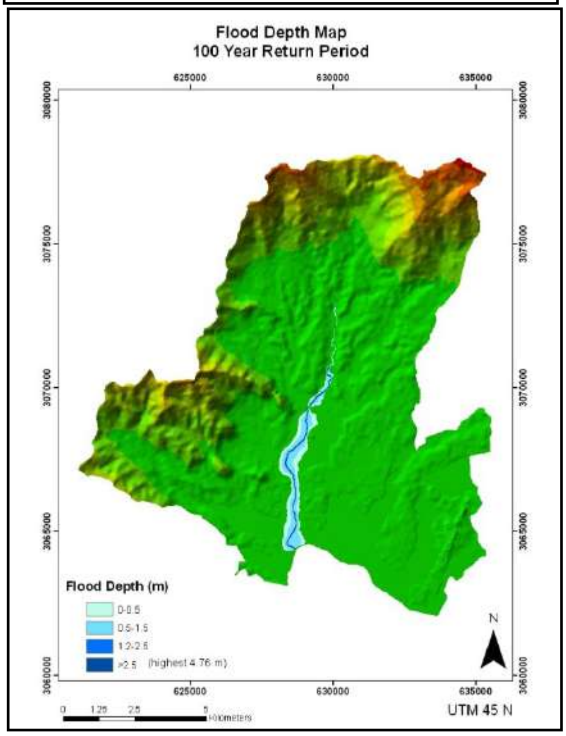
	Affected Buildings per Depth Class (m)				Total Buildings
Magnitude of flood	(0-0.5)	(0.5-1.5)	(1.5-2.5)	>2.5	
10 yr RP	2065	1377	193	119	3754
20 yr RP	2082	1602	191	123	3998
50 yr RP	2115	1922	146	105	4288
100 yr RP	2123	2127	148	104	4502

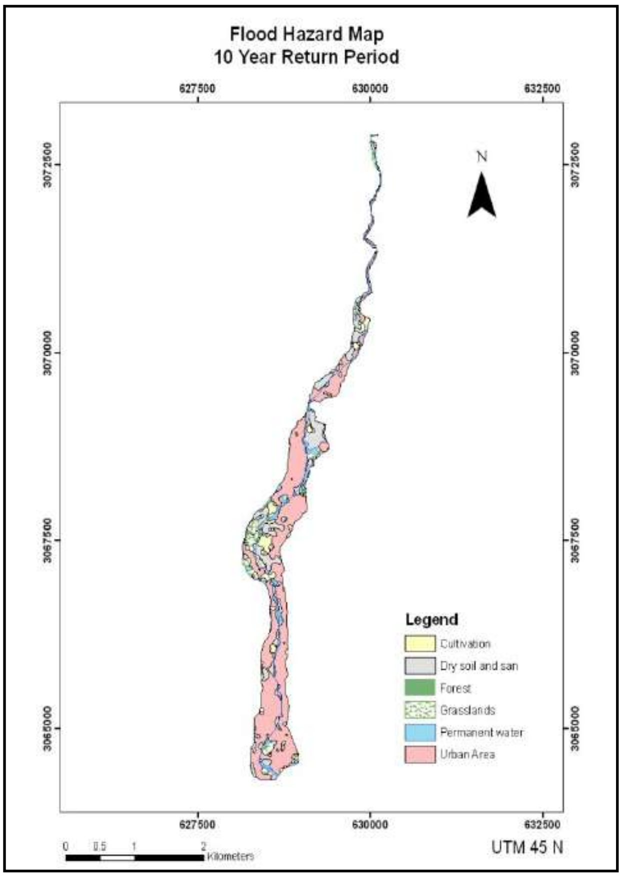
Table 5: Poplation vulnerability.

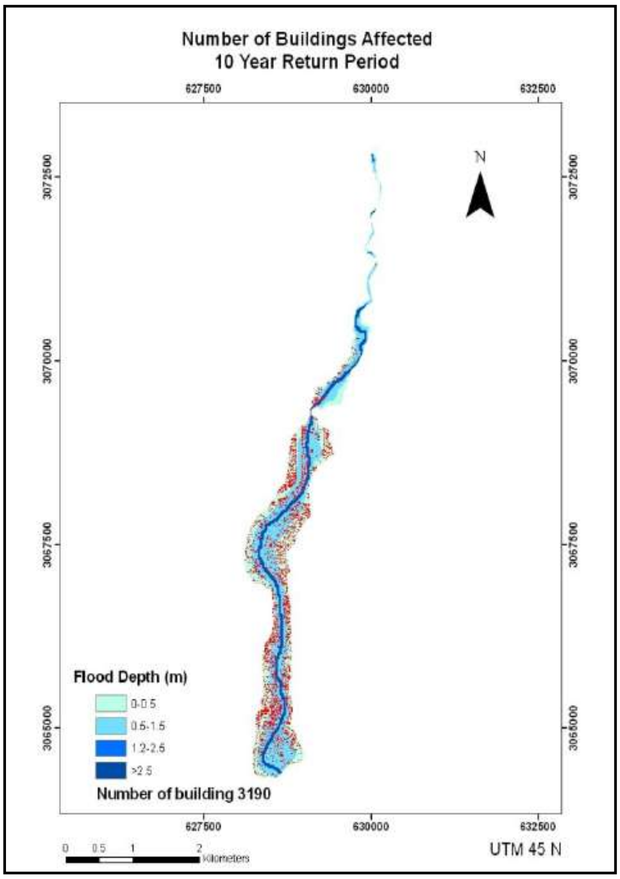
Magnitude of flood	Population affected per Depth Class (m)				Total Popl^n
	(0.0-0.5)	(0.5-1.5)	(1.5-2.5)	>2.5	
10 yr RP	14,820	11,692	894	1,531	28,937
20 yr RP	14,701	13,742	900	1,639	30,982
50 yr RP	14,580	16,337	910	1,692	33,519
100 yr RP	14,554	17,980	942	1,750	35,226

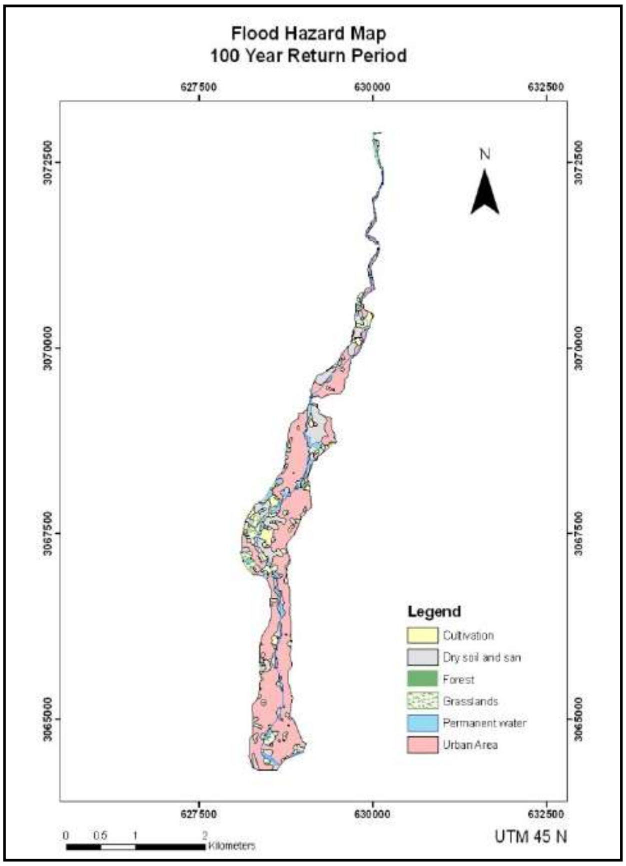
Table 5 shows total population vulnerabel based on the available population census of 2001 AD.

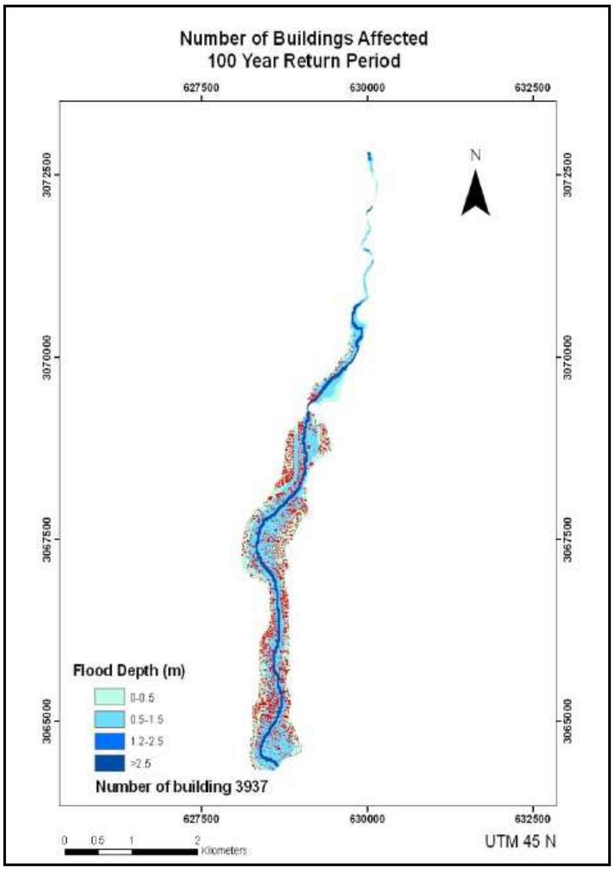





Flood Hazard Map
10 Year Return Period
627500
630000
632500
3072500
3070000
3067500
3065000
N
Legend
Cultivation
Dry soil and san
Forest
Grasslands
Permanent water
Urban Area
0 0.5 1 2 Kilometers
UTM 45 N


Number of Buildings Affected
10 Year Return Period
627500
630000
632500
3072500
3070000
3067500
3065000
N
Flood Depth (m)
0-0.5
0.5-1.5
1.2-2.5
>2.5
Number of building 3190
0 0.5 1 2 Kilometers
UTM 45 N


Flood Hazard Map
100 Year Return Period
627500
630000
632500
3072500
3070000
3067500
3065000
N
Legend
Cultivation
Dry soil and san
Forest
Grasslands
Permanent water
Urban Area
0 0.5 1 2 Kilometers
UTM 45 N


Number of Buildings Affected
100 Year Return Period
627500
630000
632500
3072500
3070000
3067500
3065000
N
Flood Depth (m)
0-0.5
0.5-1.5
1.2-2.5
>2.5
Number of building 3937
0 0.5 1 2 Kilometers
UTM 45 N

8. CONCLUSIONS / RECOMMENDATIONS:

The study shows the systematic process of preparation of flood vulnerability and hazard maps with the application of one dimensional model HEC RAS and ArcView with HEC-GeoRAS as interface between two. The application of this models and procedure provide effective results within less time consumption and little resources. The result obtained as graphical output (maps) from the model for different return period of flood can help in decision making.

The flood vulnerability was assessed with regard to land use pattern of the study area. It shows that huge percentage of vulnerable area lies under urban area in different flood frequencies showing considerable impact of flooding on the human beings of the area. Further, the analysis showed that maximum area under flood was between 0.5 to 1.5 meters for all the return periods.

Similarly, flood hazard assessment was also done according to different return periods. The relation between flood discharge and flooded area shows that there is increment of flooded area with increase in discharge. One of the biggest challanges remain here is the generation of the precise DEM. In this study freely available ASTER DEM of 30m resolution has been used which is not sufficient for hyrological modelling in a small catchment like this.

Thus, availability of high resolution DEM is necessary to get higher accurate results. This kind of models are very useful and important for pre-planning of disaster and also planning for proper land use, land developement and settlement planning.

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Current Designation: Chief Survey Officer
Work Experience: 8 years
Published Papers/Articles: Two
e-mail: susheeldangol@gmail.com

CALENDER OF INTERNATIONAL EVENTS

International workshop on the 'Role of Land Professionals and SDI in Disaster Risk Reduction; In the context of Post 2015 Nepal Earthquake"
Date: 25-27 November, 2015
Country: Kathmandu, Nepal
Email: workshopnepal2015@gmail.com
Website: www.workshopnepal2015.com.np
Organizer: FIG, ISPRS, NRSPS, NICS.

FIG Working Week
Date: 17-21, May 2015
Country: Sofia, Bulgeria
Email: fig@fig.net
Website: www.fig.net
Organizer: FIG

Geospatial World Forum
Date: 25-29, May 2015
Country: Lisbon, Portugal
Email: info@geospatielworldforum.org
Website:
www. geospatialworldforum.org
Organizer: Geospatial World Forum

International Forum on GNSS and LBS
Date: 24-26, June 2015
Country: Shenzhen, China
Email: jjje@nsdi.gov.ch
Website: www. its-expo.com

Group on Earth Observation (GEO) Planery
Date: 11-12, November 2015
Country: Mexicon City, Mexico
Website: www.earthobservations.org
Organizer: GEO

27th International Cartographic Conference
Date: 23-28 August, 2015
Country: Rio de Janeiro, Brazil
Email: christina@congrex.com.br
Website: www.icc2015.org
Organizer: ICC

9th International Society for Digital Earth
Date: 5- 9 October, 2015
Country: Halifax, Canada
Email: ISDE@radi.ac.cn
Website: www.digitalearth-isde.org
Organizer: ISDE

55th Photogrammetric Week
Date: 7 - 11 Sept., 2015
Country: Stuttgart, Germany
Email: martina.kroma@ifp.uni-stuttgart.de
Website: www.ifp.uni-stuttgart.de
Organizer: IFP

International Astronautical Federation
Date: 12 – 16 October, 2015
Country: Jerusalem, Israel
Website: www.iafastro.org/iac-2015
Organizer: IAF

South Asia Geospatial Forum 2015
Date: 09 Feb, 2015
Country: Hyderabad, India
Email: kajal.juneja@hexagongeospatial.com
Website: www.indiageospatialforum.org
Organizer: SAGF

36th Asian Conference on Remote Sensing
Date: 19-23 October, 2015
Country: Quezon City, Philippines
Email: acrs2015.ph@gmail.com
Website: www.acrs2015.org
Organizer: ACRS

ISPRS International Workshop on Photogrammetric techniques for video surveillance, biometrics and biomedicine
Date: 25-27 May, 2015
Country: Moscow, Russia
Email: knyaz@gosniias.ru
Website: www.isprs.org
Organizer: ISPRS

LAND RECORDS INFORMATION MANAGEMENT SYSTEM

Mr. Hira Gopal Maharjan

Keywords: e-Government, Land Information System, Land Records Information Management System, Architecture, Service Delivery.

Abstract: *The land administration services are being provided using traditional methods and processes. The record keeping system is mainly based on manual system so far. There is increasing need for efficient and effective delivery of land administration services. Government organizations use Information and Communication Technology to increase efficiency and effectiveness in the service delivery. E-Government can bring improvement in efficiency, easy availability and accessibility of service and information to the citizens, business organization, professional users as well as government organizations. The main aim of LRIMS is to automate the land transaction related functions of Land Revenue Offices (LROs) based on different land transactions process requirements.*

The system is adherence to NeGIF and GEA, availability of intranet facility, provision of web-based system, and data security. System modules show the modules needed for LIS. The implementation status of LIS in Nepal is in initial stage. The old system architecture does not support the e-Government model. The system modules show the modules needed for LRIMS. The system modules help in delivering service efficiently. The three tier system architecture follows all three models of e-Government (G2G, G2B and G2C) and reduces corruption, increase access to information and improve data quality.

1. BACKGROUND

The Land Information System (LIS) history of Nepal is more than a two decade long. The first LIS was Integrated Land Information System Project 'Bhu Laxmi', which was developed in 1991/92 but could not function in practice for long time. The different application software were found that are used by LRO, SO and other organizations are discussed DLIS (District Land Information System, SAEx (Spatial Application Extension), Plot Register Management System (PRMS), Image Reference Management System (IRMS), Parcel Editor, OSCAR (Open Source Cadastre and Registration) SOLA Project. Regarding LIS Implementation Status, the data entry of DLIS has been started since F.Y. 2057/58 and consequently all the LRO's data have been digitized except Achham LRO likewise geo-database preparation in SAEx has been started since F.Y. 2066/67 and consequently all SO's geo-database have been prepared except Achham and Arghakhanchi districts. According to "Doing Business Report, 2015", Nepal's land registration is ranked at 27th out of 189 countries and 1st in South Asia and even 1st in top ten services provided within our country

2. INTRODUCTION

It is an ADB granted ICT Development Project, one of the components of e-Government applications under Office of Prime Minister and Council of Ministers of US $ 1.365 million. It was started in April 28, 2013 A.D. and will end in May 2018 A.D. (including Post Warranty Service). It is a web-based software solution developed and installed in Government Integrated Data Center (GIDC) under Government Enterprise Architecture (GEA) and Nepal e-Government Interoperability Framework (NeGIF). This will meet the needs of the Department of Land Reform and Management (DOLRM), Land Revenue Offices (LROs) and other stakeholders. DOLRM, LROs and other stakeholders will access the application via WAN within Intranet. It covers Non-spatial data at LROs only. The main aim of the project is to implement web-based centralized system in GIDC & DOLRM for automating the 14 LROs activities. The project sites are DOLRM, 14 LROs (Baglung, Banke, Bhaktapur, Biratnagar- Morang, Chabahil, Chitwan, Dhading, Dillibazar, Kalanki, Kaski, Kavre, Lalitpur, Makawanpur and Parsa).

3. OBJECTIVE

- To automate the land transaction related functions of Land Revenue Offices (LROs) based on different land transactions process requirements.
- To make the information easily accessible to land owners and related authorities.

4. SYSTEM ARCHITECTURE OF LRIMS

The system architecture of LRIMS is designed with the concept of three architecture:-One application Server, one web server and core based partitioned database server hosted in GIDC. The backup servers for application server and database server are also maintained. It is web based and centralized system. The 14 LROs are connected to the central database. This architecture consists of three layers:

Presentation Layer: This layer contains the user oriented functionality responsible for managing users' interactions with the system and consists of components that provide a common bridge into the core business logic encapsulated in the business layer. This layer comprises of user interface (that includes styling and scripting resources). This layer is responsible for gathering inputs from the user and passing the same to the business layer for processing. The presentation layer ensures that the communications passing through are in the appropriate form for the recipient business objects in the business tier. To access the system, the user will connect via intranet and need to get authenticated by the security subsystem of the application (firewall). Based on his/her role, the user will be shown the modules for which he/she is authorized. The system will provide the common front-end for all the modules.

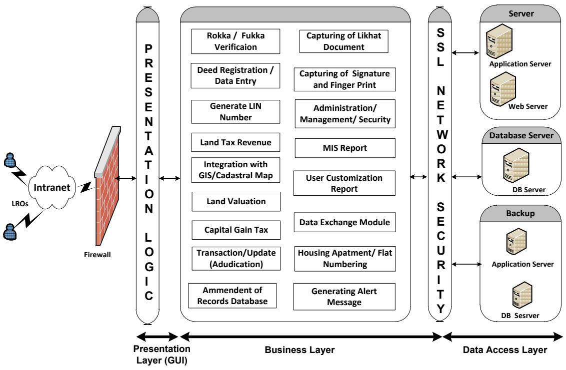

Figure 1.1: System Architecture of LRIMS

Business Layer: This layer implements the core functionality of the system and encapsulates the relevant business logic for rokka fukuwa verification, deed registration/ data entry, unique LIN number, land tax revenue, integration with GIS/Cadastral map, land valuation, capital gain tax, transaction/update(adjudication), amendment of records, capturing likhat document, capturing signature and finger prints, administration/management/security, MIS reports, user customization report, data exchange for various applications, housing apartment/flat numbering and generating alert message modules. It consists of components which may expose service interfaces that other callers can use.

Data Access Layer: This layer provides access to data hosted within the boundaries of GIDC and data exposed by other networked systems; perhaps accessed through services. The data layer will expose generic interfaces that the components in the business layer can consume. It handles the translation from data in its native format, such as SQL tables or XML elements, to a form more suitable for the business logic tier, such as objects. It consists of application, web server and database server. There are backup servers for all the servers in standby condition so that if one fails other will take over. There is SSL network security to protect from unauthorized access to server and database.The system modules of LRIMS are as follows:

Rokka/ Fukka Verification

This is a restriction and release of land transaction implemented by district offices on request from agencies like banks, CIAA, court, government decision. Traceable to 'Dohoro Darta' needed to be recorded for necessary action.

Deed Registration / Data Entry

The Deed Registration is capturing of land records maintained in LROs. It is a process of transferring ownership rights of a land parcel / building from one owner to another due to sale / purchase of land by one owner to another. This module entries/captures/updates records originating in LRO such as Deeds, 'New Land Records,' etc.

Generate LIN Number

The module generates unique Landowner's Identification Number (LIN) for finding records. LIN code is similar to Personal Identification Number index to locate/find the records and is generated with the key combination of date of birth, district code, s/n, gender, calculated result of special formula etc.

Land Tax Revenue

The module records tax revenue levied to each land record. It also shows tax amount to be paid by the land owner plus delay charges, rebates and produce receipt of payment and report about the status of revenue.

Integration with GIS/Cadastral map

The module integrates with GIS/Cadastral map information and produce comprehensive information. It should be possible to link with the National Geographic Information System (NGIS) in future.

Land Valuation

Land Valuation is the process of calculating land value as per specific circle rate for different land areas. The module enters land value and produce land/property valuation report.

Capital Gain Tax

The module calculates capital gain tax according to conditions for Deed Registration process.

Transaction/Update (Adjudication)

There are various types of transactions or Deeds, such as 'Rajinama', 'Hal Ko Bakaspatra', 'DanPatra', 'Chhod Patra', 'Sagol Naama', 'Ansha Banda', 'Chhut

Darta', 'Bejilla Da Kha', 'DaKha by Auction', 'Purano Dakha' etc. The module performs transactions on the different types of transaction.

Amendment of Records

The module handles amendment of records by application request such as 'samsodhan' / 'namasari' or other related tasks.

Capturing Likthat document

The module captures "Likhat", "Tameli" data etc.

Capturing Signature and Finger Print

The module captures and store the signature and finger prints wherever applicable.

Administration / Management / Security Module

The module administers and manages various levels of users and different types of security. It also manages parameters (Zone, District, VDC codes, land types, etc.). It will also have Audit Trail System.

MIS reports

The module provides various types of MIS reports required for the different levels of management (LAOs, Central level). The module will also be able to query information by different criteria available in database.

For District Level

- Information Query on Current status of Parcel
- Information Query on Land Holding against Land Holding Ceiling
- Daily Revenue Collection Report
- Monthly Progress Report
- Parcel History Report
- 'Sresta' Reproduction (printing)
- Annual Land Revenue 'Lagat'
- Tenants status

Central Level MIS report

- Land ceiling
- Gender wise , Administrative unit wise (i.e. VDC wise, district wise, ward wise)
- Land size , type, class, ownership share
- Total private, public and government land

User Customization Report

The module provides different end-user customization reports.

Data Exchange for various applications

The module generates data to exchange between other applications such as NID, IRD, Muncipality, Bank etc.

Housing Apartment/Flat Numbering Module

This module manages housing apartment and flat related transactions.

Generating Alert Message

This module generates an alert message and forward it to the concerned citizens address (email, mobile etc.) while performing any kind of transaction. It will also have functionality of query reply when query is performed through SMS.

5. SYSTEM DESIGN ARCHITECTURE FOR IMPLEMENTATION

The system design architecture for implementation is depicted in the figure below:

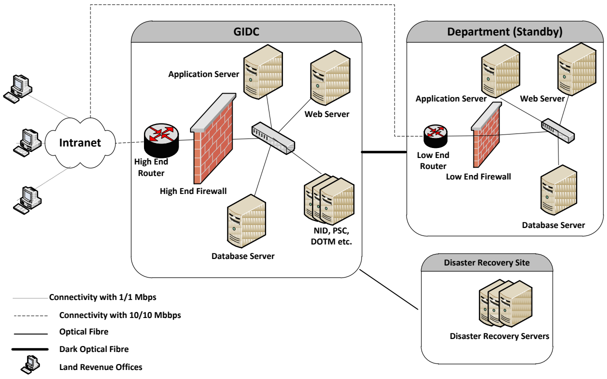

Figure 1.2: System Design Architecture for Implementation

The System Design Architecture connects all the LROs to the centre office and the GIDC which is established for the integration of government database. The LROs connecting to the application over intranet link using browser are authenticated before allowing connections. The web, application and database servers are stored by the GIDC i.e. DC sit. There will be Standby site in department which is the exact replica of the system in GIDC. All the changes in GIDC system will automatically be saved in Standby system in department.

The servers are RISC based IBM machines. The web server will be in redundant configuration by means of dual power supply and raid array configuration to avoid the failure of server. The system will independently work and will ensure continuous running of the web services. The RAID 6 configuration has advantage over RAID 5 will be preferred here to better. The RAID 6 is configured for better redundancy and data protection. RAID 6 can protect mission-critical data from two concurrent disk drive failures. The application server will have similar setup to that of web server. This is middle tier in the setup architecture and used for application installations. These servers have AIX operating system. The servers will be part of local area network and placed behind the firewall. The web server communicates with this middle tier application server for functioning of entire application. Port based secured communication is allowed using firewall for enhanced security. The database is Oracle 11g. This is the third tier and part of LAN. The web, application server and database servers are kept in LAN for preventing from hacking and for better security. For data security the servers have iptables as firewall and there is also a high end firewall for more security. The technologies like cryptography, PKI, digital signature are used for security purposes.

All the LROs access through the application at the GIDC. The users connect the web server which is kept in intranet via the intranet link. The web server will communicate with application server and database server which are kept in LAN. The GIDC has dual high connectivity internet link and dual electrical feeder. The connectivity of LROs with GIDC is via 1/1Mbps intranet link. The connectivity of department to GIDC is dual. The primary link is dark optical fiber and secondary link is 10/10 Mbps dedicated optical fiber intranet link for continuous data replication to occur in the severs located at department. However, this connectivity is only for the initial stage and will be increased in future. The concept of DR site for whole GIDC has also been initiated and feasibility study for this has been done and proposed for Hetauda DR site with the aid from KOICA. So, the system will have high availability.

The GIDC will be connected to disaster recovery and the backup of all the servers in GIDC will be maintained in disaster recovery site. There is high end firewall for the authentication process in GIDC and low end firewall in department. The web interface will feature single sign on and authentication system to prevent unauthorized access.

If the system in GIDC fails, the standby system in department will take over the system. It is designed in such a way that the entire setup will be located in a central location and the data will be accessed over the intranet link from anywhere, the entire solution is web based thus providing unhindered accessibility and ease of use.

6. WORKING PROCEDURE OF LRIMS APPLICATION

The working procedure of LRIMS application is as follows:

- Super Administrator: Manage the overall system
- Local Administrator: User Management, Valuation Mgmt. & Report Generation etc.
- Service Desk: Form fill up, upload document, photo, thumb & signature capture and form submission.
- Junior Officer: Verify the form contents with attached document including online verification, issue letter for parcel split, public notice, collects revenue if no bank is available, generate LOC etc.
- Bank Officer: Cash in and receive revenue. Submit collection report to LRO
- Land Revenue Officer: Verify and approve the application/form, forward application/form to CLRO / backward to lower level

Chief Land Revenue Officer: Verify and approve the application/form, forward application/form to DOLRM for suggestion / backward to lower level

7. FEATURES OF LRIMS APPLICATION:

- The Front-end (Programming Language) is in Java.
- A web based application based on GEA (Government Enterprise Architecture), SOA and NeGIF (Nepal e-Government Interoperability Framework)
- Bilingual-Developed in English and Nepali (Unicode)
- Centralized system and standby backup (DOLRM and GIDC)
- 24x7 (24 hours, 7 days a week) service availability
- Accessible throughout the worldwideweb (www.nepal.gov.np) and a land owner can check his/her application status, own property details and can lodge application from own place in future
- An application can be lodged into a LRO from other service desk/center for a transaction (Bejilla)
- Secure (Thumb verification, Photo & Signature capture, User & Password) and transparent transaction maintaining history of each activity
- Automation of functions of LROs, Land Reform offices and Guthi offices making working procedure uniform throughout the country
- Introduction of paper less system
- Automatic valuation & tax management
- Provide an Integrated Land Ownership Certificate (LOC).
- Land ceiling and Rokka can be automatically verified by system
- Generation of different types of LIN, LOC and different types of Reports
- Alert message to the registered mobile/email.
- Fields of forms are configurable (Mandatory and Optional)
- Provision for online validation of thumb impression, password, land parcel no., NID, PAN etc.

8. COMPARISON OF OLD SYSTEM AND LRIMS ARCHITECTURE

Table 1.1: Comparison of old system and LRIMS Architecture

S.N.	Parameters	Old System Architecture	LRIMS Architecture
1.	Architecture	Client server (2 – tiered)	3-tiered

2.	Adherence to NeGIF and GEA	No	Yes
3.	Centralized	Stand alone	Centralized
4.	Web based system	No	Yes
5.	Integrated LIS	No	Yes
6.	Data security	Low	High
7.	Duplication of Records	High	No
8.	Electronic services	Do not support	Supports
9.	Chances of theft, Fire, Natural Disaster	Always	Rare
10.	Interoperable	No	Yes
11.	Availability	Low	High

Table 1.1 describes about the comparison of old system and LRIMS architecture. The comparison is done on the basis of 11 parameters viz. architecture, adherence to NeGIF and GEA, centralized, web based system, integrated LIS, data security, duplication of records, electronic services, theft, fire & natural disaster, interoperable and availability. In case of architecture, the old system is 2-tiered but LRIMS is 3-tiered architecture. The LRIMS is compatible with GEA standard and NeGIF but the old system is not compatible with GEA standards and NeGIF. The old system is standalone system with separate server for different offices while the LRIMS is centralized so that the whole system can be controlled by one location and management of server and database is easy.

The LRIMS is web based and it can be accessed from anywhere via intranet but the old system can be accessed by concerned office only. The data security is high in LRIMS as it uses Oracle database but old system uses MS-SQL and MS-Access. There is more duplicate data in old system as it does not have unique LIN but there is provision of unique LIN in LRIMS so there will be no duplication of data. The flow of information takes place through electronic media in LRIMS and supports digital signature. But the old system does not support electronic services. There is always chance of theft, fire & natural disaster in old system as it is located in the local office but less chance of theft, fire & natural disaster in LRIMS as it is located in GIDC where there is good physical security, facility system like leakage detection system, firefighting system etc. The old system is not interoperable with other system as it is standalone and not compatible with GEA and NeGIF but the LRIMS is interoperable with other systems. The LRIMS system has high availability as the system is centrally located in GIDC where there is dual power system with UPS and generator, dual high speed internet connectivity, and the exact replica of the system is also installed in department and the disaster recovery site for GIDC will be established soon in Hetauda. There is also backup server for the application and database server itself in GIDC. If one server gets crashed other server will take over. Likewise if the GIDC system fails, the system will automatically take over by the standby system located in department. So, there is high availability in LRIMS.

9. BENEFITS

i.To Citizens:

- 24 x 7 (24 hours, 7 days a week) service availability
- Economical (Labor, Time & Cost), Transparent, Equitable and Convenience
- Fast and efficient service
- Can get an integrated LOC from any LRO.

ii. To Government:

- Centralized LIS database
- Correct and up to-date land information for better policy making and regulatory and development functions
- Very fast acquisition, storage and retrieval of data leading to better decision-making
- Protect the information from disaster like fire, earthquake etc.
- Better management of land administrative functions/processes –uniformity
- Better performance in regulatory functions like taxation, valuation, land use etc.
- Protect unauthorized transaction of Personal, Government & Public land
- Capture land ceiling land
- Helpful to reduce land disputes and to make officials and landowner accountable
- Protect officials- Maintains history of each activity
- Helpful for supervision and monitoring of the work from Centre
- Creates the positive image of modern and progressive land administration.

iii. To Stakeholders:

- Get correct information on time

10. LIMITATIONS

The map related data i.e. spatial component is not included in this system but this system has provision of one module that can integrate with GIS/ Cadastral maps in future. Currently the parcel splitting trace is scanned and uploaded in the system.

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NIGERIA-CAMEROON BORDER DEMARCATION AT A GLANCE AND LESSONS LEARNED FOR NEPAL

Mr. Prabhakar Sharma

Keywords: Border demarcation, international land disputes and settlements, WGS84 system, geodetic network, Nigeria-Cameroon border demarcation, Indo-Nepal border, Sino-Nepal border.

Abstract: *The border demarcation between two countries usually takes place after wars or serious conflicts. Nigeria, which has the largest army in Africa, showed that it had a big heart when it reached an agreement with Cameroon as per the 2002 ICJ judgment without waging a war with its much smaller neighbor Cameroon. Although many Nigerians feel that Cameroon has gained a lot more than Nigeria, especially when Nigeria decided to hand over sovereignty of the 1000 sq-km oil-rich Bakassi peninsula to Cameroon, the Nigerian government is eager to make a closure of the boundary demarcation as per the 152-page ICJ judgment.*

Ever since the demarcation activity started with a pilot project in 2005, many field missions have taken place with the mediation/facilitation of the United Nations, which has provided logistical and partial financial support and has brought in experts from all over the world.

The field demarcation along the land, river and ocean boundaries between Nigeria and Cameroon has mostly been completed, except for the final mapping and emplacement of boundary pillars along some sections of the border which are inaccessible or are marked 'disagreement areas'. There are some serious security threats posed by Boko Haram in the disagreement areas in the north.

The best practices used in the Nigeria-Cameroon border demarcation are outlined below. Nepal could take some valuable lessons from the demarcation methods used by these two countries and maintain the political will to carry on the border demarcation works which can be technically and physically challenging and politically complex.

1. INTRODUCTION

Nigeria and Cameroon share about 1950 km of boundary (960 km of land boundary and 990 km of river boundary), starting from Lake Chad in the north all the way to Bight of Biafra in the easternmost part of the Gulf of Guinea.

These two countries that had a few skirmishes in the past and nearly went to war are engaged in the orderly and peaceful implementation of the 2002 International Court of Justice (ICJ) Judgment regarding the land and maritime boundary between the two countries. They also established a Mixed-Commission to ensure implementation of the agreement. The Mixed-Commission holds regular meetings under the auspices of the United Nations.

So far, the Mixed Commission has agreed on the framework of the assistance provided by the UN, the timetable for the withdrawal of forces, the transfer of authority, the cost of demarcation , the budget and the fund-raising, the sequence of operations and the scope of work contracted out to the private sector. The Geneva Communiqué of 15 Nov. 2002 is the charter for the Mixed Commission.

Since its first meeting in December 2002, the Mixed Commission has met at regular intervals in the capitals of each country with the United Nations establishing a support team based at its Office for West Africa in Dakar, Senegal.

The peaceful withdrawal and transfer of authority of over 30 villages in the Lake Chad area (in 2003) and along the land boundary in 2004 took place successfully under the supervision of United Nations civilian observers who were overseeing all these exercises.

The modalities governing the withdrawal and transfer of authority in the Bakassi peninsula were signed on 12 June 2006 in Greentree, New York. This agreement was signed by the presidents of Cameroon and Nigeria, the Secretary General and representatives of five witness countries-France, Germany, United Kingdom and the United States and by August 2006, as per the agreement, 80% of the peninsula was returned to Cameroonian administration with full withdrawal of Nigerian troops. The remaining 20% was handed over to Cameroon in June 2010.

On 11th May 2007 an agreement was signed on the delimitation of the maritime boundary. The objective of this mission was to survey selected physical features in order to geo-reference the chart containing the boundary line as defined by the ICJ into the WGS84 datum.

In addition, the direction of the Loxodrome which forms the remainder of the maritime boundary up to its tri-point with Equatorial Guinea, was approved and signed in August 2007.

Hence all the four sections of the ruling-Lake Chad, the land boundary, Bakassi peninsula and maritime boundary- have been implemented peacefully.

2. SUB COMMISSION ON DEMARCATION

Alongside these more high profile legal and political issues, the process of demarcating the land boundary has continued with the Mixed Commission establishing a Sub-Commission on Demarcation (SCD) which in turn established a Joint Technical Team (JTT). The JTT includes technical experts from the UN, Cameroon and Nigeria responsible for carrying out the physical demarcation of the land boundary.

3. PRELIMINARY MAPPING

131 preliminary map sheets to 1:50,000 scales were prepared from partially rectified SPOT5 satellite imagery by the United Nations Cartographic section based in New York. These map sheets, which cover a 30-km corridor on either side of the land boundary, are used for planning and field reconnaissance.

These maps will be augmented at a later date from the measurement of ground control points to fully rectify the imagery, leading to the production of the final mapping including the agreed boundary line.

A provisional boundary line based upon the delimitation instruments defined by the ICJ judgment is shown on the maps in conjunction with the SPOT imagery. This provisional line helps the surveyor in following the general direction of the boundary.

4. FIELD ASSESSMENT

In the field assessment, which is carried by the Joint Technical Team (JTT) according to the Technical Guidelines, the boundary is demarcated after agreeing on the location based on the terrain described in the ICJ judgment.

For each pillar location, a “pillar site template’ on land or "river site template" on the river bank or on an island in the river, is used. On each site template, the GPS coordinates (UTM) based on Trimble Pro XRP with real time corrections from Omni-star are recorded, description cards prepared and signed by the delegations comprising of the UN, Nigerian and Cameroonian representatives. In general, pillars are placed at 500m intervals, increasing to 100 m intervals in towns and villages.

In areas of disagreement, ‘disagreement templates’ with the comments of Nigerian or Cameroonian representatives are signed. There are 2 disagreement templates for each pillar site. The areas of disagreement are then referred to the SCD/Mixed Commission (MC) for a technical or even a political decision.

The UN provides helicopter support for the field assessment for inaccessible areas.

5. GEODETIC NETWORK

It was decided by the Parties to use the internationally-recognized WGS84 and UTM system for the land boundary work.

The Geodetic Network consists of the construction and survey of 10 primary markers more or less evenly spaced along the boundary in either country along with 30 secondary markers located closer to the boundary.

Primary markers were surveyed in 2007-2008 using GPS to an accuracy of 0.010m $\pm$ 1.0ppm (max error 0.100m) with the secondary markers to 0.020m $\pm$ 10.0ppm (max error 0.200m).

6. BOUNDARY PILLAR EMPLACEMENT

It is estimated that about 3000 pillars (500 primary and 2500 secondary pillars) will be required to complete the boundary. The primary pillars will be established at 5km intervals and the secondary pillars will be constructed every 100 (for built up areas) or 500m.

The pillars will be constructed at the locations identified by the JTT during the field assessment.

7. FINAL PILLAR SURVEY

Following the construction of the pillars each one will be surveyed using DGPS(differential GPS) with the geodetic network forming the control points for the GPS survey. Each pillar will be surveyed to an accuracy of 0.020 m± 10.0 ppm (max error 0.200m).

A separate quality assurance contract will be undertaken to provide some assurance on the GPS computations for the geodetic network and the final survey.

8. FINAL MAPPING

The coordinates based on the final survey will be plotted on the rectified (using the ground control survey) 1:50,000 mapping.

9. LESSONS LEARNED FROM NIGERIA-CAMEROON BORDER DEMARCATION APPLICABLE TO NEPAL-INDIA OR NEPAL-CHINA BORDER DEMARCATION AND MAINTENANCE

The Nigeria-Cameroon border demarcation activity is viewed as one of the most successful on-going demarcation works in the world. It is, however, not without its own share of problems. The emplacement of pillars, especially along the northern Nigeria-Cameroon border, has been stalled because of security concerns due to Boko Haram. There are also issues related to the inaccessibility of the terrain. The inaccessible areas, especially the high mountains of Atlantica and Gotel ranges, were demarcated in the office and the templates with derived coordinates and description cards were signed based on DEMs (Digital Elevation Models) from satellite imagery.

Based on the experience of working for 8 years in the international border demarcation works along the Nigeria-Cameroon border, the author proposes the following:

- The **WGS 84 and UTM system** is one that can be used for border demarcation and reconstruction works for the Nepal-India or Nepal-China border with XRP Trimble GPS units with Omni-star subscription to obtain real time coordinates to successfully identify missing pillars or to trace old river courses or for densification of pillars along the boundary. The XP Omni-star observation gives real time coordinates with differential correction to sub-decimeter accuracy in open areas. For forested areas that do not have a clear line of sight to the Omni-star satellites, the dual frequency differential GPS (DGPS) method that uses a base and a rover station should be used.

- Nepal and India agreed to restart the stalled border **maintenance** and **restoration** works during Indian Prime Minister's visit to Nepal in the first week of August 2014. The border demarcation between Nepal and India will soon take place in a spirit of friendship and mutual respect as the leaders of both countries have shown the right political will to solve the border issues. We share about 1808 km open border with India with whom we have cultural, religious, linguistic and traditional ties. We should make concerted efforts to solve remaining border issues between our two countries.

  As it is a well-known fact that boundary maintenance and restoration are important contributors to continuous boundary stability, the GoN should establish well-funded **National and International Boundary Commissions** to solve the pending issues regarding national and international boundaries.

- It is very important to establish **map libraries** and **archives** of all the treaties, documents, individual and mutual maps of the treaties, aerial photographs, satellite imagery, articles by border experts (geodesists, cartographers, mapping experts and geographers) and politicians and lawyers so that they can be studied before we send in delegations at the international and national levels for negotiations of international or state boundaries.

- The GoN and the boundary commissions should send the technical and political experts to ferret out from the archives of other countries information regarding Nepal's border during British rule in India. The technical experts should be sent on **trainings** both at the local and international levels so that they can get the technical know-how of the best practices in border delimitation, demarcation, construction, maintenance and restoration works. There should also be transfer of local and international knowledge gained by Nepali experts to the younger generation by organizing workshops and seminars and paper presentation.

- Nepal and India would benefit greatly if there is a joint list of boundary coordinates in a common geodetic system, such as the WGS 84 GPS system which uses the UTM projection. It would be advantageous for Nepal to establish a **GPS network** all over the country so that it can be used not just for engineering surveying works and hydropower development but for boundary demarcation works and a long-term monitoring of the heights of Mount Everest and other high mountain peaks by local and international experts and researchers using different models and technological developments.

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S IN GEOINFORMATICS PROFESSION

Rabin K. Sharma

Keywords: SDI, GNSS, GEOSS, GIS, RS, GPS

Abstract: *The researchers from the field of surveying, in which the first letter of the word surveying is "S", is always seeking to improve for efficient system. In the process of such development, geoinformatics word being used instead of surveying and it covers wide range of technologies to collect, process, visualize, storage, integrate and disseminate the data and information required for many applications to improve the livelihood of the people. This article tried to identify such system related to the alphabet "S".*

1. INTRODUCTION:

S is a nineteenth alphabet in roman language and first letter of word Surveying. This technology remained still for many decades; however, the techniques are modified and improved for achieving high quality of the results. Surveying is an inevitable component for developing the nation because no one can think of development without the maps. Due to which many countries established Survey organization and carried out surveying for the preparation of several types of maps. One of the oldest surveying organizations is Ordnance Survey of Great Britain. During British regime in the world, number of countries established their own Surveying organization. For example: Survey of India, Survey of Sri Lanka, et cetera for conducting surveying works for the preparation of different types of maps. Whereas in Nepal, although Surveying work was carried out in a very primitive way since the Lichhibhi period, but formally Survey Department was established in 2014 B.S.

Technological development is a continuous process, so the same principle holds in surveying sector as well. Hence, scope of surveying is gradually increasing along with the technological development in this phenomenon and the word Geoinformatics is invented to abreast the several phenomenon in the course of technological development of surveying, such as Geographical Information System (GIS), Remote Sensing (RS) and Global Positioning System (GPS), Spatial Data Infrastructure (SDI), et cetera. It is realized that although GIS, RS and GPS are applied in their corresponding fields but these three technologies became inseparable and thus recognized as 3S in the Geoinformatics communities.

One very important fact is that if s is added in most of the noun words it will qualify as plural such as ships, snakes, books, fruits, et cetera. Such practice is being applied in different technological development not in the sense of pluralism but combining different systems either for the efficient performance of the system or for the societal benefits; for example, Global Navigation Satellite Systems (GNSS), Global Earth Observation System of Systems (GEOSS), et cetera.

2. SPECIFICATION:

In the context of the article, the first terminology for the surveying is the specification. When surveying is to be carried out, a document with detailed technical information has to be prepared beforehand. The document is termed as specification in which, datum to be used, method of survey to be adopted, type of equipment to be used, accuracy to be achieved, et cetera need to be clearly mentioned. Similarly, for every map series there should have its own specifications because the components of the specifications for a particular series such as accuracy standards, map layout, map contents, et cetera may vary according to its characteristics and need. The characteristics and need of the map series could be distinguished in terms of purpose and type or scale of the map.

Map specifications should be used as a guide and a controller by the individuals involved in the mapping process. Every individual should follow strictly the instructions, standard limitations and constraints outlined in the specification in order to produce a standard product. Therefore, the specification should be made available prior to the commencement of the mapping. As the quality of the map is directly linked with the standards and accuracy specified in the specifications, therefore, it should be prepared in such a way that the final product should reflect the objectives of the map. The standards and accuracy mentioned in the document should be compatible with the methodology, equipment and resources to be applied for the map preparation.

3. SPACE SCIENCE:

Space science is being applied unknowingly even during ancient civilization period of humankind. In those periods, the Shepherds used the stars and planets of the sky as their guide for the navigation and reaching their destinations. Now the importance of the space science and technology was realized, hence so many activities are in the process of technological developments and number of organizations established to promote and create awareness about the potential of the use of space technology and space related products. So space has supported directly or indirectly in human civilization. Using space science and technology, our quality of lives being enhanced and also could support sustainable development of our society.

The scientists of the world are trying continuously, to make best use of the space to facilitate the betterment of the life of the people. For instant: developed aircrafts to move from one place to another through the space, launched artificial satellites for establishing communication between two persons staying in different corners in the world, forecasting weather to facilitate their activities as per the weather condition, and many more.

Space related applications revolutionized the survey profession. In the past, space related technology was limited to finding out azimuth of a line and the location of the points by observing stars in the space. Now due to availability of artificial satellites, so many new technologies have been evolved such as Remote Sensing technology, Global Positioning System technology, et cetera.

4. THREE Ses OF GEOINFORMATICS:

As mentioned above, in Geoinformatics, Remote Sensing (RS), Global Positioning System (GPS) and Geographical Information System (GIS) are referred to three Ss. Reason being, in most of the application in Geoinformatics, these three technologies could not set apart. In other words, they have to be applied as an integrated way in number of applications. For example to locate a car parking location in nearby place when you are driving your vehicle, to spread net in the sea for fishing by locating the potential fishing area, et cetera.

5. REMOTE SENSING (RS):

The first S of 3S is Remote Sensing and this word is invented around 1961, originally to describe the topic of the conference entitled "Remote Sensing or Environment" held at the University of Michigan in 1961. Remote Sensing deals with air or space borne images created with devices other than conventional cameras. In airborne system, data are collected from the sensors installed in an aircraft or in helicopter where as in space borne system data are collected from the sensors installed in artificial satellites. Remote Sensing is characterized by satellites. They enforce a data transfer by telemetering rather than by film and the data collected from a distance are termed as remotely sensed data.

Remote Sensing technology is being used for mapping and interpretation of the features for different purposes for instance; extraction of geological features, land use features, forest related features, et cetera.

6. GLOBAL POSITIONING SYSTEM (GPS)

The second S of 3S is Global Positioning System (GPS), also termed as Navigation System with Time and Ranging which was developed for Navigation by United States of America (USA) in 1978. The system provides the services for determination of three dimensional coordinate of the observation station and for navigation in aviation, maritime and road transport using the signals received by the receiver at the station from several satellites orbiting the Earth. In order to locate the position, the receiver should receive signals from at least four satellites from a constellation.

7. GEOGRAPHICAL INFORMATION SYSTEM (GIS)

The third S of 3S is Geographical Information System (GIS). There are so many versions of definition of GIS, however, one of the definitions given by Arnoff in 1989 is as follows:
"Geographical Information System (GIS) is a computer based system that provides four sets of capabilities such as data input, data management (data storage and retrieval), manipulation and analysis, and data output to handle geo-referenced data ".

8. SYSTEM DEVELOPMENT TREND:

The scientists, researchers and data developers are always exploring to develop efficient, reliable, user's friendly and cost effective system. Recent trend in survey profession in this perspective is developing a system comprises of several similar systems or an integrated multi system approach. Some of such systems are Global Navigation Satellites Systems (GNSS), Global Earth Observation System of Systems (GEOSS), multi-sensors system, et cetera. In the following paragraphs some of such systems will be briefly described.

9. GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS)

Due to growing applications, easy operational system, high reliability in accuracy and affordable system in using GPS constellation of United States of America (USA); number of such constellations emerged from different countries or group of countries with their corresponding limitations. Accordingly, the constellations are categorized into Global constellation, Regional Constellation and Satellite Based Augmented System (SBAS).

In Global constellations, there are GPS from United States of America, GLONASS from Russia, Galileo from Europe and COMPASS/BEIDOU from China. In Regional Constellations there are QZSS from

Japan and IRNSS from India. Similarly in Satellite Based Augmented System from different countries around the world are also developed such as WASS from USA, MTSAS from Japan, EGNOS from Europe, GAGAN from India and SDCM from Russia *[5]*. Some of these systems are fully operational and some are partially operational and would be fully operational from the date announced by the corresponding organizations.

In order to make use of these systems, a concept of Global Navigation Satellite System (GNSS) was developed. In this system, satellites signals from the satellites of any constellations mentioned above could be used not only for Positioning, Navigations and Timing (PNT) but also for non PNT applications such as to compute wind velocity, height of sea waves, et cetera. Based on this approach of GNSS, the users could use satellites from different constellations at the same time and it believes that using this system, the users can be benefited in many aspects such as a user can receive signals of at least four satellites at any time at any corners of the world. This will certainly save time for the observation and consequently, will be cost effective without losing the expected accuracy.

10. GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS (GEOSS)

An international organization named Group on Earth Observations (GEO) has initiated Global Earth Observation System of Systems (GEOSS). GEOSS is being realized to provide benefits to humankind through the process of informing comprehensive and sustained Earth observations and in a coordinated approach. "*GEOSS will build on and add value to existing Earth-observation systems by coordinating their efforts, addressing critical gaps, supporting their interoperability, sharing information, reaching a common understanding of user requirements, and improving delivery of information to users*". Information for Societal Benefits covered the sector of Agriculture, Biodiversity, Climate, Disaster, Ecosystem, Energy, Health, Water and Weather *[6]*.

11. SPATIAL DATA INFRASTRUCTURE (SDI):

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

A good and reliable spatial and non-spatial data related with NSDI are the prerequisite for the effective and efficient decision making to address some of the major national issues of the Government such as poverty reduction, good governance, social justice, environmental protection, sustainable development and gender equity, et cetera.

12. SPACE SCIENCE RELATED ORGANIZATION:

In order to create awareness of usefulness of space science and technology for the society, several national, regional and international organizations are established. In Nepal, some of the national organizations are Nepal Surveyor's Association (NESA), Nepal Remote Sensing and Photogrammetric Society (NRSPS), Nepal Engineer's Association (NEA), and so on. Some of the regional organizations are Asia Pacific Regional Space Agency Forum (APRSAF), Asian Association on Remote Sensing (AARS), and similarly some of the international organizations are International Society for Photogrammetry and Remote Sensing (ISPRS), International Steering Committee for Global Mapping (ISCGM), International Federation of Surveyors (FIG), International Union of Geodesy (IUG), Group on Earth Observations (GEO) and so on. These organizations always organized events in regular basis in some parts of their working regions for promoting the applications of space technologies, informing achievements and status of latest development in space technology, increasing public awareness of the societal benefits, et cetera. If we surf the net for the calendar of events related to space science and technology, we can find some events are going to be held in one of the parts of the world in some days in every month throughout the year. So by participation in some of the events one could gain lots of space related information, update the knowledge and enhance the horizon of vision.

13. SERVICE DELIVERY:

Customer's satisfaction during service delivery is the most crucial component of the Government. The government always attempts to improve service delivery system but due to lack of adequate resources and appropriate infrastructure the problem remains as ineffective. Secondly, when a new minister or secretary comes, she/he will change the previous policy and mechanism. Therefore, in order to improve the service delivery, there should be cohesiveness in implementing the system. The officials involved in service delivery should be morally boosted and should be able to supply reliable, accurate and appropriate information to the users. Furthermore, the process of delivery system should not be complicated rather it should motivate the users to receive the information by themselves so that they should not take help from the brokers. The most importantly, the user should receive their information within the reasonable time.

14. CONCLUSION:

There are so many terminologies in the field of Geoinformatics which are related to the alphabet "S". However, discussion is made from the specification of the mapping, space science technology, and the trend towards the development in the space science. Some information is also provided to know the several national and international organizations working with the space science. Finally, a small hint is given about the status of the service delivery to the customers and the ways to be improved for effectiveness in the delivery system.

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SPATIAL STRUCTURE OF URBAN LANDUSE IN KATHMANDU VALLEY

Shobha Shrestha, PhD

Keywords: Urban landuse change, spatial structure, landuse fragmentation, spatial metrics, GIS and RS

Abstract: *Spatial structure of urban land use has been interest of study since early 20th century. The current study examines dynamics of spatial structure of urban agricultural landuse and how agricultural landuse is placed within the existing structure. The study explores the direction and dimension of landuse change and characteristics of spatial fragmentation in Kathmandu Valley. Technological tools like GIS and Remote Sensing, and Spatial metrics/indices has been used for spatial analysis. The study shows that within ten years time span of 2003 to 2012, urban land use has gone drastic change in Kathmandu valley. Remarkable change in terms of pace and direction is evident in agriculture and built-up classes which signifies the rapid urbanization trend in the valley. The finding shows that spatial structure of the urban landuse of the valley is impending towards more heterogeneous and diverse landscape. Similarly, spatial fragmentation analysis highlights characteristic development of new isolated urban patches inside relatively larger agriculture patches fragmenting them into number of smaller patches. The study concludes that the importance of GIS/RS tools and technology in identifying and analyzing structure and dynamics of land use within prevailing complex urban system of Kathmandu valley is reasonable. The composition and configuration of spatial structure computed through spatial metrics are thus helpful for understanding how landscape develops and changes over time.*

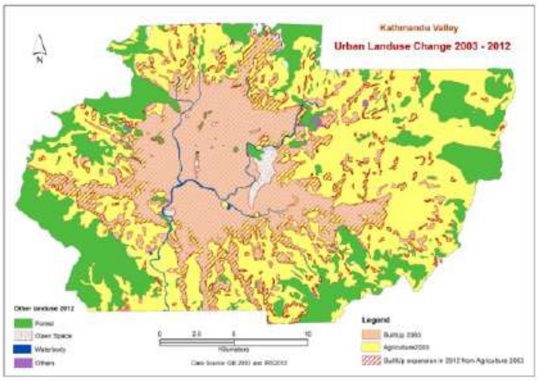
1. OBJECTIVE:

The objective of the current study is to explore to what extent and how the spatial structure of urban landuse has changed between 2003 - 2012.

2. METHODOLOGY:

The current study has used integrative methodology of combined use of remote sensing, GIS and spatial metrics which is relatively new approach and has shown considerable potential for structural analysis of urban environments (Torrens, 2008). The current research has used integrated methodology. Exploratory descriptive and analytical framework is adopted for spatial assessment. Tools and techniques applied are documentary review, Remote Sensing and GIS based mapping and spatial metrics. Qualitative and quantitative analysis using both primary and secondary sources for data and information collection is carried out depending upon nature and type of data and information collected. Through field observation and informal discussions are carried out in the field. Kathmandu valley is selected as a study area. It is selected as study area because despite being the most urbanized area and capital region of the country, it embraces heterogeneous land use including larger coverage of agricultural land. Digital database created from satellite images of different temporal and spatial resolutions are the major sources for bio-physical land use/land cover and agriculture data. Urban land use/land cover change from 2003 to 2012 was carried out using high resolution remote sensing images of three time period: 2003, 2007 and 2012. For the time period 2003 and 2006/7 Quick Bird images with spatial resolution less than 1meter were used. For 2012, ResourceSAT images of December, with 5meter spatial resolution from Indian Remote Sensing organization, IRS was used to identify/analyze more recent structure and dynamics of urban land cover/land use in the study area. Multi spectral analysis included digital classification of land use. At least ten training sample sites were selected for each land use class and these sampling sites were field verified. Major visible changes were noticed and verified through informal conversation with locals of the study area. GIS maps and satellite images of different time periods were used as field verification tools and land cover/land use found on the ground and in the map/images compared. Final landuse data layer of each time period was produced with six major land use classes as specified in topographical sheets from Survey Department of Nepal

Figure 1: Major Land use Change between 2003 and 2012



namely, agriculture, built-up, forest, open spaces including barren land, water body and other which includes all except aforementioned classes. Land use change analysis is carried out overlaying landuse data layers and change from one class to another is calculated and spatial analysis carried out based on the GIS output map and table.

Another tool used is spatial metrics for fragmentation and heterogeneity analysis. The spatial metrics is quantitative measures of spatial pattern and composition which describe the spatial heterogeneity for each land use class. Spatial metrics derived from satellite imagery also help to describe the morphological characteristics of urban areas and their changes through time. Spatial metrics as discussed by Eric J. Gustafson (1998) is used in this study for analysis of spatial structural morphology and heterogeneity of urban land use in Kathmandu valley during different periods. The indices developed by McGarigal (McGarigal et. al., 1995) used. Landscape level valley level for overall fragmentation and heterogeneity analysis and landuse individual class level analysis were carried out to quantify shape and pattern of urban landuse in the study area which measures fragmentation, dominance, proximity and diversity. Selected spatial metrics includes spatial Indices measuring composition and spatial configuration. Composition is quantified, and is described by:

(a) Number of landuse classes in the data/map, (b) Proportion of each class relative to the data/map, and (c) Diversity which combines two components of diversity: richness, which refers to the number of classes present, and evenness, which refers to the distribution of area among the classes.

Simpson's (Simpson, 1949) diversity index is example of such. The spatial configuration of structure properties is much more difficult to quantify, and attempts have focused on describing spatial characteristics of individual patches (patch based) and the spatial relationships among multiple patches (neighborhood based). Patch-based measures of pattern include size, number, and density of patches. These measures are calculated for all classes together or for a particular class of interest. Similarly, edge information includes various edges metric that incorporate the contrast (degree of dissimilarity) between the patch and its neighbors.

3. OVERVIEW OF URBAN LAND USE CHANGE 2003 -2012:

Number of studies focusing on urban land cover/land use issues of Kathmandu valley has been carried out using GIS and RS tools in different time period (Tamrakar, 1998; Koirala, 1999; Pradhan, 2001; Paudel & Karki, 2005; Haack & Rafter, 2006; Hack, 2009; Hack & Khatiwada, 2007; ICIMOD, 2007; Ghimire, 2008; Thapa & Murayama, 2009, 2010; Zurick, 2010; Rimal, 2011). These studies show accelerating urban growth of the valley resulting significant change in land use structure. Spatial expansion of Kathmandu city from historical period and change in morphological characteristics had also been explored (Ranjitkar & Manandhar, 1981). Directional expansion towards east and on patches as multiple nuclei are major characteristics from 1846 to 1964 whereas construction of road infrastructure (particularly Ring road) is characteristics after 1977 causing overall change in morphological structure of the city.

Direction and dimension of change in land cover/ land use class between 2003, 2007 and 2012 in Kathmandu valley is shown in figure l and detailed in table 1.

The table reveals that within ten years time span land use has gone drastic change. Remarkable change is evident in agriculture and built-up classes which signifies the rapid urbanization trend in the valley. Agriculture land coverage has decreased from 52.5 percent to 44 percent whereas built-up area has increased from 23 percent to 31.5 percent. As compared to agriculture and built-up area, forest area has remained relatively constant covering 22 percent of the valley. Major land use conversion observed during all three period is agriculture and built up classes. Most of the agriculture lands next to the core area followed by surrounding agriculture area have been converted to urban built-up during the decadal period of 2003-2012.

Table 1: Kathmandu valley Landuse change Statistics 2003 – 2012

SN	Land use Class	2003 (%)	2007 (%)	2012 (%)
1	Agriculture	52.58	46.58	44.70
2	Built up	23.25	29.59	31.54
3	Forest	22.61	22.35	22.20
4	Open Space	0.93	0.90	0.93
5	Water Body	0.15	0.12	0.15
6	Others	0.45	0.45	0.45
	Total	99.98	99.98	99.97

Source: Calculated from GIS data (satellite image QB 2003, 2007 and IRS 2012)

4. MORPHOLOGY AND STRUCTURE OF URBAN LANDUSE: FRAGMENTATION AND HETEROGENEITY ANALYSIS:

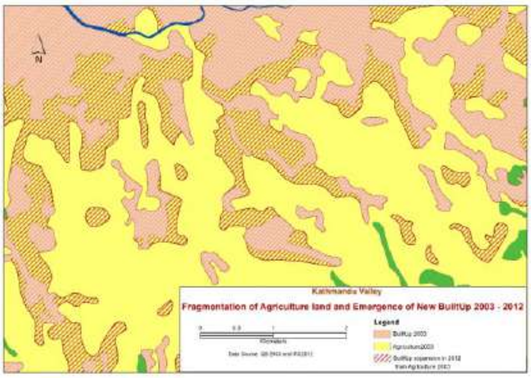
Spatial structure is a major subset of the concept of spatial heterogeneity which refers to the spatial configuration of the landscape. In this section, morphological dynamics i.e. spatial fragmentation and heterogeneity analysis at landscape level (i.e. heterogeneity among all types of land use existing within the valley, which provides overview of spatial heterogeneity) is carried out for Kathmandu valley using land use data of three different periods (2003, 2007 and 2012).

At the landscape level, Patch density (PD), Edge density (ED), Largest patch index (LPI), Perimeter-area fractal dimension ratio (PAFRAC), Euclidian nearest neighbour area weighted mean (ENN_AM), Contagion index (CI), Patch cohesion index (PCI), Landscape division index (LDI) and Simpson's diversity index (SIDI) are calculated to assess heterogeneity and fragmentation in spatial structure of land use.

PD has increased gradually from 0.812 to 1.008 at the landscape level, indicating the growth of new patches. With the development of new patches, new edge segments are created which is visible from increasing ED value of three time periods. The gradual increase in PD and ED value shows fragmentation of agricultural patches with new residential developments. The positive correlation between LPI and PD (increasing patch density and decreasing size of largest patch) is also evident from the table 2.

Calculated LPI value shows that the size of largest patch has decreased from 34 to 27. This indicates the decrease in size and increase in fragmentation. Variable proximity (variable ENN value) is another characteristics showing reducing proximity between 2003 and 2007 and relatively lower reduction between 2007 and 2012. Between 2003 and 2007 new isolated urban patches developed in relatively larger agriculture patches increasing distance between urban patches whereas expansion of urban area in the existing built-up periphery and expansion of isolated patches merged into one-another between 2007 and 2012 decreasing the distance between urban patches. This is also evident from the variable value of perimeter-area fractal ratio. Though the decreasing value between 2003 and 2007 shows connected expansion of urban area in the existing built-up, shape of patches became more complex between 2003 and 2012 (figure 2).

Figure 2: Fragmentation of continuous Agriculture land and emergence of new Built in Southern part of Kathmandu Valley 2003-2012



Contagion index on the other hand shows the increasing fragmentation of patches as decreasing index value shows increasing disaggregated patches. Highest difference between 2003 and 2012 shows increasing disaggregated patches as compared to 2007 and 2012. The evidence of increasing number of disaggregated patches is marked by patch cohesion index value. The decreasing value highlights gradual decreasing of physical connectedness. Increasing landscape division index values exemplify further fragmentation of landscape into smaller patches and decrease in proportional patch sizes. Simpson's diversity index value indicates increasing heterogeneity within urban landscape. Relatively higher difference value between 2003 and 2007 also shows increased heterogeneity. On the other side, moderate value between 2007 and 2012 indicates comparative homogeneity due to expansion of built-up areas through guided land development and organized housing by private companies.

Spatial fragmentation and heterogeneity analysis reveal that the urbanization process resulted mostly in

Table 2: Landscape Level Spatial Heterogeneity Analysis

Year	Patch Density (PD)	Largest Patch Index (LPI)	Edge Density (ED)
2012	1.008	27.485	28.806
2007	0.936	29.583	27.551
2003	0.812	34.994	25.645
Value	Increasing	Decreasing	Increasing
Year	Contagion index (CI)	Patch cohesion index (PCI)	Landscape division index (LDI)
2012	60.019	99.323	0.839
2007	60.307	99.358	0.836
2003	61.987	99.394	0.819
Value	Decreasing	Decreasing	Increasing
Year	Perimeter Area Fractal dimension Ratio (PAFRAC)	Euclidean nearest neighbor area weighted mean (ENN-AM)	Simpson's diversity index(SIDI)
2012	1.375	134.123	0.649
2007	1.369	141.072	0.645
2003	1.370	132.606	0.617
Value	Variable	Variable	Increasing

Source: Calculated from GIS data (satellite image QB 2003, 2007 and IRS 2012)

previously agricultural dominant lands and has caused fragmentation. The land use patch density significantly increased during the period of 2003- 2012. This has resulted heterogeneous and diverse land use within urban landscape of the valley. With the increasing urbanization, land use structure undergoes changes in their shape and size (Thapa and Murayama, 2010). Spatial heterogeneity is ubiquitous in urban landscape and its formation and interaction with urban process is central issue in urban land use dynamics.

5. SUMMARY & CONCLUSION:

Within ten years time span of 2003 to 2012, urban land use has gone drastic change in Kathmandu valley. Remarkable change in terms of pace and direction is evident in agriculture and built-up classes which signifies the rapid urbanization trend in the valley. Agriculture land coverage has decreased from 52.6 percent to 44 percent whereas built-up area has increased from 23 percent to 31 percent between 2003 and 2012. Most of the agriculture lands next to the built-up core area followed by surrounding agriculture area have been converted to urban built-up during the decadal period of 2003-2012. Spatial pattern of urban growth is radial around road network and expansion is in all direction. Noticeable urban growth is visible in three different parts of the valley, central north, central-east and western-south. Despite all spatial dynamics and decrease of agricultural landuse due to urban expansion in Kathmandu valley, the overall spatial extent of urban agricultural land use still holds 44 percent of total area and thus remained as significant urban landscape for decades.

Spatial fragmentation and heterogeneity analysis of landuse at landscape and class level carried out using spatial metrics found that the urbanization process resulted mostly in previously agricultural dominant lands and has caused fragmentation. The size of largest patch has decreased from 34 to 27 percent between 2003 and 2012 showing decrease in size and increase in fragmentation. Spatial structure of the urban landuse of Kathmandu valley is hence impending towards more heterogeneous and diverse landscape. Similarly, the resultant spatial heterogeneity of land use at class level structure is characterized by development of new isolated urban patches in relatively larger agriculture patches separating them. Connected expansion of existing built-up in the periphery and merging of isolated patches into one-another decreasing the distance between built-up patches is also evident. The evidence of increasing number of disaggregated patches and more complex shape is also marked.

The importance of GIS/RS tools and technology in identifying and analyzing structure and dynamics of land use within prevailing complex urban system of Kathmandu valley is reasonable. The composition and configuration of spatial structure computed through spatial metrics are thus helpful for understanding how landscape develops and changes over time.

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23rd Anniversary Program of NRSPS

The 23rd Anniversary Program of Nepal Remote Sensing and Photogrammetric Society (NRSPS) was organized on May 9, 2014. The programme was initiated by Rabin K. Sharma, **President of NRSPS**. After opening of the programme, Babu Ram Acharya, former Secretary of Government of Nepal released Earth Observation: Volume VI; Annual Newsletter of NRSPS in which two articles: ***A Glimpse of Geo-spatial International Workshop at Pokhara*** and ***Unmanned Aerial System for Data Acquisition: a Review*** written by Rabin K. Sharma and Suresh Joshi respectively were included. Besides the regular columns of the Newsletter, a message from Mr. Buddhi Narayan Shrestha, President of Nepal Institution of Chartered Surveyors (NICS) was also included. Mr. Acharya also delivered a very inspiring speech as a Chief Guest of the programme.

Another attraction of the anniversary programme was the delivery of felicitation messages from Nagendra Jha, the then Director General, Survey Department, Punya Prasad Oli, Vice President, Nepal Institution of Chartered Surveyors (NICS) and Saroj Kumar Chalise, General Secretary, Nepal Surveyor's Association, (NESA).

The 35th Asian Conference on Remote Sensing

With the capacity of the President of the Society, Rabin K. Sharma participated several workshops and meetings organized by different organizations. Among them, the participation of the 35th Asian Conference on Remote Sensing (ACRS) which was organized by Asian Association on Remote Sensing (AARS) from October 27-31, 2014 at Nya Pye Taw, Myanmar is worthwhile to mention. The purpose of the participation was to inform the international professionals of Geoinformatics participating the Conference about the "**International Workshop on Strengthening Education for Land Professionals and Opportunities for Spatial Data Infrastructure Development"** to be held in **Kathmandu** from **November 25-27, 2015** which is a joint event of *International Federation of Surveyors (FIG), Commission 2* and *International Society for Photogrammetry and Remote Sensing (ISPRS), Technical Commission IV, Working Group 4* and the workshop is going to be organized jointly by **Nepal Institution of Chartered Surveyors (NICS)** and **Nepal Remote Sensing and Photogrammetric Society (NRSPS)** with cooperation and support from several Governmental and non-governmental organizations.

International Geospatial Workshop

Some of the attractions of the "**International Workshop on the Role of Land Professionals and SDI in Disaster Risk Reduction: in the Context of Post 2015 Nepal Earthquake"** to be held from **November 25-27, 2015** in **Kathmandu** are as follows:

1. **Objectives:** To explore opportunities for strengthening and promoting good practices in education for land professionals and advancing Spatial Data Infrastructure concepts and spatially enabled societies.
2. **Expected participants:** Professors, researchers, professionals, industrialists and students in the field of surveying and mapping and land sector from around the globe.
3. **Presentations:** Delivery of Keynote speeches on relevant topics from international renowned dignitaries and technical papers on the theme of the workshop from several authors
4. **Side Events:** Annual Meeting of FIG Commission 7, Exhibition from several National and International organizations, and many more.

DON'T MISS TO PARTICIPATE

NICS

"International Workshop on the role of land professionals and SDI in disaster risk reduction: in the context of 'Post 2015 Nepal Earthquake'
November 25-27, 2015
Kathmandu,Nepal

Nepal Surveyors' Association (NESA)

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Mr. Madhusudan Adhikari
President

Mr. Ambadatta Bhatta
Chief Vice President

Mr. Saroj Chalise
General Secretary

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Eastern Development Region

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Other Members:
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Ms. Geeta Neupane
Mr. Laxmi Chaudhari
Mr. Kamal Bahadur Khatri
Mr. Bibhakta Shrestha
Mr. Sahadev Subedi
Mr. Balam Kumar Basnet
Mr. Nawal Kishor Raya
Mr. Santosh Kumar Jha
Mr. Khim Lal Gautam

Background

Utilizing the opportunity opened for establishing social and professional organizations in the country with the restoration of democracy in Nepal as a result of peoples movement in1990, Survey professionals working in different sectors decided to launch a common platform named Nepal Surveyors' Association (NESA) in 1991, as the first government registered Surveyors' Organization in Nepal.

Objectives

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

- To make the people and the government aware of handling the survey profession with better care and to protect adverse effects from it's mishandling.
- To upgrade the quality of service to the people suggesting the government line agencies to use modern technical tools developed in the field of surveying.
- To upgrade the quality of survey professionals by informing and providing them the opportunity of participation in different trainings, seminars, workshops and interaction with experts in the field of surveying and mapping within and outside the country
- To upgrade the quality of life of survey professionals seeking proper job opportunities and the job security in governmental and nongovernmental organizations
- To work for protecting the professional rights of surveyors in order to give and get equal opportunity to all professionals without discrimination so that one could promote his/her knowledge skill and quality of services.
- To advocate for the betterment of the quality of education and trainings in the field of surveying and mapping via seminars, interactions, workshops etc
- To wipe out the misconceptions and illimage of survey profession and to uplift the professional prestige in society by conducting awareness programs among the professionals and stakeholders
- To persuade the professional practitioners to obey professional ethics and code of conduct and to maintain high moral and integrity
- To advocate for the satification of Survey Council Act and Integrated Land Act for the better regulation of the profession and surveying and mapping activities in the country.

Organizational Structure

The Organization is nationwide expanded and it has the following structure: 14 Zonal Assemblies (ZA), 14 Zonal Executive Committees (ZEC), 5 Regional Assemblies (RA), 5 Regional Executive Committees (RAC), Central General Assembly (CGA) and a Central Executive committee (CEC).

Membership Criteria

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

Activities

- The Surveyors' day was celebrated organizing blood donation on Bhadra 01, 2071
- Donation of NRS 151,000.- to the victims of flood through Prime Minister's Relief Fund in 2071/05/18
- Distribution of fruits to the elderly citizens in Tinkune, Kathmandu
- Interaction programme at Reporter's Club on professional right

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 300.00 Rs 1000.00 Rs 1000.00 Rs 2000.00 Rs 3000.00
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 80.00 Rs50.00
Photo lab facilities	US$ 200/day

Incase if the materials are provided by the clients, the office will charge only 40% of the marked price as service charge.

Price of Digital Topographic Data Layers

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

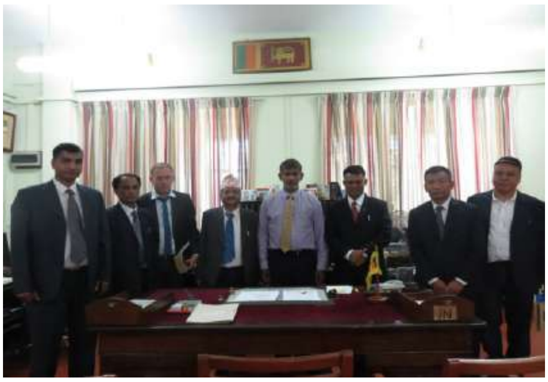
Image Data:

Digital orthophoto image data of sub urban and core urban areas mintained in tiles conforming to map layout at scales 1:10000 and 1:5000, produced using aerial potography of 1:50000 and 1:15000 scales respectively are also available. Each orthophotoimage data at scale 1:5000 (covering 6.25Km^2 of core urban areas) costs Rs. 3,125.00. Similarly, each orthophotoimage data at scale 1:10000 (covering 25 Km^2 of sub urban areas) costs Rs 5,000.00.

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

CSO Mr. Sushil Narsingh Rajbhandari, participating in the Study Visit and 6th International Summer School 2014, in Phnompenh, Cambodia, November 8 - 18, 2014.

A delegation from the Ministry of Land Reform and Management, led by the Deputy Director General Mr. Ganesh Prasad Bhatta, after a meeting with the Surveyor General of Sri Lanka, during a study tour to Sri Lanka from April 1-4, 2015



Survey Officers Ms. Shanti Baba Bajracharya, Section Officer Ms. Shanti Basnet, Ms. Ganga Subedi and Surveyor Ms. Rupa Dotel participating in Empowering Women Working in the Land Information and Management Sector, Perth, Australia, May 11 – June 5, 2015

Participants of the Joint Field Inspection Teams on Nepal – India boundary works, June 02 – 06, 2015.

Making Sense of Geo-spatial data for total solution in National and Local Development Activities

Available Maps and Data

- Geodetic Control data
- Aerial Photographs
- Topographic Base Maps
- Terai and middle mountain at the scale of 1:25,000
- High hills and Himalayas at the scale of 1:50,000
- Land Resources Maps
- Administrative and Physiographic Maps of Nepal
- Maps of
  - Village Development Committees/Municipalities
  - District, Zone and Development Region
- Digital Topographic Data at scales 1:25,000 & 1:50,000
- Cadastral Plans
- Orthophoto Maps
- Orthophoto Digital Data
- SOTER Data
- VDC Maps (Colour)
- Topographic Digital Data at scales 1:100,000 1:250,000 1:500,000 1:1,000,000

Available Services

Establishment of control points for various purposes of Surveying and Mapping
Cadastral Surveying
Photo Laboratory Services
Surveying and mapping for development activities
Topographic and large scale mapping
Digital geo-spatial database support
GIS Development

Contact Address:

SURVEY DEPARTMENT

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