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# Features

# Contents



**The front cover**
Nepalese women surveyors at work

## Contents

# Advisory Council



# Editorial Board

# Editorial

*Publications released on a regular basis dedicated to particular subject are means of sharing information and increasing knowledge in the related field. Survey Department started to publish Nepalese Journal on Geoinformatics as annual publication since 2002A.D. & the ninth issue is in your hand. We are constantly trying to improve the content and quality of the Journal. Since the 8th issue we have added a new column: professional organization page. We hope this will facilitate the readers about the activities of the organization.*

*In this issue Prof. Stig Enemark, President of International Federation of Surveyors (FIG) kindly provided an article titled "Land Management: A Global Perspective". I would like to express my sincere thanks to him.*

*All the journals published so far are available in the website of Survey Department www.dos.gov.np. We hope this provision will help the readers to update the knowledge in the field of Geoinformatics to some extent.*

*I would like to express sincere appreciation to Raja Ram Chhatkuli, the Chairperson of the Advisory Council for his valuable suggestions. Similarly, I would like to express my sincere thanks to all the authors, members of the Advisory Council, members of the Editorial Board and to all who have contributed for the publication of the Journal.*

*June, 2010*
*Kathmandu*

*Jagat Raj Paudel*
*Editor-in-chief*

# Message from Director General; Survey Department

*I am pleased to offer the ninth issue of the Nepalese Journal on Geoinformatics (NJG) to the esteemed readers. Survey Department, the National Mapping Organization (NMO) of the country, feels immense pride to publish the journal as its annual publication. The department is the sole government authority responsible for facilitating and regulating the surveying and mapping activities in the country and makes every possible endeavor to strengthen and develop the profession within the country. The journal is an attempt to disseminate to the readers on the activities of the department and also transfer knowledge to the fellow professionals.*

*In the modern world, advancement in information and communication technology (ICT), more specifically Geo-ICT, has great influence to the business strategy of an organization. Therefore, a close tie with Geo-ICT strategy is necessary for revisiting the business strategy of the department. The main challenge for the department is to build Geo-ICT capacity within itself. Initiation of National Spatial Data Infrastructure (NSDI) and digitalization of topographic and cadastral maps are some major steps in the modernization of the departmental services. Piloting of digital technology, using numerical survey in cadastral surveying in Banepa is leading to the expected success, though the efficiency in terms of time is not very high so far. As a continuous effort to introduce modern technology in surveying and mapping, the department plans to introduce application of orthophoto maps for cadastral surveying in Achham and Arghakhachi districts beginning from next fiscal year. This attempt will not only help the department complete the cadastre of the districts in a short period of time but also help in providing up-to-date information in the cadastral sector. At the same time, an attempt to carry out air borne gravity survey is planned for next year. The department will constantly provide its full support to land administration and management activities in the country in addition to its national mapping and NSDI services.*

*I would like to take this opportunity to congratulate the staff of the department on the auspicious occasion of the 53rd anniversary of the department and thank all those who have contributed to bring the department to the present status. I would like to thank the authors for providing quality articles. We are specially privileged to publish a paper by Prof. Stig Enemark, the President of International Federation of Surveyors (FIG). I would also like to thank the member of Advisory Council and Editorial Board for their tireless efforts to bring this volume at your hand.*

*Thank You.*

*Raja Ram Chhatkuli*

*Jestha 2067 (June 2010)*

# Adopting Geo-ICT in Survey Department: Need for Capacity Building

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***Abstract***

*The Geospatial Information and Communication Technology (Geo-ICT), is gaining momentum and has revolutionized the Surveying and Mapping profession. Since the geo-technology is evolving continuously, constant efforts are being made for its diverse applications. Most of the users are convinced that digital technology is known for its easy use and the power to improve their work process. Survey Department has witnessed tremendous changes in the technologies and corresponding policies in Global scenario in last fifty two years of its history and particularly during last two decades. Adoption of Geo-ICT has become indispensable in the present context. Even though Survey Department, so far, is not in the stage of fully exploiting the Geo-ICT, Time has come to think of adopting Geo-ICT application. Because, the wider use of Geo-ICT could be prime instrumental to support the overall Surveying and Mapping business. The success of efficient Geo-ICT application heavily depends on the capacity building, institutional reforms, devolution, education and continuous training, and ultimately the commitment of the government.*

*This article has tried to focus on various factors responsible for successful implementation of Geo-ICT in Nepalese context.*

## 1. Introduction of Geo-ICT

Geo-ICT means Geospatial Information and Communication Technology. The concept of Geo-ICT is to integrate the Geospatial technology into the mainstream of Information and Communication Technology. Geo-ICT is rapidly gaining momentum as key research methodology in geography, environmental science etc.

Geo-Information and Communication Technology (Geo-ICT) includes convergence of various modern technologies dealing with various aspects of spatial data management including: data acquisition, data integration, data analysis, information generation, decision support, and information dissemination. Geographic Information System (GIS), Remote Sensing (RS), Global Positioning System (GPS), satellite communication system and web technologies are the chief technologies falling under Geo-ICT.

There are many Geo-ICT applications. GIS could be considered as part of Geo-ICT. Geo-ICT provides even broader applications that traditional GIS may have not addressed well. Geo-ICT is truly an interdisciplinary area that would require the integration of GIS, GPS (position tracking), RS (remote sensing), satellite wireless communication systems, mapping technologies etc..

Geo-spatial revolution led to acquire and update knowledge towards high end research resulting Geo-ICT. The role of Geo-ICT has become vital for local level geo-spatial planning. Spatial data management includes: data acquisition, data assimilation, data analysis, information extraction, decisions support and data/ information dissemination.

## 2. Necessity for adopting Geo-ICT

Now-a-days, most of the professionals have moved from conventional analogue to digital. Since the geo-technology is evolving continuously, constant efforts are made in its diverse applications. This acceptance comes from a growing understanding about the technology and its benefits. Most of the users are convinced that digital technology is known for its easy use and the power to improve their work process.

The twenty-first century is the age of ICT and numbers of technologies are evolving day by day to accelerate the efforts for the maximum yields. Among the many applications of the information technology, Spatial Information System holds the potentiality of rendering significant contribution on policy-making, formulation of plans, infrastructure development, natural resource management and other development activities. The blending of ICT applications with Geomatics (GEO-ICT) is providing new insights into global issues such as the patterns and degradation of forests, climatic change, home land security and prevention of cultural heritages, monitoring of crops, war strategies and conflict management activities.

Even though the traditional disciplines were very essential for infrastructure development of mapping, the specialized and modern areas are becoming more important for comfort, safety, accuracy and reliability.

Geo-ICT will have a significant impact on Geomatics sector, industry, research and academia. This emerging Geo-ICT will open up many new applications resulting from a great improvement of data flow efficiency, dissemination, on-line data processing, quality management and calculable savings of operational costs of geo-information products.

## 3. Adoption of Geo-ICT in Nepal

In over 50 years of history of Survey Department, the technologies and corresponding policies have undergone tremendous change. Speedy development of technology in the field of surveying and mapping demands the changed role of surveyors and surveying institutions.

Survey Department is responsible for cadastral survey and preparing land records or establishing cadastre. Cadastral survey is the source of key information for the comprehensive Land Information System. An efficient Land Administration can not be imagined without accurate and reliable cadastral information.

Survey Department is gradually and slowly replacing the traditional methods adopting modern methods but yet much remain to be done. Survey Department, so far, is not in the stage of fully exploiting the Geo-ICT

In this context, it has already introduced some of the systems such as establishment of Geodetic Network and densification of control network by Global Positioning System Survey, Topographical base maps updating using Remote Sensing technology and Nepal-India border strip mapping by Geographical Information System technique and Digital technology for cadastral mapping. .

The advancement of Geo-ICT technology has been so rapid that it is supposed to be very difficult to adopt in our organization by virtue of lack of resources (Human, finance and others). Majority of the Human resources are turning out of date with the speed of change.

In Nepal, university education in Geomatics started only recently. Indeed low levels of technology, less skilled staff and exhausted processes are the critical issues in geospatial field. Appropriate ICT investment and capacity building are necessary conditions for establishing accurate geodata management for sustainable development. Education, training and research on geoinformation science are the fundamental factors for sustainable Geo-ICT use.

Although the cadastre system was focused to fiscal purpose in the beginning, it is being gradually used as legal and multipurpose cadastre. Updating of the cadastral maps is undertaken by district survey offices of Survey Department. Computerization of existing land records and cadastral maps to develop land information system and provide computer-based land administration services is under progress.

Land Administration is strongly influenced by social, cultural and bureaucratic environment, and overlooking of the existing practices and capacity would make failure in adopting such new technology. In this context, Geo-ICT has the vital role to play and has to be looked upon the overall objective

## 4. Progress so far achieved in adopting Geo-ICT

GPS survey for establishing geodetic controls was initiated by Survey Department in 1992. This survey is continuing to provide necessary control points to support cadastral surveying in different districts of the country.

Survey Department produced a new series of Topographic Base Maps between 1992 to 2001 at the scale of 1:25,000 (for the terai and middle mountains) and the scale of 1:50,000 (for the higher mountains and Himalayas) covering entire country in paper print. And subsequently converted all those maps into digital form by GIS technology and made available to the users as National Topographical Database (NTDB). Survey Department is working to create digital data files at smaller scales as well. Data files at a scale of 1: 100,000 are already available and has a plan to produce in 1:250,000, 1:500,000 and 1:1000,000.

With the mission of strengthening and developing geographic information infrastructure for the access of geographic and related data for decision-making, National Geographic Information Infrastructure Project (NGIIP) was established under Survey Department in 2002. This project facilitates the sharing of Geographical information among Geographical information user organizations within the country. This project has published Socio-economic atlas of Nepal and made available in CD-ROM, hard copy and on the web.

Topographical base maps, which were prepared during 1990's are updating with Remote Sensing

Technology. Survey Department has also prepared Global map of Nepal, Ortho-photomaps of Urban areas, and has developed an Operational Metadata system through NGIIP. The department also provides CD of Soil and Terrain Data of Nepal SOTER NEPAL Version: 1

Survey Department proposed Cadastral Logical Framework Plan in Fiscal Year 2005/2006 with a vision of replacing traditional technology with digital technology in ten years time. In this line Cadastral Survey Branch under Survey Department started re-cadastral mapping by Digital technology and development of Land related information system from 2006 in Ward no. 6 of Banepa Municipality of Kavre District as a piloting project. After evaluating the success of piloting job, survey was extended to the rest of the wards too. Survey works have been finished so far in 9 out of 11 wards of the Municipality. Surveys in rest of the two wards are continuing. Survey Department has proposed a plan of extending this kind of job in Dhulikhel Municipality for the coming fiscal year.

Significant numbers of Geo-referenced cadastral map sheets from various district survey offices have been digitized and being digitized by Department of Land Information and Archive. Survey Department can use these data if needed.

Himalayan Airborne Gravity survey is on the way to achieve a modern Geoid model for Nepal to contribute to Geodetic Network Infrastructure of Nepal.

## 5. Capacity building for efficient Geo-ICT application

The present pace of progress in Cadastral surveying in Village blocks and Topographical map cyclic updating seems far lag behind to meet the real sense of cadastral mapping and topographical map updating. It would take many many years to complete at the current rate of progress; so that it should be accelerated with unconventional methods.

Peoples of the urban areas are demanding accurate and reliable measurements of their land, but the present method applied in cadastral surveying is the traditional graphic method using plane tables, and does not fulfill the requirements of the people. The methodology adopted does not contain the dimensions of the parcel, and the cadastral plan does not meet the needs of the people. Furthermore, digital cadastral mapping is needed to cover the interest of the people.

Survey Department is thinking of initiating cadastral survey through applications of high-resolution satellite data for the generation of ortho-images for Achham and Arghakhanchi districts, where old cadastral records were completely destroyed by arsenal during conflict.

Our present capacity may not be sufficiently supportive to bring about the desired result with the situation at hand. The accomplishment of above mentioned jobs can be materialized only if we strengthen our current capability. Immediate plan of action for Capacity Building is thus an essential aspect to be addressed upon before adopting Geo-ICT for our anticipated purpose.

Geo-ICT offers an opportunity to build land administration enhanced and efficient. But in a developing country like Nepal, where traditional methods or processes are still in practice, full fledged Geo-ICT application is still a far-cry. However, constant efforts for positive development should not be left out.

Effective utilization of any technology depends mainly on the qualified and well trained manpower. So, effective education and training programs are to be imparted. Attempts are on in this direction. Kathmandu University and Land Management Training Center have collaboratively commenced academic under-graduate course of B.E. in Geomatics Engineering since August 2007. Till date three batches have been enrolled. This program includes Geo-ICT based land administration education. Versatile and qualified manpower's team can be expected from academic course of B.E. in Geomatics Engineering.

Land Management Training Centre (LMTC) has a proposal to transform its one year Basic and Junior Surveyor's Courses into a three-year Diploma in Geomatics Engineering course, and to offer a two-year post-graduate degree programme.

The continuous support of ITC in providing scholarships to various level courses ranging from Diploma to Masters Level for capacity building of Survey Department has contributed. Coordination and cooperation among some other international organizations involved in space technology application and enhancing awareness in its importance could boost up the effectiveness. Furthermore, regional cooperation in this sector including human resource development, a proper platform for data sharing, etc. is equally essential for maximizing benefits.

The success of efficient Geo-ICT application heavily depends on the capacity building, institutional reforms, devolution or location based services, education and continuous training, and ultimately the commitment of the government.

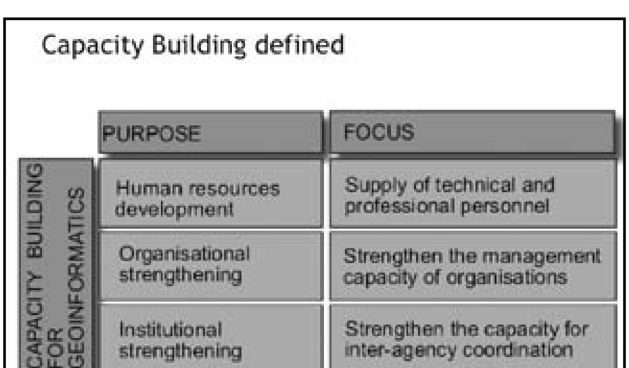
## 6. Constraints

In present context, Survey Department has following constraints for adopting an efficient adoption of Geo-ICT :-

- Lack of awareness among political leaders and policy planners resulting low priority in this discipline. There is little recognition that ICT can be used to supplement and complement the conventional system or processes,
- Lack of proper and sufficient education in this field, proper human resources and expertise.
- Lack of Infrastructure: Some of the problems include lack of reliable electricity supply, lack of bandwidth capacity in internet.
- Lack of financial support for managing Hardware, Software and Humanware.
- Related technology changes very fast and is difficult to keep pace with such changes.
- Replacement of traditional equipments and methodologies by digital technology has tremendously demanded increased and enhanced knowledge and skill.
- The original cadastral plans of half of the districts of Nepal were based on local survey control. They are described as so-called island maps and those map sheets are in hardcopy format. The "island maps" are not geo-referenced and hence cannot be digitized directly into the geo-spatial database.

## 7. Issues to be addressed

Adopting Geo-ICT remains a complex problem in Survey Department and the implementation of Geo-ICT is certainly a challenging task ahead in the present context. A firm commitment on the part of Policy planners, high level managers and whole hearted support from all the staffs to transform the technology may be the starting point.




The following prime issues were identified for successful implementation of Geo-ICT:-

**Technical issues**, which include system components, system design, and technical expertise; Project management and process re-engineering related issues;

**Organizational issues**, which include how well the staff of an organization understands the technology and its role, and how the organization adapts to new sources and types of information;

**Institutional issues**, which include factors external to an agency that influence an organization's ability to adopt or use Geo-ICT.

## 8. Plan of Actions

The efforts should be concentrated for the following plan of actions to adopt Geo-ICT effectively and efficiently:-

**1.** All the issues namely technical, organizational, project management, and institutional are important for geo-information management in the country. These issues are to be addressed while making plan of actions.

- Development of human resource is a pre-requisite; a continuous system of education, training and technology transfer need to be planned in house or abroad.
- Job placement and transfer should be wisely administered.
- Hardware and software:
    - adding Geo-ICT aids,
    - its maintenance and updating
- Policy for the Geo-ICT to be adopted to ensure effective and efficient utilization of resources.
- A strategy for formulating measures to control brain-drain.
- Organizational re-structuring suited to Geo-ICT need to be carefully planned.
- Resistance and/or non-cooperation from the existing staff in adopting new technology need to be addressed effectively

- A strategy for the transformation from manual to Geo-ICT (re-engineering) has to be carefully planned and adopted
- Participation of the public and private parties: and winning their faith in the new system is a pre-requisite: However, there are very few private parties, which can contribute to the implementation in Nepal.

**2**. Geo-ICT applications at present have disgraceful implementation scenario. Hence a strong need for research is felt in the area of geo-information management in the country.

**3**. Task force on 'Geo-information management' can be suggested by inducting professionals having expertise in technical, organizational, project management, and institutional areas. This task force should be assigned to bring out a business model for Geo-ICT products at Private partnership for its greater sharing between various stakeholders.

## 9. Private participation in Geo-ICT

All necessary conditions for the successful adoption of Geo-ICT cannot be imagined to be materialized only through the governmental efforts. In the new political environment, there may not be of exclusive control of government in mapping and geo-information sector.

Realizing the role of Private Parties in the changed context, Land (Survey and Measurement) Act, revised in 1999 made a provision of licensing to qualified surveyors, twenty seven surveyors have already got licenses, but have not fully implemented yet due to lack of supportive regulations and few other bureaucratic reasons. It can be expected that the system will start soon. Licensing surveyor's participation in Geo-ICT application in the country can be expected. Their activity will have some kind of direct or indirect influences in Survey Department as well.

There are four professional associations namely Nepal Surveyor Society, Nepal Surveyor's Association, Nepal Remote Sensing and Photogrammetric Society, and the Nepal Association of Chartered Surveyors to promote the Geoinformatics profession. However, their activities in the professional development and contribution to the Geo-ICT technological development in their respective fields lag far behind. Their activities are found limited to arranging a few number of seminars and publication of journals.

Some private educational institutes including School of Geomatics and Himalayan College of Geomatic Engineering are also contributing Geo-ICT manpower development.

Currently the private sector has limited potential capacity to contribute to cadastral surveying and mapping. Private survey professionals are demanding establishment of a Survey Council for the development and promotion of healthy, independent and responsible professionalism. Framing and enactment of a Survey Council Act is believed to strengthen, promote and protect private surveyor's role.

Survey Department should take a pivotal role in the country through Public-Private Partnership and Public-Public Partnership by bringing in the professional's associations and private licensed Surveyors in Geo-ICT activities for land management.

## 10. Conclusions

In spite of numerous constraints, the importance of Geo-ICT applications can not be neglected to keep pace with the advancement of technology and to serve the overall development of the country. Due to various reasons mentioned above the Department has not been in position to adopt Geo-ICT to desired potential. So, national and international cooperation in this respect might be the possible solution to address the capacity building of the department. However, Government policy makers continued support and the participation of the stakeholders are also equally vital for its sustainability.

The success of Geo-ICT heavily depends on the capacity building, institutional reforms, devolution of functions and services, education and continuous training, and ultimately the full commitment of the government and other stake holders.

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# Assessment of Groundwater Recharge Using GIS

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**Key words:**

GIS, groundwater recharge, water balance, Discharge

***Abstract***

*Pressure on drinking water is increasing tremendously due to the increase in population in Kathmandu valley. Groundwater is serving as one of main source of water supply in the valley. Due to the scarcity of surface water and high demand for drinking water, excess extraction of groundwater than it replenishes may cause negative effect to Kathmandu valley like subduction. Thus, proper quantification of groundwater recharge must be done to define sustainable extraction of the groundwater. This study is conducted with the aim to demonstrate the simple water balance model within the GIS environment in order to quantify the spatial distribution of groundwater recharge. The simple water balance model Thornthwaite and Marther (1955) was used to quantify the water balance components in the upper bagmati watershed. The study shows that the groundwater recharge is high at the northern part specifically where there is high water holding capacity.*

## Background

The demand of water for domestic use has increased due to the high population growth along with the increasing number of industrial, tourism and institutional establishments which have put tremendous pressure on the limited source of water of Kathmandu. In order to fulfill these demands groundwater could be the alternate source. In spite of the limitedness in amount, groundwater is being used as alternative source for fulfilling the water demand. Groundwater occurs in the cervices and pores of sediments and occurrence are seen in the form of springs and seepages. The groundwater resource in Terai and the Inner Terai Valleys is estimated to be 12 billion $m^3$ (Kansakar 2001). Systematic evaluation of Nepal's groundwater resources began in the late 1960s under the auspices of a USAID (LRMP report, 1986). Based on the hydrological formation of various characteristics including river deposits and others, the Kathmandu Valley is divided into three groundwater zones:

a) the northern zone

b) the central zone and

c) the southern zone (JICA 1990).

According to the Snowy Mountains Engineering Corporation (SMEC, 1992), the upper limit of groundwater extraction in Kathmandu should be about 40.1 MLD. In spite, in 2002, NWSC's Optimizing Water Use in Kathmandu Valley Project (OWUKVP) found that the amount of groundwater extracted by NWSC and private wells for domestic use was about 47 MLD (Table 1). In addition, it is estimated that extraction for other domestic and private use is 13.2 MLD, yielding a total extraction of about 60 MLD a figure very much higher than the upper limit of extraction calculated by SMEC in 1992 (Dixit & Upadhaya, 2005).

Table 1: Groundwater extraction in Kathmandu Valley

| System | Groundwater extraction (MLD) | | | |
|---|---|---|---|---|
| | Deep tube wells | Shallow tube wells | Dug wells | Total |
| MWSC | 23.79 | 2.06 | 3.31 | 29.17 |
| Hotels | 5.50 | 0.90 | 0.12 | 6.53 |
| Private | 2.47 | 1.30 | 0.71 | 4.48 |
| Domestic | 0.07 | 0.32 | 0.19 | 0.58 |
| Govt./Inst. | 5.22 | 0.41 | 0.03 | 5.67 |
| Embassy | 0.43 | 0.00 | 0.00 | 0.43 |
| Total | 37.49 | 5.00 | 4.37 | 46.86 |

*Source: OWUKVP, 2004*

The increasing population in the Kathmandu valley is increasing high demand for drinking water. The surface water available for drinking is not sufficient to fulfill the demand. Thus, groundwater is being one of the alternative sources. However, the over extraction of the groundwater has also started producing problems which is seen as decrement in the water level at the well. So in order to go for sustainable yield of water, proper analysis of the groundwater recharge potential is necessary This study attempted to analyze the potential ground water recharge zone for extraction.

## Objectives

The main objective of this case study is to demonstrate water balance model in GIS environment to:

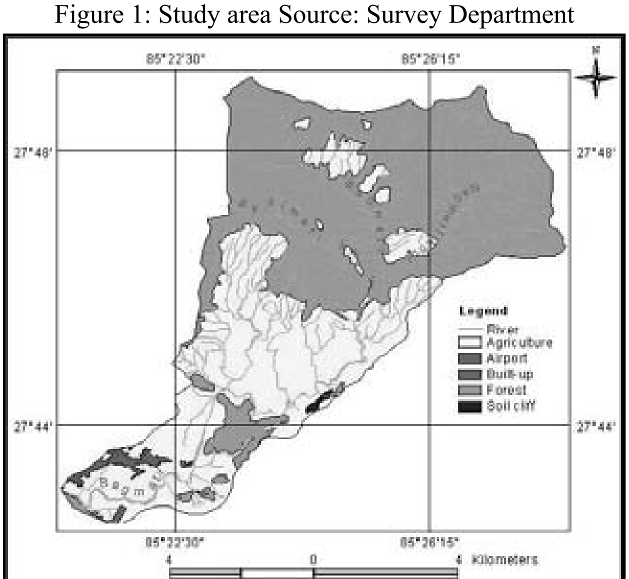
- quantify groundwater recharge potential
- delineate groundwater recharge zone

## Study Area

The Bagmati river and its major tributaries Nagmati Khola and Syalmati Khola originate from the Northern fringe of Kathmandu valley (figure 1). The hydrological boundary of the Bagmati river considering Gaurighat as outlet is selected for this case study. The total area of the study watershed is 65.43 km$^2$. The study area extends from Latitude 27°42’11”N to 27°49’2”N and Longitude 85°21’6”E to 85°29’13”E. The study area includes some portion of Shivapuri National Park.

The study area lies in the Mid Mountain Region and the elevation within the study area ranges from 1,320 masl to 2,710 masl. Mean annual precipitation in the study area ranges from 1500mm to 2000mm (DHM).

Figure 1: Study area Source: Survey Department




## Methods

The simple water balance model (Thornthwaite and Marther, 1950 was applied in the study. The water balance is modeled taking into account the spatial distribution of rainfall and evapotranspiration, and soil texture.

Each and every component of water balance model (*Figure 2*) was computed in GIS environment using Integrated Land and Water Information System (ILWIS) 3.3.

In this model, it was assumed that a portion of rainfall will leave the area as surface runoff.

i. **SR=c1*rain**

Where, SR is surface runoff, C1 is runoff coefficient & rain is the total rainfall occurred in the study area in the concerned month.

Remaining part is called effective rainfall. From the total amount of effective rainfall, portion of it is returned to atmosphere as evapotranspiration. The remaining part is available for infiltration into the soil as surface recharge.

ii. **SRECH = (rain - SR) - ET**

where SRECH is surface recharge and ET is evapotranspiration

When the soil is below the water holding capacity (WHC) and surface recharge is positive i.e. effective rainfall is more than evapotranspiration, then surface recharge is used to replenish the soil moisture.

iii. $\mathbf{SM_{(i)} = SM_{(i-1)} + SRECH_{(i)}}$

Where, $SM_{(i)}$ is soil moisture of the month i and $SM_{(i-1)}$ is soil moisture of previous month (i-1)

As soon as the soil moisture reaches WHC, the remaining part will percolate to the groundwater called as groundwater recharge. Thus soil moisture remained after loosing portion of water into groundwater recharge from total soil moisture is the remaining soil moisture.

iv. **GRECH = SRECH - (WHC - SM)**

where GRECH is ground water recharge

When surface recharge is negative i.e. the effective rainfall is less than the evapotranspiration, water will be withdrawn from soil moisture, thus resulting in the exponential soil moisture depletion. The soil moisture depletion curve is described by the following formula:

v. $\mathbf{SM=WHC*Exp^{(-APWL/WHC)}}$

Accumulated potential water loss (APWL) is a variable which describes the dryness of the soil. In the months with surface recharge less than zero, APWL is calculated as

**vi.** $\mathbf{APWL_{(i)} = APWL_{(i-1)} - SRECH_{(i)}}$

In the months with a surplus of water i.e. SRECH>0, APWL=0. If previous month (i-1) with surplus of water is followed by the month (i) with water deficit, APWL is calculated by using the formula:

**vii.** $\mathbf{APWL_{(i-1)} = -WHC*ln\ (RSM_{(i-1)}/WHC)}$

where RSM is remaining soil moisture from previous month.

Underground surface contains groundwater store called as detention. This detention causes delay in groundwater runoff. Some percentage of water holding capacity of the soil is taken as detention coefficient. When groundwater recharge is greater than zero, water is added to the detention from the previous month.

Not all the water in the groundwater store becomes part of groundwater flow but only a certain fixed percentage goes as runoff in same month.

**viii.** $\mathbf{GRO_{(i)} = C2*(DET_{(i-1)} + GRECH_{(i)})}$

where GRO is ground water flow DET is detention andC2 is detention coefficient Rest is detained till next month. Thus the new detention for the month will be

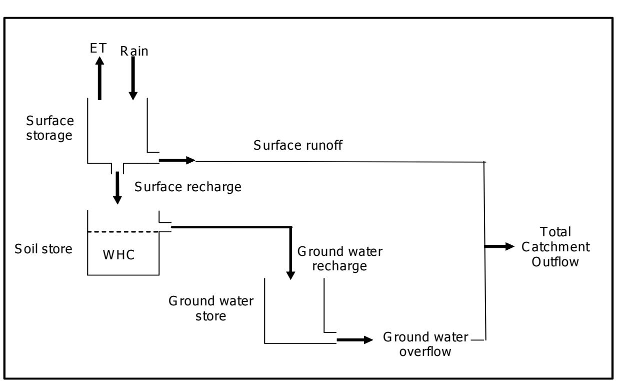
**ix.** $\mathbf{DET_{(i)} = (1-C2)*(DET_{(i-1)} + GRECH_{(i)})}$

In this study 20% is taken as detention coefficient.

The direct runoff (surface runoff) together with groundwater flow forms total catchment outflow.

As after the rainy season, soil moisture will be at it's full capacity. Hence, September was selected as starting month to begin the calculation.

*Figure 2:*
*Graphical representation of the water balance model*
(Adopted from Meijerink et al 1994).




## Materials

Drainage map, contour map, land use map and land system map of the Kathmandu Valley were collected from ICIMOD (Shrestha & Pradhan 2000).

The rainfall data recorded at the rain gauge stations which lies within and around the study area were collected from Department of Hydrology and Meteorology (DHM). The stations were Sundarijal, sundarijal Power House, Tribhuvan International Airport, Changunarayan, Budhanilkantha and Sankhu. Similarly, long term evaporation data of the Khumaltar station. Average monthly discharge from the Upper Bagmati Watershed at the outlet point (Gaurighat) was also collected from DHM.

## Limitations

This study was conducted as case study to fulfill the partial requirement for M. Sc. in Environmental Science within limited time and resources. Hence, the estimation of runoff and detention coefficient which need long calibration process could not be carried out. These coefficient were estimated by trial method for number of times till the value of discharge after computation match with that of the observed data at the outlet

## Results

Total inflow volume of water received as rainfall by the system is 154.2 million $m^3$. Similarly total outflow (includes depletion from evapotranspiration and discharge at the river) volume was 166.93 million m3. Thus, the percentage error was 8.25%. The error could be due to assumed runoff coefficient, detention coefficient and excluding the water use for irrigation at Gokarna due to unavailability of data.

From the study it is seen that maximum recharge is in the month of July.

*Table 2: Estimated and measured river discharge*

| Month | Measured average monthly discharge (m3/sec) | Estimated monthly discharge (m3/sec) |
|---|---|---|
| January | 0.439 | 0.009 |
| February | 0.318 | 0.008 |
| March | 0.356 | 0.007 |
| April | 0.420 | 0.010 |
| May | 0.734 | 0.009 |
| June | 1.611 | 2.998 |
| July | 8.666 | 8.371 |
| August | 13.375 | 12.325 |
| September | 7.509 | 6.674 |
| October | 2.949 | 1.087 |
| November | 1.080 | 0.555 |
| December | 0.570 | 0.035 |

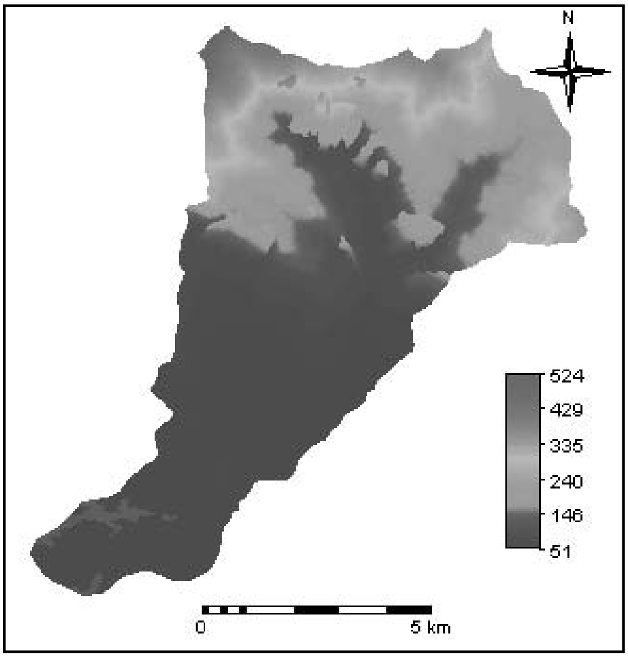



Figure 3: Total annual rainfall (mm)

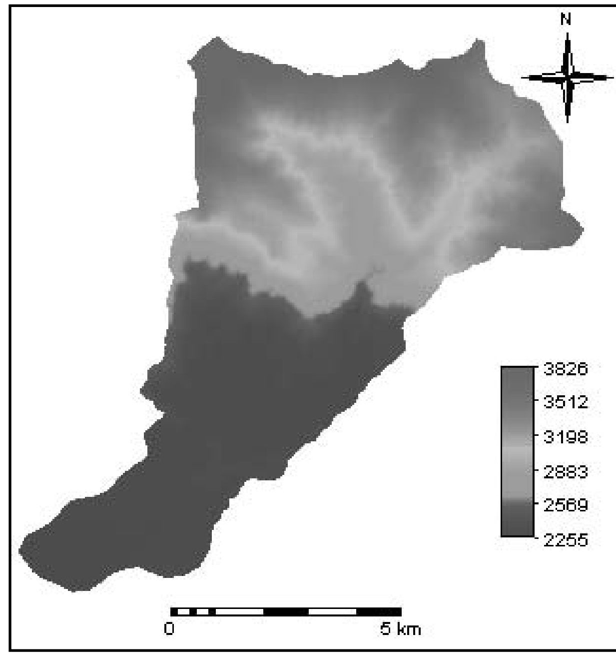



Figure 4: Total annual groundwater recharge (mm)

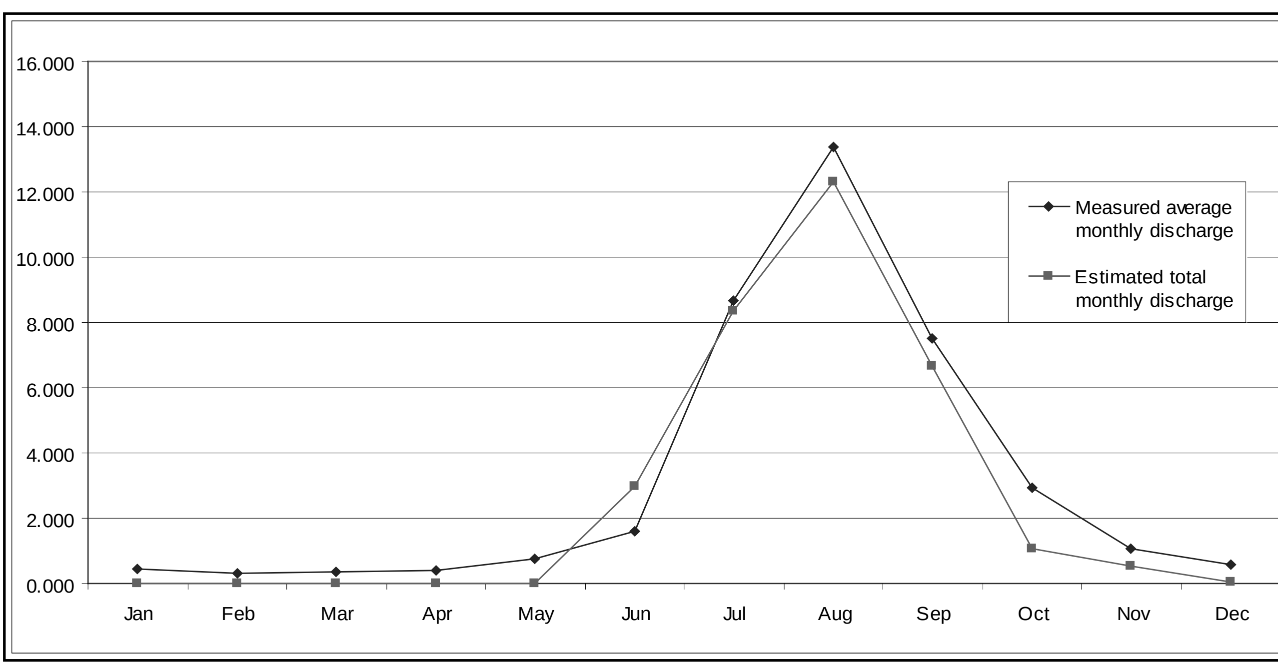



Figure 5: Graphical representation of measured and estimated discharge

## Conclusions

Since last decade, population of Kathmandu valley is increasing day by day. Some of the reasons are the job opportunities, facilities, security, political issues etc. Thus the required resources for day to day life are being scarce to fulfill the needs of this increasing population. Among these resources water resources is also one. Surface water is not enough to fulfill their demand. Thus groundwater is one of the alternate sources.

This case study is used to access the groundwater potential zone by using available data in GIS environment which makes the task easier and reliable too. From the study it is seen that the major groundwater potential zone is the Sundarijal VDC area. At the southern part of the study area i.e. urban area, groundwater recharge is less in comparative to northern part. This is because of the soil texture at that area with low water holding capacity than in the northern part. The next reason is the increasing urbanization which increases surface runoff rather than surface recharge. The maximum groundwater recharge occurs in the month of July.

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# 2009-2010 at a Glance

**1. Discussion program on Cadastral Survey**

Cadastral Survey Branch organized a discussion program from 24th to 26th August 2009 to review the progress of the previous fiscal year and to discuss the program for the running fiscal year. The closing session of the program was addressed by Mr. Chhabi Raj Panta , Secretary of the Ministry of land reform and management and Mr. Raja Ram Chhatkuli , Joint Secretary of the ministry.

**2. Visit of consultant of CADASTRE Limited, New Zealand**

Mr. Neil Pullar consultant of Cadastre limited New Zealand visited Survey Office Banepa on 20th November 2009 concerning the digital cadastral survey work conducted by the survey office.

**3. Distribution of Land ownership certificate**

Secretary of Ministry of Land Reform and Management, Mr. Chhabi Raj Panta, distributed Land ownership Certificate of Banepa Municipality ward no. 6, resurveyed first time using Digital Technology amid a function on 15th October 2009. Director General of Survey Department, Mr. Rabin Kaji Sharma chaired the function. Joint Secretary of the Ministry, Mr. Raja Ram Chhatkuli highlighted on the role of media to aware the General public about the digital technology. Chief District officer of Kavre district, Mr. Netra Prasad Neupane stressed that the service delivery will be better using digital technology. Branch Chief of the Cadastral Survey Branch, Mr. Jagat Raj Paudel delivered the welcome speech and stressed on the use of digital technology in Cadastral Survey work. Chief Survey Officer Mr. Yadab Raj Dawadi delivered vote of thank to the guests and participants of the function. Survey Officer of Banepa Survey Office, Mr. Khil Raj Chauhan presented the process of digital survey works conducted in Banepa Municipality.

**4. Change of leadership in Survey department**

Government of Nepal appointed Mr. Raja Ram Chhatkuli the Joint Secretary of the Ministry of land reform and Management as Director General of Survey Department on 23rd November 2009. After taking charge of the Director General, Mr. Chhatkuli addressed the staffs in the meeting hall of the Department.

**5. Interaction program**

An interaction program was organized by Survey Department with the representative of the Geographical Survey Institute (GSI), Japan on 22nd December 2009. Project Chief of National Geographic Information Infrastructure Program Mr. Suresh Man Shrestha presented the introduction and activities of Survey department. Dr. Hirishi P. Sato presented the different activities of GSI Japan.

## 6. Survey Office buildings under construction

Survey Office building of Bhaktapur and Dhading are under construction as per the annual programme of fiscal year 2066/67 B.S. of the department. After the completion of these two office buildings, 20 Survey offices out of 83 will operate from their own building.

## 7. Preparation of topographic maps for Joint Project Office - Saptakoshi Sunkoshi Investigation (JPO-SKSKI)

As per memorandum of understanding between Survey Department and Joint Project Office Saptakoshi Sunkoshi Investigation, final maps of small scale have been submitted and large scale maps preparation are under progress.

## 8. Distribution of Land ownership certificate

Minister of Land Reform and Management, Mr. Damber Shrestha, distributed Land ownership Certificate of village blocks of Kumroj and Khairahani V.D.C. of Chitawan district amid a function on 8th March 2010. Director General of Survey Department, Mr. Raja Ram Chhatkuli chaired the function. Chief District Officer of Chitawan district, Mr. Maheswor Neupane stressed the importance of land ownership certificate in the daily life of the land owner. Branch Chief of the Cadastral Survey Branch, Mr. Jagat Raj Paudel delivered Vote of thank. Surrvey Officer of Survey Office Chitawan, Mr. Puspa Raj Joshi Delivered the welcome speech.

## 9. Mini-project activities

Mini-Project is a research type RS/GIS training program which is held annually at Geo-Informatics Center, Asian Institute of Technology (GIC-AIT) for about 2 months having a 1-week field work at the participants' countries. As the continuation of this programme, under the sponsorship of Japan Aerospace Exploration Agency, total 13 mini projects were carried out for the year 2009-10 from 12 different countries which include Bangladesh, Cambodia, Indonesia, Kyrgyz Republic, Lao PDR, Mongolia, Nepal, Pakistan, Sri-Lanka, Thailand and Vietnam.

Two projects from Nepal were accepted for this year mini project. The participants were Mr. Susheel Dangol from Ministry of Land Reform and Management with the project title "Flood Hazard Mapping Using Geoinformatics" and Mr. Sijan Dhakal from National Geographic Information Infrastructure Program, Survey Department with the project title "Landslide Susceptibility Mapping, A Case Study of Laprak VDC Gorkha, Nepal". The purpose of this training was to help the participating organizations to solve their RS/GIS-relating problems at their work for the purpose of expanding their capabilities for future.

# Involvement of Survey Professional Organizations in International Activities

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## 1. Introduction

Some of the major works of the organizations from survey profession are to create and disseminate spatial and non-spatial data, to produce proper human resources and also to recommend policy on geoinformatics for implementing development activities of the country. So these organizations have greater role and responsibilities in the process of building the nation. Some of the responsibilities of the organization are to educate and enhance the knowledge of the officials of the organization, to keep abreast in the recent technologies available in the world and to build capacity of the organization for customer's satisfaction and to disseminate the data and information related to mapping effectively. In order to fulfill these responsibilities, the professionals of the organization must have proper education and should be competent enough among their colleagues within the organization and counterparts from abroad. The means to develop their competency could be combination of the net surfing, reading proceedings of the conferences, studying higher level education, attending refresher courses in a particular topic, participating conference/ workshop, etc. In the present context of globalization in technological development, an organization without having its staffs reasonably competent, it will be hard to follow the technological development trend. Therefore the organization should create environment to allow the staffs for participation in international activities and interact, discuss and share the knowledge with the experts, researchers, and scientists from other parts of the world. There are so many international activities occurring throughout the year in different parts of the globe. In most cases, it is open to all. However, all the staffs in the organization may not have ability to prove herself/himself as a competent staff, so the organization should have mechanism to choose the correct event, in right time and proper staff for attending the event.

## 2. Survey Professional Organizations of Nepal

Although the modern technology of surveying and mapping has entered in Nepal, organizations involved in survey profession have not been able to discard the classical methods and so they are dealing parallel both with classical and modern approaches of surveying and mapping. The reasons could be unavailability of required number of new generation of professionals and the financial support needed to establish the advanced technology.

In the modern technology of surveying and mapping, every steps of the procedure such as data acquisition, data processing, data analysis and visualizations, and data dissemination has to handle with the computer based systems. Furthermore, the development in the domain of surveying and mapping is so rapid that the professionals involved in this discipline need to update their knowledge and skills more frequently. Hence there is a greater role of teaching institutes to upgrade and update the knowledge of the human resources working in the organizations and to produce fresh candidates for the recent technology.

On the other hand, there are few professional organizations of survey profession which are established to advocate, promote and assure the related organizations to apply technology for the process of national development and also to recommend the means to provide efficient and effective service delivery to the users. So noting the existence of number of organizations related to survey profession in Nepal, this article shall limited to Survey Department, Land Management Training Centre and Nepal Remote Sensing and Photogrammetric Society of Nepal in order to represent a government organization, a teaching institute and a professional organization respectively. Furthermore, these organizations are trying to give more and more exposure in the international forums.

## 3. Activities of International Organizations

There are so many international organizations established around the globe with specific objectives related with surveying and mapping, remote sensing, earth observation and space technology. Some of the common objectives are to share the knowledge and information on research activities and to pursue and promote to adopt newly developed technology in application of diverse field such as surveying and mapping, land resource management, weather forecasting, disaster prevention, and etcetera. The means of communicating information to the related organizations around the world are the activities defined by the corresponding international organization such as training programme, conference, workshop, meeting, summit, project implementation, dissemination of information through e-news, etc.

## 4. Involvement in the Activities

Survey Department, Land Management Training Centre and Nepal Remote Sensing and Photogrammetric Society are moving ahead to achieve the goals defined in their respective objectives. They have one objective is in common which is clearly visible from their corresponding activities that they are trying to give their exposure into international arena and to involve in the activities of related international organizations as far as possible although there are limited financial resources and constraints to invest the resources.

### 4.1 Survey Department

Survey Department was established in 1957 AD mainly for cadastral mapping to assist in the collection of land revenue. Due to advancement in the technology of surveying and mapping field and also considering the responsibility to deliver services efficiently to variety of disciplines for their current demand of the different categories of maps and data, the scope has been widened to greater perspective to apply several advance technologies. In the process of acquiring, processing and dissemination of spatial and non-spatial data, Survey Department had so many projects jointly implemented with concerned foreign agencies under different grant cooperation programme of respective Governments. The details can be obtained either from the brochure of the department or by net surfing the webpage of the department (www.dos.gov.np). Furthermore, on November 2009 AD, Survey Department signed on a Memorandum of Understanding with National Space Institute, Technical University of Denmark for taking up Airborne Gravity measurement programme to achieve a modern geoid model of Nepal to contribute to Geodetic Network Infrastructure Programme of Nepal.

Under the policy to expose the department into the international forum, Survey Department joined number of International Organizations as a member. Involvement of the department in the activities of those organizations can be summarized as follows:

- Survey Department joined Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) in 1995 AD and then participated in the preparation of Cadastral Template of Nepal; the template was designed by PCGIAP in 2003 AD. The information of the template of Nepal can be viewed in the official webpage of PCGIAP (www.pcgiap.org). It needs to be regularly updated.
- Survey Department, Ministry of Foreign Affairs and Nepal Academy of Science and Technology (NAST) jointly conducted First SAARC Technical Meeting on Cartography on March 1995 to discuss in the common problems specifically on environment degradation and unplanned land and other natural resources. In the meeting, a SAARC Networking Arrangements on Cartography (SNAC) was formed to pursue further for common benefits of the SAARC member countries and since then the Director General of Survey Department is the Chair of the Committee.
- The department became ordinary member of Asian Association on Remote Sensing (AARS) during 19th Asian Conference on Remote Sensing (ACRS) held at Hong Kong in 1999 AD. Since then the department had been regularly participating in ACRS. The department also successfully conducted the 23rd ACRS with approximately 450 participants (more than 200 participants from abroad) in Kathmandu. Now it is again the right time to conduct next ACRS so the department should take initiations to propose at AARS.
- The department joined International Steering Committee for Global Mapping (ISCGM) in 2000 AD as a Category B member of the Committee. In this category, the member country itself has to prepare global spatial data of the country at the scale of 1:1M with spatial data resolution of 1km x 1km. But at that time, the department does not have capacity to prepare the data mainly due to lack of skilled human resources and the competent technology. However, Survey Department managed to prepare the data working jointly with Geographical Survey Institute

(GSI) of Japan. ISCGM released the global data of six countries including Nepal as a version 1.0 on November 2000 AD. The data can be viewed from the official webpage of ISCGM (www.iscgm.org). After the establishment of National Topographic Database (NTDB) of Nepal, the department is committed to provide updated Global data of Nepal as soon as possible and the department is working hard to prepare the data based on the specifications released by ISCGM.

- The department became Affiliate Member of International Federation of Surveyors (FIG) in 2002 AD. The membership was awarded to Survey Department by FIG during XXII[th] FIG Congress held at Washington D.C. on April 2002 AD. There are 10 Commissions working under FIG in which Survey Department appointed National Delegates except in Commission 4: Hydrology, as the scope of work of this discipline has no direct relation with that of Survey Department. The further details of the Commissions of FIG can be viewed from the webpage of FIG (www.fig.net). On February 17, 2009, Survey Department organized a lecture program in honour of Dr. Stig Enemark, President of FIG where he delivered a lecture on "Land Administration Systems: managing rights, restrictions and responsibilities in Land"
- The department received the membership of Asia Pacific Regional Space Agency Forum (APRSAF) at the 10[th] Session of the APRSAF which was held at Chiang Mai, Thailand in 2003 AD. Since then the department continuously attending the sessions of APRSAF.
- The department received membership of Group on Earth Observations (GEO) during GEO-4 meeting which was held at Tokyo, Japan on April 2004 AD. Since then the department participated the number of Ministerial Level Summits and other GEO preparatory meetings. GEO already launched 10 years implementation plan of Global Earth Observation Systems of System (GEOSS), accordingly the department will have to take necessary steps in implementation.
- After establishment of National Geographic Information Infrastructure Programme in Survey Department, the department applied the membership for Global Spatial Data Infrastructure Association (GSDIA) and received the membership in 2004 AD. The department occasionally attended the events organized by the Association.
- Survey Department joined Sentinel Asia Joint Project Team (SA JPT) from the very beginning of the project in 2006 AD. The project regularly organized the general meeting in different parts of the Asian countries where official from the department took part in the events. The project so far conducted four Sentinel Asia Operational System Trainings in different city of the Asian countries and the officials of the department participated in all of these training programmes. During Koshi flood in 2008 AD, the department prepared flood map of affected areas for the evaluation of damage caused by the flood and to prepare a plan of action for relief operation using satellite data received through Sentinel Asia Project.

Besides the activities mentioned above, the department has been involved in so many other events of other international organizations. Few of which will be discussed as follows:

- United Nations Education and Social Commission for Asia and the Pacific (UNESCAP) whose Head Quarters is based at Bangkok, Thailand organize United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCCAP) and Ordnance Survey of Great Britain organize Cambridge Conference in regular interval of time period. These two organizations never miss to invite Survey Department to participate in their corresponding events and whenever situation permits the department showed up actively in the events.
- In the early period of Survey Department, the department regularly received scholarships from Japan International Cooperation Agency (JICA) to study Training Course on Surveying and Mapping at Geographical Survey Institute (GSI), Japan. So few of the staffs of the department got opportunity to study the course in Japan. A Follow-up Study Team from JICA visited Survey Department to conduct a "Seminar on Surveying and Mapping" for ex-participants of the Training Course. The seminar was successfully conducted in Kathmandu, Nepal on October 29, 1997.
- The relation between ITC, The Netherlands and Survey Department was established from 1978 AD and four of the officials of the department got opportunity to study at ITC under Dutch Government scholarship programme in the same year. The author was one of the first officials to join ITC from Survey Department which was also quoted in the official webpage of ITC (www.itc.nl). The relationship was renewed at a special function organized by the department to welcome Prof. Dr. Martien Molenaar, the then Rector

of ITC during his visit to Nepal for giving Keynote speech in the 23rd ACRS organized in Kathmandu on November 2002 AD. Few years back, ITC has started ITC scholarship programme and some of the officials also received chances to study under this programme. One very worthwhile fact to mention here is, when Mr. Sjaack Beerens, Director, Foreign Affairs of ITC visited Survey Department in 2007 AD, just before the Golden Jubilee celebration of Survey Department, he announced to award ITC scholarship to one of the staffs of the department in the name of Golden Jubilee Celebration of Survey Department at a special function organized by the department to welcome him and received the scholarship for one of the staffs of the department. The lucky staff of the department to receive this award was Mr. Krishna Prasad Sapkota, the then Survey Officer of Survey Department.

- Since 2004 AD, Survey Department established relationship with Asian Institute of Technology (AIT), Bangkok Thailand through Mini-project which was designed jointly by Japan Aerospace Exploration Agency (JAXA) and Asian Institute of Technology (AIT). The objective of the mini-project is to implement space development programmes for promoting space technology utilization. This is one of the ways of JAXA to cooperate developing nations to encourage using space technology for different purposes such as evaluation of natural disaster, hazard mapping, etc.

## 4.2 Land Management Training Centre (LMTC)

Land Management Training Centre (LMTC), originally its name was Survey Training Centre, was established in 1969 AD as one of the Branches of Survey Department to impart training course for Amins (Basic Surveyors) only. Its scope of work has been gradually increase to impart junior and surveyor course to meet the demands of the skilled technicians from several organizations. In 1999 AD, Ministry of Land Reform and Management remodeled its organizational structure and in this process, the Centre has been upgraded to department level and placed directly under its own umbrella by adding more responsibilities for imparting training programmes for Land Managers. Since then the name of the Centre has been changed to Land Management Training Centre. More information of LMTC can be viewed in the webpage of LMTC (www.lmtc.gov.np).

In the early period of LMTC, it has received human resources cooperation for the post of Principal and Instructors through Indian Cooperation Mission (ICM) under Colombo Plan Programme of Government of India. The officials involved in this programme were from Survey of India. The project was terminated in 1980 AD. Again, some Volunteers for a limited period under the project of Japanese Overseas Cooperation Volunteer (JOCV) of Japanese International Cooperation Agency (JICA) of Government of Japan also received for supporting training progarmmes of LMTC.

Land Management Training Centre (LMTC) decided to expose the organization in international forums. So, it is gradually increasing its participation in some of the international activities. The results of its involvement are as follows:

- LMTC became the Academic Member of International Federation of Surveyors (FIG) in 2006 AD. When the President of FIG, Dr. Stig Enemark visited LMTC on February 2009, LMTC organized a lecture programme to welcome the President and the President delivered a lecture on "Promoting the Interaction between Education, Research and Professional Practices" on February 16, 2009.
- LMTC received the membership of Sentinel Asia Joint Project Team (SA JPT) in 2009 AD. Prior to become the member, some of the officials of LMTC had already attended the Sentinel Asia Operational System Training Programme. After having the membership of SA JPT, the Centre attended first time in the 3rd Sentinel Asia JPT meeting held at Indonesia in 2009 AD and also the fourth Sentinel Asia Operational Training programme held at Sri Lanka in 2010 AD.
- Noting the usefulness after participation of the 23rd ACRS which was held at Kathmandu in 2002 AD, LMTC proposed to the Government of Nepal through its annual program for attending the ACRS of AARS mainly for capacity building of its staffs from the fiscal year 2005-2006 (2063-64 BS). After getting approval from the government, the officials of LMTC attended the 26th ACRS which was held at Hanoi, Vietnam in 2005 AD and then continued for participation in the ACRS events regularly.
- LMTC and Kathmandu University (KU), Dhulikhel jointly commenced Bachelor Degree in Geomatics Engineering from 2007 AD. Then a "Fact Finding Mission" having a team of experts from ITC, The Netherlands visited Nepal on April 2008 AD for exploring the activities to develop mutual cooperation between LMTC and KU and a report containing 12 activities was submitted. Based on the report and getting approval from the ITC and the government of Nepal, a "Workshop on Curriculum Development for Bachelor Degree, Geomatics Engineering" was successfully conducted on October 2008 AD.

Furthermore, Dutch Government and ITC, the Netherlands sanctioned scholarships for studying different courses in the institute for the staffs of LMTC as well as KU. Under this scheme, five officials from LMTC and two from KU had completed the course and three more staffs of LMTC are studying at the institute.

### 4.3 Nepal Remote Sensing and Photogrammetric ociety (NRSPS)

Nepal Remote Sensing and Photogrammetric Society (NRSPS) was established in 1991 AD mainly to promote related organizations for applying photo grammetric and remote sensing technology in various fields of national development. More information on NRSPS is available in the webpage of NRSPS (www.nrsps.org.np). Involvement of NRSPS in the activities of International organizations is not much but most of its members are involved directly or indirectly in the international activities through their respective working office. However, NRSPS is trying to give as much exposure as possible in international forums and the achievement so far made can be summarized as follows:

- Since 1994 AD, NRSPS is an Ordinary Member of International Society for Photogrammetry and Remote Sensing (ISPRS) and whenever possible some of the members of NRSPS participated in the events of ISPRS such as Congress, Workshops and Council Meetings, etc.
- Asia Pacific Regional Space Agency Forum (APRSAF) awarded the membership to NRSPS in 2007 AD. The President of NRSPS participated first time in the event of APRSAF which was the 16th Session of APRSAF held from January 26-29, 2009 at Bangkok, Thailand.

## 5. Benefits

Involvement of an organization in international events is a positive response with respect to the globalization principle of working together in a common platform. So there will be benefits to the organizations which could be analyzed as follows:

- Participants could gain experiences and acquire knowledge on the theme of the event by sharing information with the professionals, scientists and experts participated from different parts of the globe
- Presentation of status and research activities of the organization will definitely give not only exposure of the organization in international forum but also could attracts number of international organizations for developing relationship between the two organization by implementing feasible project which could benefits mutually.
- If an international event be organized in the country it will benefits in number of aspects such as help and support for technological development in the organization, get opportunity to participate by a large number of local technicians in an international event at a time, able to establish identity of the country in technological field, help in promotion of tourism, etc.

Since participation of the events by the survey professionals creates not only the opportunity to share the experiences and gain knowledge on the topic but also helps to establish its competency. So this could be considered as one of the means to educate the officials of the organizations and to keep abreast in the recent technologies available in the world. Hence, the organizations should encourage its officials to participate in international events as many as possible.

## 6. Improvement

Participation in the international events alone by the staffs may not help to give proper exposure of the organization in international forum but the participant should display a competent professionalism in the field. In order to achieve this, some improvements within the organization and changing attitude of the staffs are inevitable. The corresponding organization should support the individual for its capacity building and at the same time the individual should develop some characteristics to obey the ethics and code of conduct of the professionalism, some of which could be listed as follows:

- Give opportunity to participate in the international events
- Encourage to prepare quality technical and research papers to present in the events
- Create environment to share the experiences and knowledge with the colleagues before and after participation of an event
- Maintain diary of the international events and share the information with the colleagues
- Habituate to study the current technological development to update the information
- Develop presentation skill for delivering the lecture
- Build capacity to discuss and handle the issues that could raise during discussion period

- Show sportsmanship to discuss the issues with the subordinates, colleagues and the managers
- Display positive attitude while arguing in the topic

## 7. Conclusions

It is clear that the organizations of survey profession mentioned in the articles are giving more and more exposure in the international community by participation of the events organized by the international organizations. The benefits for the organization and for the country could be increased further by organizing regularly the events in the country which is lacking at present and concerned organizations should take initiations in this line of thoughts. In order to give proper exposure of the country or organization in particular, the professionals of the organization should posses a quality of professionalism which could be developed by following some criteria identified above. Hence participation in international events not only gives exposure of the organization but also provides opportunity to enhance the knowledge of its officials.

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# Participation in the International Events by the Officials of Survey Department

- Suresh Man Shrestha, Chief Survey Officer
  Second Joint Project Team Meeting for Sentinel Asia Step-2
  15-17 July, 2009
  Bali, Indonesia

- Raja Ram Chhatkuli, Director General
  7th FIG Regional Conference
  19-22 October, 2009
  Hanoi, Veitnam

- Raja Ram Chhatkuli, Director General
  16th Asia Pacific Regional Space Agency Forum (APRSAF–16)
  22-29 January 2010
  Bangkok, Thailand

- Raja Ram Chhatkuli, Director General
  ITC, the Netherlands, Dutch Cadastre,
  National Survey and Cadastre, Denmark
  5-14 February 2010
  The Netherlands, Denmark

- Durgendra Man Kayastha, Deputy Director General
  4th GEOSS Asia Pacific Symposium
  10-12 March, 2010
  Bali, Indonesia

- Raja Ram Chhatkuli, Director General
  5th Session of the World Urban Forum
  22-26 March, 2010
  Rio de Janeiro, Brazil

- Sijan Kumar Dhakal, Survey Officer
  Mini-project Training
  September 2009 to February 2010
  Bangkok, Thailand

- Mukunda Hari Paudyal, Survey Officer
  Sentinel Asia Operational Training
  22-27 February, 2010
  Colombo, Srilanka

# Land Management: A Global Perspective

**Prof. Stig Enemark**

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*This article provides an overall understanding of the land management paradigm and the importance of land governance in support of the global agenda. Sustainable land administration systems provide clear identification on the people to land relationship. The land management perspective and the operational component of integrated and spatially enabled land administration systems therefore need high-level political support and recognition.*

## 1. The Global Agenda

"Do surveyors have a role to play in the global agenda?" - from a FIG (International Federation of Surveyors) point of view the answer to this question is clearly a "Yes"! Simply, no development will take place without having a spatial dimension, and no development will happen without the footprint of surveyors – the land professionals.

The eight Millennium Development Goals (MDGs) are placed at the heart of the global agenda. They form a blueprint agreed to by all the world's countries and the world's leading development institutions. The first seven goals are mutually reinforcing and are directed at reducing poverty in all its forms. The last goal - global partnership for development - is about the means to achieve the first seven. To track the progress in achieving the MDGs a framework of targets and indicators is developed. This framework includes 18 targets and 48 indicators enabling the ongoing monitoring of the progress that is reported on annually (UN, 2000).

The MDGs represent a wider concept or a vision for the future, where the contribution of the global surveying community is central and vital. This relates to the areas of providing the relevant geographic information in terms of mapping and databases of the built and natural environment, and also providing secure tenure systems, systems for land valuation, land use management and land development. The work of the surveyors forms a kind of "backbone" in society that supports social justice, economic growth, and environmental sustainability. These aspects are all key components within the MDGs.

## 2. Land Governance

All countries have to deal with the management of land. They have to deal with the four functions of land tenure, land value, land use, and land development in some way or another. A country's capacity may be advanced and combine all the activities in one conceptual framework supported by sophisticated ICT models. More likely, however, capacity will involve very fragmented and basically analogue approaches.

Arguably sound land governance is the key to achieve sustainable development and to support the global agenda set by adoption of the MDGs. Land governance is about the policies, processes and institutions by which land, property and natural resources are managed. This includes decisions on access to land, land rights, land use, and land development. Land governance is basically about determining and implementing sustainable land policies. Figure 1 provides such a global perspective.

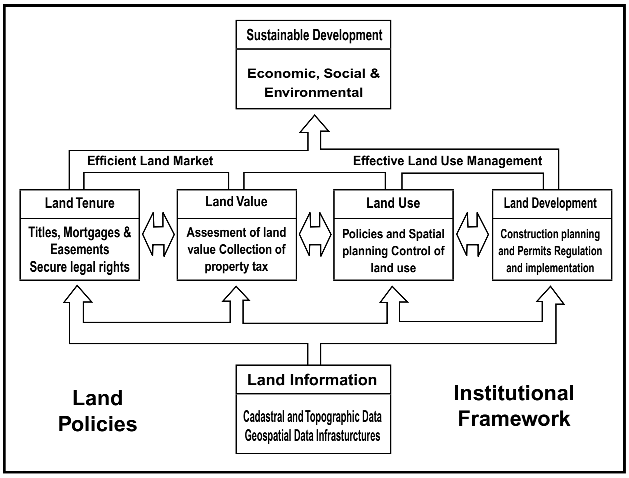


Figure 1. A Global Land Management Perspective (Enemark, 2004).

Land governance covers all activities associated with the management of land and natural resources that are required to fulfil political and social objectives and achieve sustainable development. The operational component of the concept is the range of land administration functions that include the areas of land tenure (securing and transferring rights in land and natural resources); land value (valuation and taxation of land and properties); land use (planning and control of the use of land and natural resources); and land development (implementing utilities, infrastructure, construction planning, and schemes for renewal and change of existing land use).

Land administration systems are the basis for conceptualizing rights, restrictions and responsibilities related to land and property. Property rights are normally concerned with ownership and tenure whereas restrictions usually control use and activities on land. Responsibilities relate more to a social, ethical commitment or attitude to environmental sustainability and good husbandry. In more generic terms, land administration is about managing the relations between people, policies and places in support of sustainability and the global agenda set by the MDGs.

## 3. Property Rights

In the Western cultures it would be hard to imagine a society without having property rights as a basic driver for development and economic growth. Property is not only an economic asset. Secure property rights provide a sense of identity and belonging that goes far beyond and underpins the values of democracy and human freedom. Historically, however, land rights evolved to give incentives for maintaining soil fertility, making land-related investments, and managing natural resources sustainably. Therefore, property rights are normally managed well in modern economies. The main rights are ownership and long term leasehold. These rights are typically managed through the cadastral/land registration systems developed over centuries. Other rights such as easements and mortgage are often included in the registration systems.

The formalized western land registration systems are basically concerned with identification of legal rights in support of an efficient land market, while the systems do not adequately address the more informal and indigenous rights to land that is found especially in developing countries where tenures are predominantly social rather than legal. Therefore, traditional cadastral systems cannot adequately supply security of tenure to the vast majority of the low income groups and/or deal quickly enough with the scale of urban problems. A new and innovative approach is found in the continuum of land rights (including perceived tenure, customary, occupancy, adverse possession, group tenure, leases, freehold) where the range of possible forms of tenure is considered as a continuum from informal to towards more formal land rights and where each step in the process of securing the tenure can be formalised (UN-Habitat, 2008).

## 4. Property Restrictions

Land-use planning and restrictions are becoming increasingly important as a means to ensure effective management of land-use, provide infrastructure and services, protect and improve the urban and rural environment, prevent pollution, and pursue sustainable development. Planning and regulation of land activities cross-cut tenures and the land rights they support. How these intersect is best explained by describing two conflicting points of view – the free market approach and the central planning approach.

The free market approach argues that land owners should be obligated to no one and should have complete domain over their land. In this extreme position, the government opportunity to take land (eminent domain), or restrict its use (by planning systems), or even regulate how it is used (building controls) should be non-existent or highly limited.

The central planning approach argues that the role of a democratic government includes planning and regulating land systematically for public good purposes. Regulated planning is theoretically separated from taking private land with compensation and using it for public purposes. In these jurisdictions the historical assumption that a land owner could do anything than was not expressly forbidden by planning regulations changed into the different principle that land owners could do only what was expressly allowed, everything else being forbidden.

The tension between these two points of view is especially felt by nations seeking economic security. The question however is how to balance owners' rights with the necessity and capacity of the government to regulate land use and development for the best of the society. The answer to this is found in a country's land policy which should set a reasonable balance between the ability of land owners to manage their land and the ability of the government to provide services and regulate growth for sustainable development. This balance is a basis for achieving sustainability and attaining the MDGs.

## 5. Property Responsibilities

Property responsibilities are culturally based and relate a more social, ethical commitment or attitude to environmental sustainability and good husbandry. Individuals and other actors are supposed to treat land and property in a way that conform to cultural traditions and ways of good ethical behaviour. This relates to what is accepted both legally and socially. Therefore, the systems for managing the use of land vary throughout the world according to historical development and cultural traditions. More generally, the human kind to relationship is to some extent determined by the cultural and administrative development of the country or jurisdiction.

This relates to cultural dimensions as described by the Dutch scientist Gert Hofstede (2001), especially the dimensions of: *Uncertainty avoidance*, that is the preference of structured situations over unstructured or flexible ones; and *Power distance*, that is the degree of inequality among people accepted by the population. These cultural dimensions determine the social and ethical behaviour of people also in relation to the way land can be hold and used within a given culture. Systems of land tenure and land-use control therefore vary throughout the world according to such cultural differences.

Social responsibilities of land owners have a long heritage in Europe. In Germany, for example, the Constitution is insisting on the land owner's social role. In general, Europe is taking a comprehensive and holistic approach to land management by building integrated information and administration systems. Other regions in the world such as Australia creates separate commodities out of land, using the concept of "unbundling land rights", and is then adapting the land administration systems to accommodate this trading of rights without any national approach.

## 6. Good governance

Governance refers to the manner in which power is exercised by governments in managing a country's social, economic, and spatial recourses. It simply means: the process of decision-making and the process by which decisions are implemented. This indicates that government is just one of the actors in governance. The concept of governance includes formal as well as informal actors involved in decision-making and implementation of decisions made, and the formal and informal structures that have been set in place to arrive at and implement the decision. Good governance is a qualitative term or an ideal which may be difficult to achieve. The term includes a number of characteristics: (adapted from FAO, 2007):

- **Sustainable and locally responsive:** It balances the economic, social, and environmental needs of present and future generations, and locates its service provision at the closest level to citizens.
- **Legitimate and equitable:** It has been endorsed by society through democratic processes and deals fairly and impartially with individuals and groups providing non-discriminatory access to services.
- **Efficient, effective and competent:** It formulates policy and implements it efficiently by delivering services of high quality
- **Transparent, accountable and predictable:** It is open and demonstrates stewardship by responding to questioning and providing decisions in accordance with rules and regulations.
- **Participatory and providing security and stability:** It enables citizens to participate in government and provides security of livelihoods, freedom from crime and intolerance.
- **Dedicated to integrity:** Officials perform their duties without bribe and give independent advice and judgements, and respects confidentiality. There is a clear separation between private interests of officials and politicians and the affairs of government.

Once the adjective "good" is added, a normative debate begins. In short: sustainable development is not attainable without sound land administration or, more broadly, sound land management.

## 7. The Land Management Paradigm

Land management underpins distribution and management of a key asset of any society namely its land. For western democracies, with their highly geared economies, land management is a key activity of both government and the private sector. Land management, and especially the central land administration component, aim to deliver efficient land markets and effective management of the use of land in support of economic, social, and environmental sustainability.

The land management paradigm as illustrated in figure 2 allows everyone to understand the role of the land administration functions (land tenure, land value, land use, and land development) and how land administration institutions relate to the historical circumstances of a country and its policy decisions. Importantly, the paradigm provides a framework to facilitate the processes of integrating new needs into traditionally organised systems without disturbing the fundamental security these systems provide.

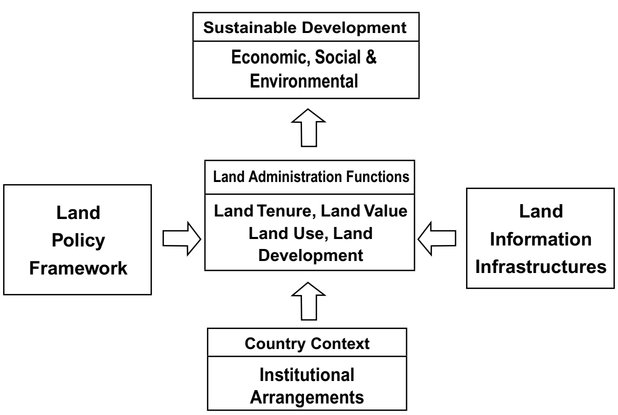


Figure 2. The land management paradigm

(Enemark, 2004)

Sound land management requires operational processes to implement land policies in comprehensive and sustainable ways. Many countries, however, tend to separate land tenure rights from land use opportunities, undermining their capacity to link planning and land use controls with land values and the operation of the land market. These problems are often compounded by poor administrative and management procedures that fail to deliver required services. Investment in new technology will only go a small way towards solving a much deeper problem: the failure to treat land and its resources as a coherent whole.

## 8. The Role of FIG

FIG is an UN recognised NGO representing the surveying profession in about 100 countries throughout the world. FIG has adopted an overall theme for this period of office (2007-2010) entitled “Building the Capacity”. This applies to the need for capacity building in developing countries to meet the challenges of fighting poverty and developing a basis for a sustainable future, and, at the same time, capacity is needed in developed countries to meet the challenges of the future in terms of institutional and organisational development in the areas of surveying and land administration.

In general, FIG will strive to enhance the global standing of the profession through both education and practice, increase political relations both at national and international level, help eradicating poverty, promote democratisation, and facilitate economic, social and environmental sustainability. FIG can facilitate support of capacity development in three ways:

- **Professional development:** FIG provides a global forum for discussion and exchange of experiences and new developments between member countries and between individual professionals in the broad areas of surveying and mapping, spatial information management, and land management. This relates to the FIG annual conferences, the FIG regional conferences, and the work of the ten technical commissions within their working groups and commission seminars. This global forum offers opportunities to take part in the development of many aspects of surveying practice and the various disciplines including ethics, standards, education and training, and a whole range of professional areas.
- **Institutional development:** FIG supports building the capacity of national mapping and cadastral agencies, national surveying associations and survey companies to meet the challenges of the future. FIG also provides institutional support to individual member countries or regions with regard to developing the basic capacity in terms of educational programs and professional organisations. The professional organisations must include the basic mechanisms for professional development including standards, ethics and professional code of conduct for serving the clients.
- **Global development:** FIG also provides a global forum for institutional development through cooperation with the United Nations Agencies such

as FAO, UN-HABITAT and the World Bank. The cooperation includes a whole range of activities and joint projects such as the joint FIG/WB conference on Land Governance in support of the MDGs held in Washington May 2009 see (http://www.fig.net/pub/figpub/pub45/figpub45.pdf). This should lead to joint efforts of addressing topical issues on the international political agenda, such as reduction of poverty and enforcement of sustainable development.

FIG, this way, plays a strong role in improving the capacity to design, build and manage surveying and land administration systems that incorporate sustainable land policies and efficient spatial data infrastructures towards building spatially enabled societies in support of the Millennium Development Goals.

## 9. Final Remarks

No nation can build land management institutions without thinking about integration of activities, policies, and approaches. Technology opportunities provide additional motivation. Careful management of land related activities on the ground are crucial for delivery of sustainability.

Land administration systems, in principle, reflect the social relationship between people and land recognized by any particular jurisdiction or state. Such a system is not just a GIS. On the other hand, Land Administration Systems are not an end in itself but facilitate the implementation of the land policies within the context of a wider national land management framework.

Sustainable land administration systems provide clear identification of the individual land parcels and land rights attached to these parcels. This information on the people to land relationship is crucial and plays a key role in managing a wide range of activities in society. The land management perspective and the operational component of integrated and spatially enabled land administration systems therefore need high-level political support and recognition.

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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 remembered them for their contribution towards the achievement of the goal of the department.

1. Late Dr. Krishna Prasad Dhungana – Section Officer
2. Late Mr. Laxman Bharati – Surveyor
3. Late Mr. Chandreshwor Purwe – Surveyor

## *Price of some of the publications of Survey Department*

*1. List of Geographical Names volume I to V - NRs 600/- for each volume.*
*2. Nepalese Journal on Geoinformatics - NRs 100/-*
*3. The Population and Socio-economic Atlas of Nepal (Hard Copy) NRs. 2,500 (In Nepal), € 200 (Out side Nepal)*
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*The Editorial Board requests for Papers / articles related with Geoinformatics for the publication in the tenth issue of the Nepalese Journal on Geoinformatics. Last date for submission of the article is March 31, 2011.*

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# Land Policy Issues in Nepalese Context

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**Key Words:**

Land Policy, Land policy instruments

***Abstract***

*The land issues comprise all social, economical and legal measures that determine the access to land and allocation of land related benefits. Land administration plays important role in obtaining national political objectives by operating land policy instruments properly. This paper aims to discuss various land policy issues in Nepal. The literature regarding land policy and land administration, concerning laws and reports are reviewed. The concept and definition of land policy and land administration and their relationship is provided first; and then the land policy issues and major challenges are discussed, some measures to overcome such challenges are also presented; and conclusion is drawn from the whole study. Lack of national land policy and land use policy, no guarantee of registered deed, lack of fair compensation in case of expropriation, lack of clear governement policy to regulate land market, improper land valuation system, traditional, complex and cumbersome procedure, lack of coordination between land administration organizations, poor management of land records, manual recording system, lack of one stop shopping, difficult to retrieve land information, lack of skilled manpower, misuse of public land, lack of national policy to provide land to the landless and poor people and protection of rights of the indigeneous people are the major problems identified from the study. Formulation of national land policy and land use policy addressing all land issues, improvement in registration system, simplification of procedures, integration of land administration organizations, digitization of land records, establishment of National Spatial Data Infrastructure, providing online services and hiring trained manpower/providing training to existing manpower are some of the measures for improvement in the existing land administration system of Nepal.*

## 1. Introduction

Land administration plays important role in obtaining national political objectives by implementing land policy instruments properly. In Nepal, the system of land administration was developed for the purpose of collecting land revenue. Presently, its role and functions are increased. This paper aims to evaluate the land administration system of Nepal from different perspectives and explore its challenges.

The concept of land policy, land administration and land governance is provided in Section 2. In Section 3, the status of land policy issues and major problems are discussed. Finally, conclusion is drawn in Section 4.

## 2. Concept & Definition

The concept of land policy, land administration and land governance and the relationship between land policy and land administration is provided in the following sections:

### 2.1 Land Policy, Land Policy Instruments & Land Administration

Land policy concerns with the allocation of land and land related benefits. United Nations Economic Commission for Europe (1996:58) has stated that "the land policy consists of a whole complex of socio-economic and legal prescriptions that dictate how the land and the benefits from the land are to be allocated". This definition has considered that the land issue comprises social, economical and legal measures to allocate land and land related benefits. Deininger (2003:178) has defined land policy in the same way. According to him, land policy is the rules governing access to and the distribution of the benefits from one of the economy's main assets.

The European Union Land Policy Guidelines (European Union, 2004) has described that the land policy aims to achieve certain objectives relating to the security and distribution of land rights, land use and land management, and access to land, including the forms of tenure under which it is held; defines the principles and rules governing property rights over land and the natural resources it bears as well as the legal methods of access and use, and validation and transfer of these rights; details the conditions under which land use and development can take place, its administration, i.e. how the rules and procedures are defined and put into practice, the means by which these rights are ratified and administered, and how information about land holdings is managed; and specifies the structures in charge of implementing legislation, land management and arbitration of conflicts.

Thus, the land issues comprise all social, economical and legal measures that determine the access to land and allocation of land related benefits.

Land administration is defined as the process of determining, recording and disseminating information about the ownership, value and use of land, when implementing land management policies (United Nations Economic Commission for Europe, 1996:13-14). This definition comprises the relationship between the tools and land policy. Land settlement, land survey, land registration, land valuation and assessment, land use control and management are the activities involved in the land administration (United Nations Economic Commission for Europe, 1996:58).

van der Molen (2008) has mentioned that political objectives such as economic growth, poverty reduction, sustainable housing and agriculture, social equity and fairness, protection of vulnerable groups in society, require a policy of the government how to deal with the allocation of access to land and land related benefits. It requires intervention measures of a more technical nature which concern the application of property right regimes, the extent to which a government wants to secure those rights, access to credit markets, the regulations of the

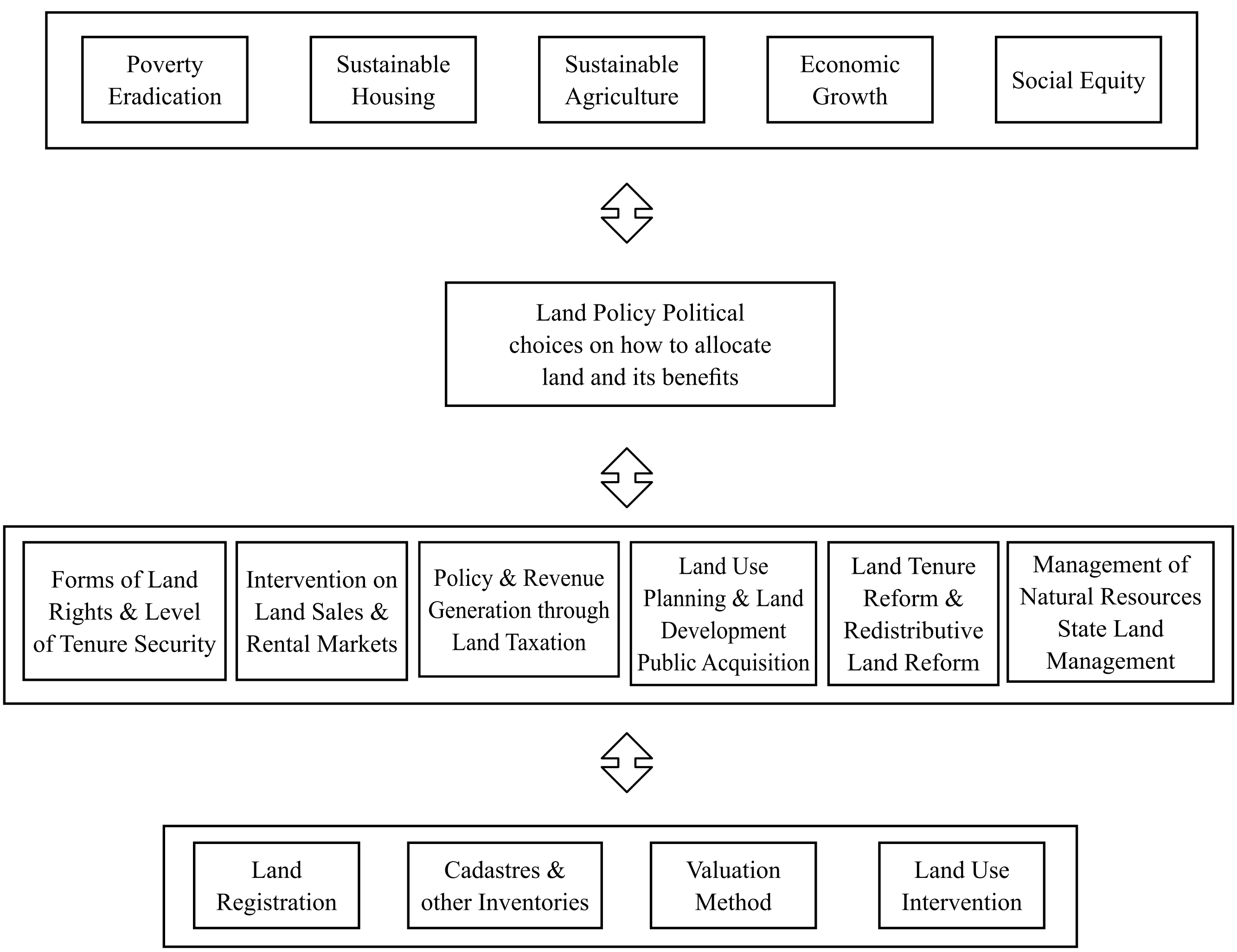


Figure 1:Relationship among national objectives land policy and land administration (van der Molen, H. Silayo et al. 2008)

land sales and rental markets, the measures to enhance sound land use planning, land reform, land taxation and management of natural resources which are called land policy instruments. Land administration is a tool to operate land policy instruments. The relationship between land policy and land administration is shown in Fig. 1.

## 3. Nepalese Context

The status of land policy instruments is discussed below:

### 3.1 Land Tenure Arrangements

There is statutory land tenure system in Nepal. The privately owned land is called Raikar which is of freehold nature. Tuladhar (2004) has mentioned that “the present Raikar tenure system allows distinct relationships between the landholders and the land through ownership providing a bundle of real rights, which can be held, used, inherited and enjoyed by landholders on the condition that they keep paying the tax fixed annually by the state”. There is another category of land called Guthi or trust land which is an endownment made by any philanthropist for religious or philanthropic purposes. The State land is also categoriseed as government land and public land. There is provision of leasehold as well. All other types of land tenure systems such as Birta, Ukhada, Kipat, Jagir, Jhora, Kharka, etc. are abolished in the past.

The landowner can enjoy all kinds of rights over own land however, the governement can expropriate any kind of land if it is required for the public purposes. According to the Article 19 of the Interim Constitution of Nepal, the State requisite, acquire or create any encumbrance on the property of any person (this clause shall not be applicable on prpoerty acquired by illegal means) except in the public interest and compensation shall be provided if it is requisited, acquired or encumbered by the State in implementing scientific land reform program or public interest in accordance with law. So, the State cannot expropriate private land without compensation. The amount of compensation is determined by a committee formed under the Chairmanship of Chief District Officer. Also, there is deed registration system in Nepal. The deeds are considered as evidences and firstly registered deeds get priority over late registered or non-registered deeds. However, any damage caused by the mistraque duting land transaction is not covered by the State. Because of the minimum valuation system, normally the land value determined by the Minimum Valuation Determining Committee formed under the Chairmanship of Chief District Officer in each area is mentioned in the deed of transaction which is generally less than the market price. In case of dispute over land transaction, only the amount mentioned in the deed is returned to the buyer if the deed is dismissed by the Court. The amount of compensation of acquired land is also determined based on the minimum valuation. So, the amount of compensation is generally lower than the market price.

### 3.2 Land Market

Land is an immovable asset so that it can not be handed over from one person to another during transaction. The right of land is transferred by means of registration of deeds or title. So, the land is also considered as tradable good in the land market.

Land transactions can play an important role by (a) providing land access to those who are productive, but who own no or little land; (b) allowing the exchange of land as the off-farm economy develops; and (c) facilitating the use of land as collateral in credit markets (Deininger, 2003: 79). However, this situation is not always true. Factor such as difficulties to prove evidence of ownership, unequall access to infomration, high transaction costs, bureaucreatic procedures, subsidies and fiscal measures, planning and public acquisition, etc. causes distortions in the land market (van der Molen, 2008). The land market imperfections most likely do neither direct land to its most productive use, nor provide equall access to land ownership or access to land related benefits, from which the poor have to suffer (van der Molen et. al., 2009).

Land speculation also affects in the well-functioning of land market. It promotes development of unplanned settlements, encourages urban sprawl, increases the cost of delivering services, creates an artificial shortage of development land and interferes with the government’s desire for fair distribution of land (van der Molen et. al., 2008). Holding of large track of land also influenced in the land market.

In Nepal, there is lack of governement policy to regulate land market. Most of the transactions in the rural take place through the personal contact usually mediated by the local elders or the person known by both of the parties. While in urban and peri-urban areas, the transaction is mediated by the real estate agents and land brokers. In such cases, the middle man can play important role in price determination and get benefit from it. There is no proper policy to regulate the real estate market. In recent years, the land price of the urban and peri-urban area is raising unexpectedly due to speculation, land holding and some social, economic and political reasons.

The credit market is also not developed well. In recent years, the finaincial institutions had increased investment in real estate and housing sector. However, after the depression in the world economy, they have cut down their financing in this sector. The process of finaincing is also very comples.

Contribution of real estate sector in the national economy has been increaased in recent years. According to the Economic Survey, the contribution of real estate, rent and business sector to the GDP has reached to 10.16% in the FY 2063/64 which was only 8.29% in the FY 2057/58.

### 3.3 Land Value, Valuation & Taxation

Land has certain value. The value of land should be recognized for different purposes such as land transaction, land/property taxation, rent, compensation of expropriated land, etc. So, proper land valuation and taxation policy is required.

In Nepal, the value of buildings is determined by the local bodies and that of land is determined by different authorities for different purposes. For instance, the minimum valuation of land determined by the Land Revenue Offces is used to mention in the deed of transfer; the financial institutions determine land value to fix the loan amount, District Administration Office fix the land value while determining compensation of expropriated land; and the local bodies also determine land value for taxation, property evaluation and other purposes. For the registration purpose, the valuation of building is determined by the local bodies.

There is no similarity between the value determined by different agencies although the land is same. The value determined by the Land Revenue Offices is upto 3 or 4 times lower than the current price of land in many areas whereas in some areas, it is higher than the current price. The value determined by the financial institutions and District Administration Offices is also lower than the actul price. So, normally the landowners pay lower land tax and registration fee and get lower loan and compensation from their land.

The amount of land revenue collected in the Fiscal Year 2031/32 was Rs. 90.9 millions and only Rs. 91 million was collected in the FY 2050/51. The authority to collect land revenue is given to the local bodies since B.S. 2052 and its amount is not published in the national accounts since few years. Similarly, the amount of registration fee collected from the Land Revenue Offices reached to Rs. 6.23 billions in the FY 2065/66 from Rs. 36 millions in the FY 2031/32.

### 3.4 Land Use Planning, Implementation & Maintenance

Certain governemnt interventions are required to use the available land as per the needs of the society. Planning regulations, public acquisition and expropriation and regulations for informal settlements and peri-urban areas are some of these interventions.

Land use planning (physical planning) is the process of allocating resources, particularly land, in order to achieve maximum efficiency while respecting the nature of environment and the welfare of the community (United Nations Economic Commission for Europe, 1996). Land use planning influences the private property rights. During the planning process, the effects are indirect, however, while implementing such planning, the public law measures will restrict the right to dispose by private owners and maintaining the given land use will prohibit the land owners to deviate from the regulations (van der Molen, 2008). Thus, the land use planning should be legitimate and requires institutional prerrequisites. The Land Administration Guidelines (United Nations Economic Commission for Europe, 1996) has described that there should have a formal relationship with the land administration system because of the impact that development proposals will have on the land and the associated land rights and the responsible administrative authority must adopt the administrative procedures that work closely with the cadastral system.

The government can impose restrictions on private property rights by means of land use planning. Sometimes, the government requires privately owned land for public purposes. In such cases, the government needs to acquire private land in accordance of law. There are four main types of public acquisition of land: try to buy the land right as a private buyer, imposing a pre-emptive rights, expropriation and land consolidation and consolidation. The expropriation is the ultimate government intervention. It should be strictly regulated by law and taken place only for the public purpose. Compensation should be provided in case of expropriation.

In Nepal, national land use policy is not formulated yet. So, there is lack of land use planning which has caused the haphazard and unplanned development of settlements and misuse of fertile land. It has also caused problem in balanced development. Also, there is lack of fair compensation in case of expropriation of privately own land for public purposes.

## 3.5 Land Reform

Land Reform is a broad term and can have different meaning. Land redistribution, land tenure reform, land nationalization, agrarian collectivisation, land restitution, land consolidation and readjustment are the main types of land reform.

The measure of land reform is applied to reduce the unequal distribution of land, provide access to land to the poor and landless people and increease productive efficiency. Deininger (2003) has described that the unequal and often inefficient distribution of land in many developing countries was the outcomes of power relationship and dostortionary policies rather than market forces. Only the market forces cannot lead to land redistribution to the desirable extent to maximize efficiency and welfare outcomes which has justified for land reform. He has also stated that many historical and contemporary conflicts have their roots in struggles over land. These issues should be addressed by the land policy.

In Nepal, land reform program was started in B. S. 2021 by the then King Mahendra from the purpose of justifiable allocation of agricultural land and improvement in the living standard of tenant. Fixation of land ceiling for land owner and tenant, acquision of land beyond ceiling, fixation of rent, protection of right of tenant, etc. are the main features of this program. The Fifth Ammendment (2058) in the Land Reform Related Act, 2021 has provisioned for allocating 50% of land to the tenant.

The commissions Forest Sector Reform High Level Commission, Commission for Solving Landless Problems, etc. has also allocated land to the landless and poor people including informal settlers and migrants in different time periodds. However, such problems are not solved yet. Also, the dual ownership of land is not finished.

## 3.6 Management of Natural Resources

Management of natural resources is not possible without proper land management. So, this issue should also be addressed by the land policy. It includes recognition of existing land tenure (e.g., mining rights, water rights, hunting rights, etc.), management of public land, management of environment and pastoralist's land right.

In Nepal, there is no concrete policy regarding management of public land. Article 24 of the Land Revenue, 1978 has prohibited cultivating and registering public and government land under the name of any individual. The government had formed a High Level Commission regarding Investigation and Protection of Government and Public Land (Rawal Commission), however, its report is not fully implemented yet.

The government has also approved the ILO convention 169 regarding the right of indigenous people which also includes the land right of such people. However, different forms of land tenure rights are not legally recognized. There is not clear policy regarding protection of rights of the indigeneous people (including fishing right, huning righ, etc.)

## 3.7 Problems

Although the land registration and other land administration services are faster than some countries, Nepalese land administration is not free from problems which are listed below:

- Lack of national land policy and land use policy
- No guarantee of registered deed
- Lack of fair compensation in case of expropriation
- Lack of clear governement policy to regulate land market
- Improper land valuation system,
- Traditional, complex and cumbersome procedure
- Lack of coordination between land administration organizations
- Poor management of land records
- Manual recording system
- Lack of one stop shopping
- Difficult to retrieve land information
- Lack of skilled manpower
- Misuse of public land
- Lack of national policy to provide land to the landless and poosr people and protection of rights of the indigeneous people (including fishing right, huning right)

Measures to overcome from these problems are: formulation of national land policy and land use policy addressing all land issues, improvement in registration system, simplification of procedures, integration of land administration organizations, digitization of land records, establishment of National Spatial Data Infrastructure, providing online services and hiring trained manpower/ providing training to existing manpower.

## 4. Conclusion

Land policy is one of the national policies which concerns with the allocation of land and land related benefits. Land tenure arrangements, land markets, land taxation, land use planning, implementation and maintenance, land reform and management of natural resources are the instruments of land policy and land administration is a tool to operate these instruments.

Deed registration system, fast services, separate land registry and cadastre, statutory land tenure system, no financial autonomy are some of the features of Nepalese land administration system. Lack of national land policy and land use policy, no guarantee of registered deed, lack of fair compensation in case of expropriation, lack of clear governement policy to regulate land market, improper land valuation system, traditional, complex and cumbersome procedure, lack of coordination between land administration organizations, poor management of land records, manual recording system, lack of one stop shopping, difficult to retrieve land information, lack of skilled manpower, misuse of public land, lack of national policy to provide land to the landless and poosr people and protection of rights of the indigeneous people (including fishing right, huning right) are its major problems.

To conclude, the land administration system of Nepal has both strengths and weaknesses. Formulation of national land policy and land use policy addressing all land issues, improvement in registration system, simplification of procedures, integration of land administration organizations, digitization of land records, establishment of National Spatial Data Infrastructure, providing online services and hiring trained manpower/providing training to existing manpower are some of the measures to solve these problems.

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# Calendar of International Events

ISPRS Conference
"Current issues in regulating Satellite Earth Observation"
8-9 April, 2010
Vienna, Austria
E: office@espi.or.at
W: www.espi.or.at/

XXIV FIG International Congress and XXXIII General Assembly
"Facing the challenge -Building the capacity"
11-16 April, 2010
Sydney, Australia
E: info@isaust.org.au
W: www.fig10.com

GEO EXPO China 2010
12-14 May, 2010
Beijing, China P.P.
E: sales@chinageoexpo.com
W: www.china-expo.com

Commission VII Symposium
"100 years ISPRS-Advancing Remote Sensing Science"
5-7 July, 2010
Vienna, Austria
E: ww@ipf.tuwien.ac.at
W: www.isprs100vienna.org

Map Asia 2010
"Connecting Government and Citizen through Ubiquitous GIS"
26-28 July 2010
Kuala Lumpur, Malaysia
E: info@mapasia.org
W: www.mapasia.org

16th PCGIAP Meeting
18-22 October, 2010
Singapore
E: sec@pcgiap.org
W: www.pcgiap.org

17th ISCGM
October, 2010
Singapore
E: sec@iscgm.org
W: www.iscgm.org

31st Asian Conference on Remote Sensing (ACRS 2010)
1-5 November, 2010
Hanoi, Vietnam
E: duong.nguyen2007@gmail.com
W: www.a-a-r-s.org/acrs

7th Taipei International Digital Earth Symposium 2010
Taipei , Taiwan
"Digital earth for new generation towards a green earth"
26-28 July, 2010
E: dere@mail.pccu.edu.tw
W: deconf.pccu.edu.tw/2010

12th GSDI Association World Conference
19-22 October, 2010
Singapore
W: www.infodev.org

GEO-VII
3-5 November, 2010
Beijing, China
W: www.earthobservation.org

17th APRSAF
23 - 26 November, 2010
Melbourne, Australia
E: secretariat@aprsaf.org
W: www.aprsaf.org

# Optimizing Orientation by GCP Refinement of Very High Resolution IKONOS Satellite Images

**Madhusudan Adhikari**
President NESA

***Abstract***

*The Rational Polynomial Coefficients (RPC) provided with the IKONOS images contains a large error and they need Ground Control Point (GCP) refinement. To present the technique of refinement of RPCs by the application of some appropriate transformation algorithm with some suitable number of GCPs in proper constellation in an optimal way to achieve high geometric accuracy during spatial data acquisition from IKONOS stereo image is the objective of this paper. From this study it was found that GCP refinement of RPCs by affine transformation with four GCPs in proper constellation is optimal for the orientation of the image pair under study, it was also found that at least two redundant GCPs are necessary for proper refinement by a particular transformation algorithm.*

## 1. Introduction

Since its launch in September of 1999, the IKONOS satellite has been consistently providing high quality 1-meter panchromatic and 4-meter multi-spectral images. The initial post-launch IKONOS geometric accuracy was verified during the On-Orbit Acceptance Test (OOAT), using the San Diego test range consisting of 140 GCP over a 22 by 22 km area [Grodecki and Dial, 2002]. The OOAT results indicated that the absolute horizontal and vertical accuracy of uncontrolled IKONOS stereo images, block adjusted without GCPs, was better than 6 m. The IKONOS satellite simultaneously collects imagery in four multi-spectral bands and a single panchromatic band with 11-bit resolution. For panchromatic images the ground sampling distance (GSD) of the IKONOS sensor is 0.82 m at nadir. GSD of multi-spectral images is four times that of panchromatic images, i.e., 3.28 m at nadir. At 26 degrees off nadir the GSD is 1 m for panchromatic and 4 m for multi-spectral images.

These high spatial resolution satellite images can be used as a potential alternative of the aerial photographs for producing and updating the large scale geo-information products. Not only the high spatial resolution but also their multi-spectral data and capability for stereo mapping with short revisit time giving highly frequent updatability have made a great benefit in this regard. To reach to the end geo-spatial data product these images are to be processed through different production steps applying various methods and algorithms, so, proper choice of processing methods considering the available software and other required information like ground control points (GCPs), independent check points (ICPs) is also equally important for optimal exploitation.

In this paper, how the orientation among the different steps of geometric processing of high spatial resolution satellite images can be optimised to get targeted production accuracy has been presented.

## 2. Orientation

Orientation determines the geometry of the imaging rays including the actual location of the sensor, its pointing angle with respect to the ground. Orientation results in formula to calculate image coordinates (x, y or row, column) from terrain coordinate (X, Y, Z) [N. Kerle et al, 2004].

Because of the geometrical properties of the sensors of High Spatial Resolution Image (HSRI), central perspective geometry, as used in airborne photogrammetry, cannot be directly applied onto high resolution satellite image, moreover, providers might not release information about the interior orientation parameters. So, to solve the orientation problem, some alternative approaches are applied. The orientation methods based on rational polynomial functions, affine projection and Direct Linear Transformation (DLT) are mostly used for HRSI. They can be a possible alternative to rigorous models when the calibration data are not released by the image provider or when the sensor position and attitude are not available with sufficient precision [Daniela Poli, 2005]. The rational function model (RFM) is becoming well known to the mapping community, largely due to its wide adoption as a new standard. Open GIS Consertium (OGC) has already decided to adopt it as a part of the standard image transfer format [OGC 1999a]. Space Imaging has adopted the RFM scheme in order to deliver the imaging geometry, so, instead of delivering the interior and exterior orientation geometry of the IKONOS sensor and other physical parameters associated with the imaging process, the RFM is used as a sensor model for photogrammetric exploitation [Yong Hu et al, 2004]. RFM uses a ratio of two polynomial functions of ground coordinates to compute the row image coordinate, and a similar ratio to compute the column image coordinate. The two image-coordinates (row and column) and three ground-coordinates (e.g., latitude, longitude and elevation) are each offset and scaled to fit the range from –1.0 to 1.0 over an image or image section.

$$r_n = \frac{\sum_{i=0}^{m_1}\sum_{j=0}^{m_2}\sum_{k=0}^{m_3} a_{ijk} X_n^i Y_n^j Z_n^k}{\sum_{i=0}^{n_1}\sum_{j=0}^{n_2}\sum_{k=0}^{n_3} b_{ijk} X_n^i Y_n^j Z_n^k}$$

$$c_n = \frac{\sum_{i=0}^{m_1}\sum_{j=0}^{m_2}\sum_{k=0}^{m_3} c_{ijk} X_n^i Y_n^j Z_n^k}{\sum_{i=0}^{n_1}\sum_{j=0}^{n_2}\sum_{k=0}^{n_3} d_{ijk} X_n^i Y_n^j Z_n^k}$$

where $r_n$ and $c_n$ are the normalized row and column index of pixels in image respectively, $X_n$ ,$Y_n$ and $Z_n$ are normalized coordinate values of object points in ground space, and $a_{ijk}$, $b_{ijk}$, $c_{ijk}$, $d_{ijk}$ are polynomial coefficients called rational function coefficients (RFCs) or rational polynomial coefficients (RPCs).

RPCs provided by image vendors may not always approximate the real imaging process well; RPCs can be refined in the domain of the image space or of the ground space, when additional control information is available. IKONOS Geo products and Standard stereo products can be improved to sub-meter absolute positioning accuracy using one or more high quality GCPs or be close to the accuracy of the GCPs whose quality is low [Yong Hu et al, 2004]. The RFM may be refined directly or indirectly. The direct refining methods update the original RPCs themselves while the indirect refining introduces complementary or concatenated transformations in image or object space, and they do not change the original RPCs directly. The affine transformation or a translation (shift) for the simplest case is often used [Yong Hu et al, 2004]. Leica Geosystem's LPS offers 0th 1st and 2nd order polynomial refinement which means translation, affine and 2nd order polynomial transformations respectively [LPS online help], in this study all the refinement orders with different number of GCPs has been tested.

## 3. Study Area

The study area is the southern part of China which is an area of varying terrain and land cover. It has flat, hilly and mountainous terrain; and open, water covered, forest and built-up land covers. It covers approximately 96.28 square kilometres area

Distribution of GCPs and ICPs have been given in the figure 1.2 below, the accuracy information of these GCPs and ICPs is not known but referring to the Wang Tiejun, 2005 these are highly accurate points observed with GPS. The elevation of these points ranges from minimum 62.432 to maximum 227.538 meters.

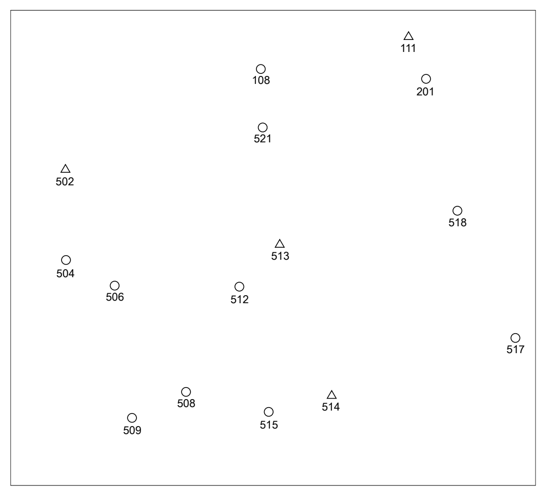
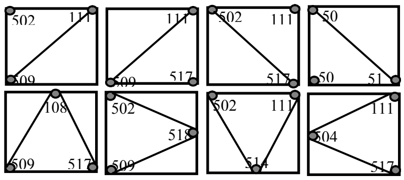



Fig1.2. Distribution of GCPs and ICPs

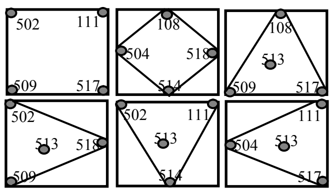
## 4. Methods

After the orientation of the pan images in LPS block with RPCs the 25 GCPs were measured carefully in the classic point measurement tool according to their description, then refinement of the orientation was proceded with following schemes.

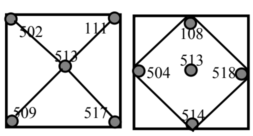
1. Simple shift transformation (0th order refinement) was applied with one control and 24 check points at five different locations at centre and at four corners.
2. Simple shift transformation was applied with two control and 23 check points at four different locations at two diagonals left right and top bottom directions
3. Simple shift transformation and affine transformation ($0^{th}$ order and $1^{st}$ order refinement) was applied with three control and 22 check points at eight different constellations as shown in the diagram below.



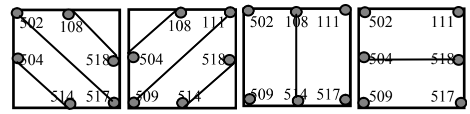

4. Simple shift transformation and affine transformation (0th order and 1st order) was applied with four control and 21 check points at six different constellations as shown in the diagram below.



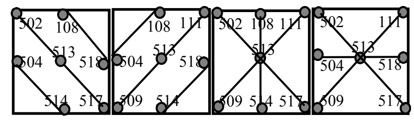

5. Simple shift transformation and affine transformation (0th order and 1st order refinement) was applied with five control and 20 check points at two different constellations as shown in the diagram below.



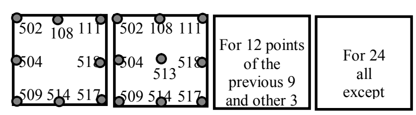

6. Simple shift transformation, affine transformation and polynomial transformation (0th order, 1st and 2nd order refinement) was applied with six control and 19 check points at four different constellations as shown in the diagram below.




7. Simple shift transformation, affine transformation and polynomial transformation (0th order, 1st and 2nd order refinement) was applied with seven control and 18 check points at four different constellations as shown in the diagram below.




8. Simple shift transformation, affine transformation and polynomial transformation (0th order, 1st and 2nd order refinement) was applied with 8, 9, 12 and 24 control and 17, 16, 13 , 1 check points respectively as shown in the diagram below.




NB: simple shift refinement is applicable if one or more GCPs are available, affine transformation refinement is applicable if at least three GCPs are available and polynomial refinement is applicable if at least 6 GCPs are available.

## 5. Results

From the aerial triangulation error report for the control points the RMSE_X, RMSE_Y, RMSE_Z and the computed value of $\text{RMSE\_XY} = \sqrt{RMSE\_X^2 + RMSE\_Y^2}$ of the refinement with the simple translation, affine and polynomial transformation for all the schemes mentioned above are plotted in the figure below,

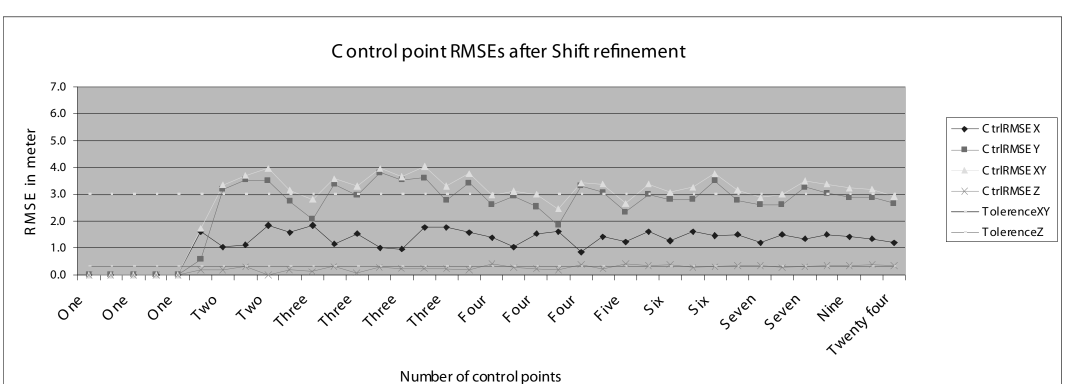



Fig 1.3 Plot of control point RMSE after 0th order refinement

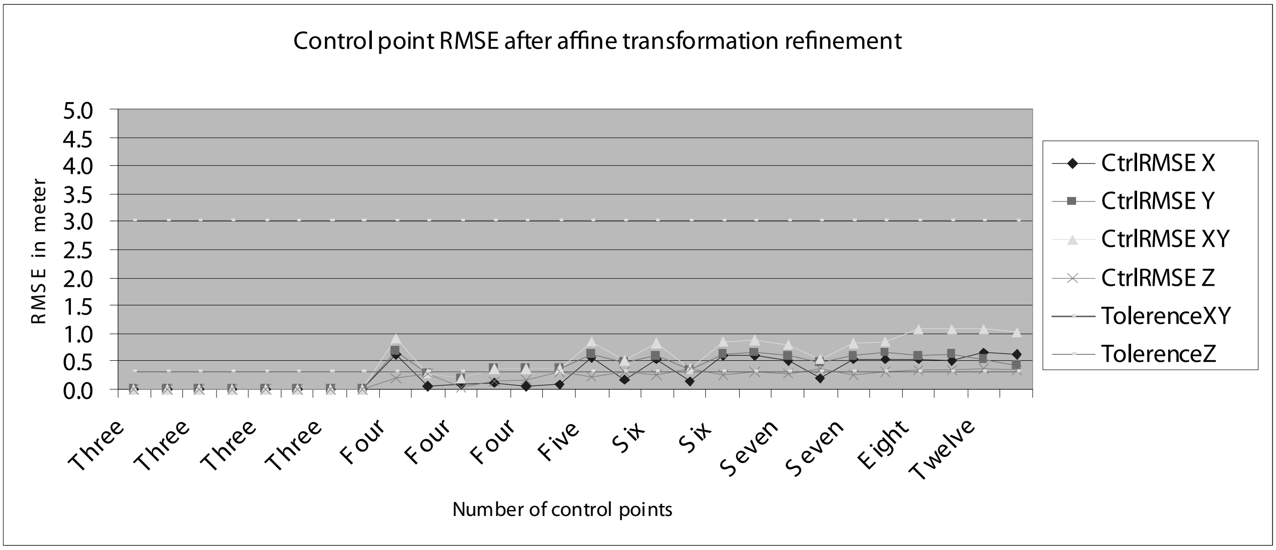



Fig 1.4 Plot of control point RMSE after 1st order refinement

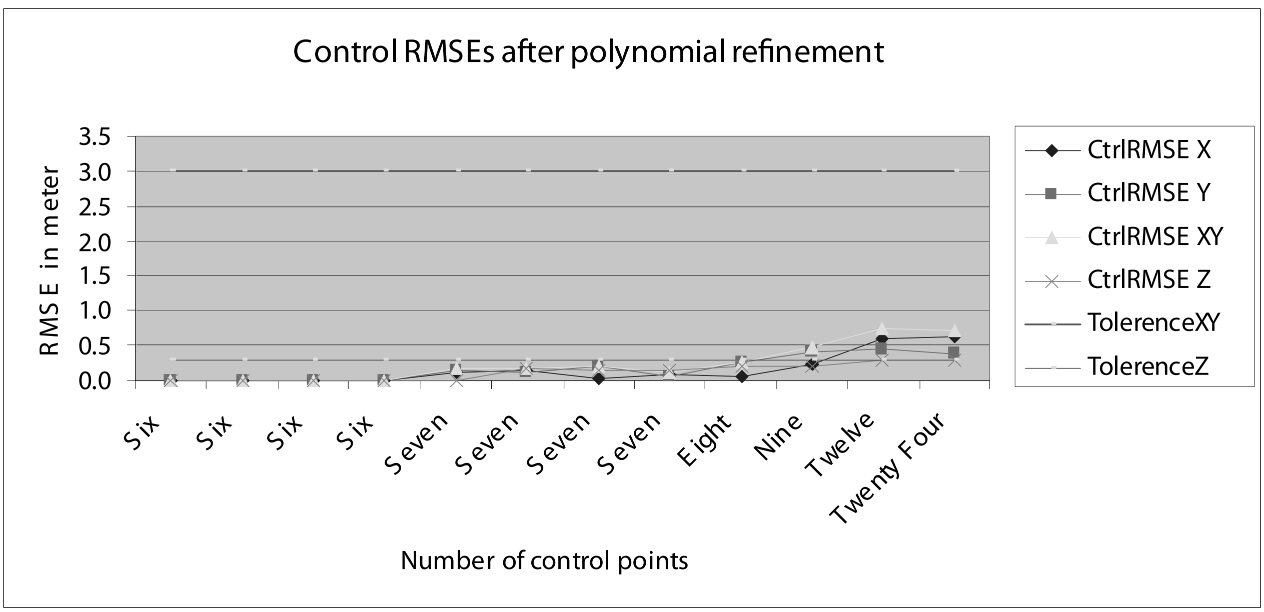



Fig 1.5 Plot of control point RMSE after 2nd order refinement

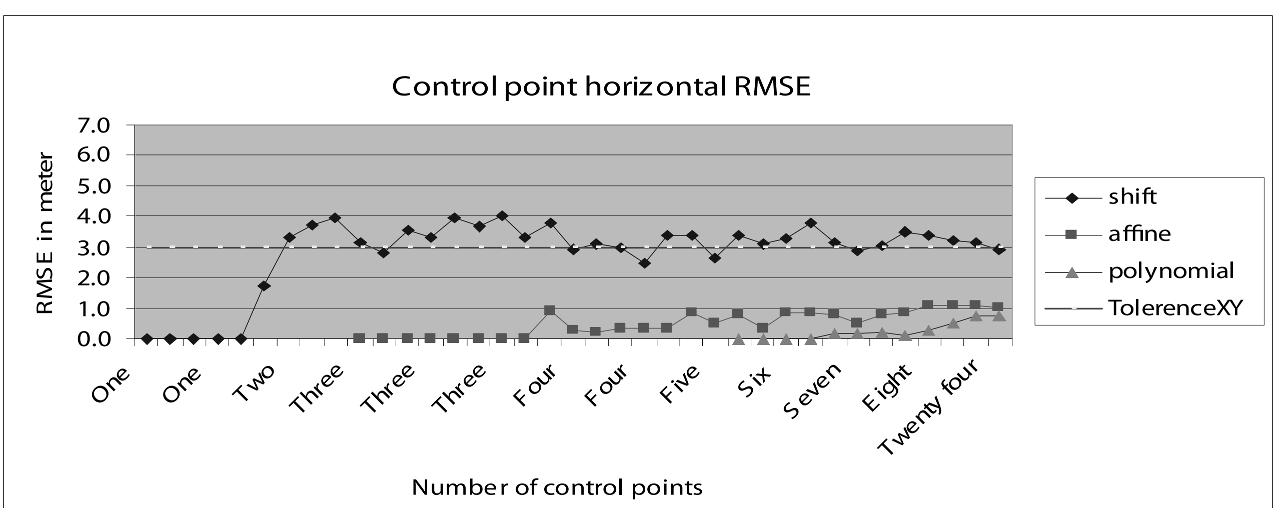



Fig1.6. Plot of control point horizontal RMSE after 0th, 1st and 2nd order refinement

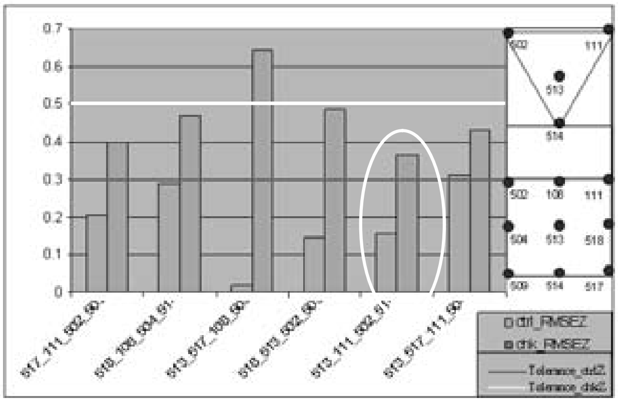



Fig 1.6 Plot of control and check point vertical RMSE after 1st order refinement with 4 GCPs

## 6. Conclusion and Recommendations

The accuracy of the required additional information like RPCs and GCPs influence the accuracy of the final product. To get the data within the required accuracy, in a time and cost effective way, the choice of proper processing method and algorithm is also equally important which is a matter of optimization of the geometric processing. In this study the IKONOS Geo product stereo images of a part of China were used for experimentation with their RPCs and 25 accurately measured and well distributed GCPs. The results were analysed and concluded on the basis of Chinese specifications for the base data of 1:10000 scale. From this study it can be concluded that the ttranslation transformation refinement does not meet the accuracy of specifications.

The minimum number of GCPs required to apply a particular transformation algorithm, is not practically sufficient for proper refinement and it needs two more redundant control points.

If the number of redundant control points increased the accuracy goes on improving up to two redundant GCPs, the further redundancy has no significant improvement.

The accuracy not only depends on the number of GCPs used but also on their constellation and spatial distribution within the study area.

The affine transformation with four GCPs in the constellation as shown in the Figure 1.6 was found to be optimal for the orientation of the experimented dataset for which the horizontal and vertical RMSEs for control points are 0.37, 0.16 meters and that for check points are 1.22, 0.37 meters respectively.

During orientation the same number of GCPs applied in similar constellations (e.g. just change of the orientation of the constellation upside-down or left side right) have different results so it is recommended to look also into the other factors influencing on the accuracy like distribution of GCPs in along- and cross- track directions, elevation differences of the used controlpoints, type of GCPs (e.g. at intersection of linear features in different angles, corner of the rectangular features in different background, centre of the circular features, edges of the linear features etc), accuracy of GCPs etc. On the basis of the findings of this study it is suggested for the further researchers that there is no point in experimenting with orientation using more than 5 control points for refinement and use of other than affine transformation algorithm

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

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

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

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

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# Surface Gravity Information of Nepal and its Role in Gravimetric Geoid Determination and Refinement

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***Abstract***

*This paper describes proposed first order gravity network which was almost abandoned and existing gravity database that has to be preserved and advocates about its importance in the determination of regional gravimetric geoid of the country. Since GPS is in full phase operation and adopted as an efficient and accurate method in position and height determination the paper also elaborates how all its three components can be taken into consideration.*

## 1. Introduction

Gravimetric geoids play a major role in the process of regional geoids determination. This approach uses the set of residual gravity anomalies determined by point gravimeter measurement on the earth surface together with global geopotential models, with the geoids undulations over the oceans determined from the method of satellite altimetry.

Nepal is a country of rugged and mountainous terrain having biggest elevation differences in the country. As a result it has greatest gravity anomalies in the world's gravity field. These anomalies cause a significant effect on the survey works both in horizontal and vertical measurements. But unfortunately although the importance of the gravity measurement was felt necessary in the geodetic activities of the country its growth and further expansion cannot meet the expectation of the organization due to the lack of skilled manpower and required equipments compared to other fields of geodetic survey such as densification of the higher order controls using Global Positioning System and extension of the precise leveling network in the country.

Introduction of the global positioning system (GPS) survey operation (establishment of geodetic controls) has become much more efficient and accurate with reference to World Geodetic System 1984 (WGS84) but in the contrary it also created a challenge of the conversion of positions and heights in Everest Spheroid 1830, which is the national datum of the country on which all the mapping activities are referred.

Secondly GPS in its relative carrier-phase mode provides three- dimensional coordinates of latitude, longitude and ellipsoidal height relative to known fixed point in the WGS84. For the transformation of horizontal coordinates (latitude and longitude) Geodetic Survey Branch has been using the local transformation where required. (Geoid for Nepal 1997).

The ellipsoidal height component must also have to be transformed to an orthometric height using information of the geoids- WGS84-ellipsoid separation at each GPS point.

Geodetic Survey Branch has been using only the horizontal component (latitude and longitude) of GPS output although the vertical component (height) is one of the vital informational product of the survey however this requirement is fulfilled by conventional method of sprit leveling till today.

## 2. Conversion of ellipsoidal height

The GPS derived ellipsoidal height is purely a geometric quantity which neglects the physical effects of the Earth's gravity field. The gravity vector provides the common experience of the vertical plumb-line, which defines the horizontal and vertical orientation of most surveying instruments used for surveying on the physical surface of the earth.

Water that is free to move will flow from higher elevation to lower elevation due to the influence of the gravity on the physical surface of the earth but in a purely geometric system it may not be true. We may then experience that the flow of water can take place from point lower to the higher side of the ellipsoidal height. Therefore the ellipsoidal height has no physical meaning hence the orthometric height which is referred to geoids must be used in surveying and engineering applications.

In Nepal the height datum is based on Mean Sea Level of India. Hence the orthometric height is related to GPS derived ellipsoidal height at a point A by the following simple transformation.

$$H_A = h_A - N_A \qquad (1)$$

Where $H_A$ is the orthometric height of point A above the geoids.

$h_A$ is the ellipsoidal height of point A above the WGS84 ellipsoid and

$N_A$ is the geoids ellipsoid separation at point A

In the relative case, between two points A and B, this relationship becomes

$$\Delta H_{AB} = \Delta h_{AB} - \Delta N_{AB} \qquad (2)$$

Therefore, given a change in ellipsoidal height ($\Delta h$) from relative GPS observation precision of the corresponding change in orthometric height ($\Delta H$) is controlled, in part, by the precision with which the change in the geoids-ellipsoid separation ($\Delta N$) is known. The gravimetric method using surface gravity information generates the geoids- ellipsoid separations with which to perform the transformation. The accuracy of the gravimetric method is a function of the coverage of gravity data, spatial density and accuracy of the data used in the computation of the geoids height.

## 3. Relationship of gravity (g) with orthometric height (H)

The fundamental relationship between the Earth's gravity field (g), orthometric height (H) and the gravity potential (W) is given by the following derivative (Heiskanen and Moritz, 1997)

$$dW = -gdH \qquad (3)$$

As the Earth' gravity field is spatially variant, so must be the relationship between W and H. This equation explains the reason behind the sprit leveling loop, even though it is error free will not close and the geoids is a unique equipotential surface (W = constant) of the earth's gravity field which is closely related to mean sea surface. Hence geoid is closed and continuous surface which undulates in and irregular fashion because of the mass density variations within the earth.

Now in order to determine the geoids using the gravimetric method, observed gravity on the earth's surface must at first be reduced to geoids by accounting for the observation elevation, whist preserving the earths mass. At present during the process of geoids determination, the Faye gravity anomaly ($\Delta g$) is used, which is computed by adding the gravimetric terrain correction to the free-air gravity anomaly.

$$\Delta g = \Delta g_{FA} - C \qquad (4)$$

Where $\Delta g_{FA}$ is the second –order free-air gravity anomaly, computed using the procedure described in Featherstone (1995) and C is the gravimetric terrain correction (Moritz, 1968).

$$C = \frac{Gr R^2}{2} \int_s \frac{(H' - H)^2}{l^3} ds \qquad (5)$$

Where : G is the Newtonian gravitational constant

$\rho$ is the topographic density, assumed to be a constant 2670 $kgm^{-3}$

R is the mean radius of the earth,

H height of the computation point,

H' is the height of each distant point,

$l$ is the separation and

$d\sigma$ is and integration element on the sphere.

## 4. Relationship between geoids height (N) and gravity anomalies ($\Delta g$)

The fundamental relationship between the geoids height (N) and gravity anomalies ( ) is given by the Stokes's formula (Heiskanen and Moritz, 1967). However, this formula requires that gravity data are used over the entire earth, which is an onerous condition that is not currently satisfied. Instead, a remove-restore approach is adopted, which significantly reduces the data and the computational requirements. It also reduces the effect of the spherical approximations inherent in the Stokes's formula. During this remove-restore approach, a global geopotential model (GGM) provides the long wavelengths geoids undulations and Stokes's formula adds those wavelengths greater than that implied by the resolution of the gravity and the terrain data. In the mathematical form, Stokes's formula in conjunction with the remove-restore technique is given by,

$$N = N_{GGM} + \frac{R}{4\pi\gamma} \int_\sigma S(\Psi)(\Delta g - \Delta g_{GGM}) d\sigma \qquad (6)$$

$$N_{GGM} = \frac{GM}{r\gamma} \sum_{n=2}^{M\max} \left(\frac{a}{r}\right)^n \sum_{m=0}^{n} (\delta\, \bar{C}_{nm}\, Cosm\lambda + \bar{S}_{nm}\, Sinm\lambda)\, \bar{P}_{nm}(Cos\theta) \qquad (7)$$

$$\Delta g_{GGM} = \frac{GM}{r^2}\sum_{n=2}^{M\max}\left(\frac{a}{r}\right)^n (n-1)\sum_{m=0}^{n}(\delta\bar{C}_m\ Cosm\lambda + \bar{S}_m\ Sinm\lambda)\bar{P}_m\ (Cos\theta) \quad (8)$$

Where,

$\gamma$ is the mean normal gravity

$S(\psi)$is the stokes's function

$\Delta g$ are the Faye (terrain corrected free-air) gravity anomalies

$\psi$ is the angular distance from the computational point to the roving point,

$GM$ is the geocentric gravitational constant

$(r,\theta,\lambda)$ are the spherical polar coordinates of the computational point

$\bar{P}_{nm}$ are the fully normalized associated Legendre polynomials for degree n and order m and

$\delta\bar{C}_{nm}$ and $\bar{S}_{nm}$ are fully normalized spherical harmonic coefficients of the GGM, which has been reduced by the even zonal harmonics of the reference ellipsoid, and are complete to degree and order $M_{\max}$.

In equation (6) the gravity anomaly used is the Faye gravity anomalies hence it generates Faye co-geoid which must be converted to true geoids by adding the indirect effect ($N_i$) corresponding to the free-air reduction and gravimetric terrain correction. This indirect effect is given by Wichiencharoen (1982) as,

$$N_i = -\frac{\pi G\rho H^2}{\gamma} - \frac{G\rho R^2}{6\gamma}\int_\sigma \frac{(H^{'3} - H^3)}{l^3}d\sigma \quad (9)$$

## 5. Numbering of the gravity stations:

The number of the first order gravity station consists of two or three digits where the last number is always designated by digit "1" signifying it as the first order. The preceding numbers before the digit "1" is the serial number of the stations within the first order network. Similarly the numbering of the second order gravity stations consists of the number two or more digits where the last number is always designated by digit "2" marking it as second order.

## 6. Gravity observation:

During the period 1981-1984 British Military Survey units were engaged in establishing the geodetic control network in Nepal. During this period some gravity was also observed to establish the gravity base in the country. The gravity reference system used for the gravity survey was IGSN 1971 and the instruments used for the gravity observation in 1981-1984 survey were Lacoste Romberg Model G gravity meter.

During 1981-84 survey 21 out of 36 stations were observed by MODUK (Ministry of Defense United Kingdom) but these stations were not monumented during the time of observation. These stations need to be monumented at the designated site according to the MODUK's Gravity Base Station Description (Reports and Results of Gravity Survey in Nepal).

## 7. Fundamental Gravity Base:

The fundamental gravity base station of Nepal was established at Tribhuwan International Airport of Kathmandu. This station is designated as Kathmandu J. In May 1981 a gravity transfer was made from station Kathmandu J to and IGSN 71 station in Bangkok. The sequence of measurement was Kath/Bangkok/Kath. The time taken for the observation was 33 hours with 13 hours layover in Bangkok. Four gravimeters were used to determine the difference in "g". The mean value obtained for the difference in "g" was + 361.12 mGal.

Apart from the fundamental gravity base most of the gravity base stations were established at the airports and in such locations where communication by road was possible. The main net consists of 45 stations at 35 different locations in the country.

For most of the detail stations the position and elevation has been taken form the best available map source during that time.

## 8. Gravity Detail Stations:

Values of the observed gravity were determined at a total of 375 detail stations. Trip to fix the detail station from a reference base station were made using single gravity meter so that no reliability can be quoted for the gravity values. However from the various evidience the Se (Standard error ) of uncertainty of gravity values is unlikely to exceed +/- 0.3 mGal relative to IGSN 71 reference system. This observation were made by MODUK.

The Eastern Nepal Topographic Mapping Project( ENTMP) observed new gravity in 43 GPS stations. The gravity data set of ENTMP includes 95 gravity measurements specified as old British points. This information created confusion whether the old British points means the gravity observation made by MODUK or the new gravity observation made by ENTMP on the trig. Stations established by British Survey Team. However it is not a serious problem because the common points in the data set can be detected.

## 9. Gravity network of Nepal

The first order gravity network consists of thirty-six (36) stations situated in different parts of the country. These gravity stations are mainly located at airports and airstrips where ever possible focusing on the need easy accessibility for the observation. There are 25 such sites located in airport and airstrips and the remaining eleven (11) stations are located in district offices or in other Government offices where it can be perfectly protected such as police stations and army barracks etc. The distribution of the first order gravity stations enables for the break down of the second order gravity positions in future.

List of the first order gravity stations are as follows:

Table 1

| Station | | Access By | | Monumentation | | Observed By | Remarks |
|---|---|---|---|---|---|---|---|
| No. | Name | Air | Road | Present | Proposed | | |
| 11 | NAGARKOT | | | PILLAR | CBL+BM | MODUK | |
| 21 | KATHMANDU | | | CBL+BM | - | MODUK | |
| 31 | LAMOSANGU | | | - | CBL+BM | MODUK | |
| 41 | KODARI | | | CBL+BM | - | MODUK | |
| 51 | JIRI | | | - | CBL+BM | - | |
| 61 | LUKLA | | | - | CBL+BM | - | |
| 71 | RUMJATAR | | | - | CBL+BM | - | |
| 81 | TAPLEJUNG | | | - | CBL+BM | | |
| 91 | BHADRAPUR | | | - | BM | MODUK | |
| 101 | DHANKUTA | | | - | CBL+BM | - | |
| 111 | BIRATNAGAR | | | | BM | MODUK | |
| 121 | RAJBIRAJ | | | - | CBL+BM | MODUK | |
| 131 | JANAKPUR | | | CBL+BM | - | MODUK | |
| 141 | NAWALPUR | | | - | CBL+BM | MODUK | |
| 151 | BIRGUNJ | | | - | BM | MODUK | |
| 161 | HETAUDA | | | - | BM | MODUK | |
| 171 | TRISULI | | | - | CBL+BM | - | |
| 181 | GORKHA | | | - | CBL+BM | - | |
| 191 | BHARATPUR | | | - | CBL+BM | MODUK | |
| 201 | POKHARA | | | - | BM | MODUK | POKHARA J, JA |
| 211 | JOMSOM | | | - | CBL+BM | - | |
| 221 | BAGLUN | | | - | CBL+BM | MODUK | |
| 231 | TANSEN | | | - | CBL+BM | - | |
| 241 | SIDARTHA NAGAR | | | - | BM | MODUK | BHAIRA WA, J |
| 251 | LAMAHI | | | | CBL+BM | MODUK | |
| 261 | BAJHYAN (ROLPA) | | | - | CBL+BM | - | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 271 | JUPHAL (DOLPA) | | | - | CBL+BM | - | |
| 281 | JUMLA | | | - | CBL+BM | - | |
| 291 | CHAUR JAHARI | | | - | BM | MODUK | CHAUR JAHARI, J |
| 301 | NEPALGUNJ | | | - | BM | MODUK | NEPALGUNJ, JA |
| 311 | BIRENDRA NAGAR | | | - | BM | MODUK | SURKHET J |
| 321 | SIMIKOT | | | - | CBL+BM | - | |
| 331 | CHAINPUR (BAJHAG) | | | - | CBL+BM | - | |
| 341 | DIPAYAL | | | | BM | MODUK | DOTI, J |
| 351 | PATAN (BAITADI) | | | - | CBL+BM | - | |
| 361 | DHANGADHI | | | - | BM | MODUK | DHANGA DHI D, J |

Notes:
CBL+BM means Concrete Block Pillar with Bench Mark
BM means Bench Mark
MODUK means Ministry of Defense United Kingdom

This first order gravity network need to revisited, checked and if the station was not monumented the Monumentation work have to be carried out at the earliest in near very future otherwise all the valuable information might be lost.

## 10. Geoid Computation

One of the oldest methods of geoid computation is the astro-geodetic method. In the first order network of Nepal 84 points have astro-geodetic deflection components and geoid heights expressed in Nepal datum. Then for the evaluation of geoid height “N” of the unknown point a graphical method was used. The geoid chart was drawn with the help of astro-geodetic values of “deflections from vertical”, the geoid height of the new point was interpolated from the existing chart. It was one of the earliest and simplest method. At present due to the advent of various mapping software and computers the interpolation of data by electronic device make faster and more accurate when dealing with the large data set. This method is almost primitive method of geoid computation. Hence the new gravimetric geoid using the above mentioned gravity data base the Gravimetric Geoid97 was computed by Finnish Geodetic Institute during the Eastern Nepal Topographic Mapping Project in 1997. The geoid NEPAL97 for the whole of Nepal was computed using materials (GPS, Leveling, Gravimetry) data collected over many years in both east and west Nepal. The technique used was “GPS-gravimetric”. First a gravimetric geoid was computed using geopotential models then this gravimetric geoid was ”fitted” to a set of geoid undulation values obtained from the GPS heighting as well as spirit leveling. This geoid has not been used yet in the geodetic computation because the data was not made available to Geodetic Survey Branch.

## 11. Conclusion and Recommendations

Fundamental geodetic network is required for general mapping, environmental studies, development of communication system, irrigation, water supply and hydropower as well as crustal dynamics. In other words in most of the major activities of national level projects there are fundamental roles of geo-information based on geodetic controls.

Quick and efficient method of providing horizontal and vertical controls are todays requirement. At present this requirement is fulfilled by the method of Global Positioning System but sometimes the output that the GPS provides may not be relevant or meaningful to the requirement that is demanded. For example GPS provides horizontal controls based on WGS84 and in the mean time gives the height above this ellipsoid.

In order to develop the conversion parameters different geodetic measurement on the physical surface of the earth is the prerequisite. This includes many types of geodetic information such as angles, distances, heights, gravity, positions etc. These all are raw vital information. These information cannot be collected in one day. The huge amount of time, money and skilled human labor was spent in its acquisition. Since it is a base for infrastructure development of the nation, government make investment in this field or even sometimes co-operates with developed countries in order to fulfill the technical skill and modern technology that is lagging in the country. All such information should be protected and preserved

In the geodetic satellite positioning heights can, however not be obtained directly from the GPS measurement, but in the present context one of the main objective is using GPS with full potential which means replacement of the geodetic sprit leveling.

This requires high resolution gravimetric geoid with dense coverage of gravity and terrain data. Therefore the point surface gravity information should be desified otherwise the densification works has to be replaced by airborne gravity survey. At present airborne gravity survey can achieve an accuracy of 2 mGal in gravity data acquisition.

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# Nepal Remote Sensing and Photogrammetric Society

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## Brief Notes on participation of the 30th Asian Conference on Remote Sensing (ACRS) by the President of the Society

The then Director General, Survey Department and President, Nepal Remote Sensing and Photogrammetric Society (NRSPS) Rabin K. Sharma along with the four more officials of Government of Nepal participated in the 30th Asian Conference on Remote Sensing (ACRS) held in Beijing, China form 18 to 23 October, 2009. This conference is convened every year at one of the Asian countries mainly to share knowledge and promote applications in Remote Sensing and Geographical Information Systems technology amongst the researchers, professors, academicians, students and the user communities. This conference is organized in general jointly by Asian Association on Remote Sensing (AARS) and the related organization of the host country, in this case, the host organization is China National Committee on Remote Sensing (CNCRS).

The main features of the conference are presentations of the technical papers, exhibition, prize distribution, General Conference of AARS and reception. The conference attracted 111 participants from different organizations of China, 597 participants form 27 countries and 113 students form different Universities of the globe and 29 exhibitors displayed and demonstrated their products. About a dozen invited papers, 253 technical papers and 103 posters were presented. A White Elephant Session was also organized specially to bridge the relationship between the teachers and students. The details of this session can be downloaded from the official web page of AARS (www.aars-acrs.org).

The prize distribution programme is one of the most attractive events of AARS in which awards are given to some best oral and poster presentations amongst the young students and young scientists and Boon Indrambarya Gold Medal Award to the most recognized scientists who contributed to Remote Sensing field. In this context, 13 Students, 3 young scientists (2 for oral and 1 for poster) and 12 scientists received the respective awards. This year, the organizers decided to give Outstanding Contribution Prize to the persons who contributed to the past achievement of ACRS in which 13 of them including Rabin K. Sharma from Nepal received the prize. The prize was distributed at the 30th ACRS Anniversary Celebration programme where 5 of them addressed the session in which Mr. Sharma was one of them to deliver the speech. Besides that Mr. Sharma nominated as one of the Members of the International Steering Committee of the 30th ACRS.

General Conference of AARS is one of the important events of ACRS where major decisions for the activities of AARS and ACRS are taken place. Mr. Sharma is selected for Rapporteur of the Sessions of the General Conference of AARS.

The welcome reception hosted by the organizer in honour of the delegates was very exciting event of ACRS where the delegates not only enjoyed the food but also entertained the cultural programme.

The outcomes of the Conference are summarized in the Minutes of the General Conferences. One of these is the termination of the tenure of thirty years of excellent service of Prof. Shunji Murai as a General Secretary of AARS and handing over this post to a new generation scientist, Prof. Kohei Cho. From the point of view of Nepalese delegates, the 30th ACRS was very much memorable because the honour given to the President of NRSPS is a great pride to Nepal.

# Nepal GIS Society

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## Activities of Nepal GIS Society in the year 2009/10

**Celebration of the 15th Anniversary of the Society**

The 15th Anniversary of the Society held on 22nd July 2009. It was celebrated by organizing a day-long workshop on "GIS education for all" the slogan of the year taken by the Society.

**GIS training and worshop conducted by the Society**

A basic level GIS training was conducted by Nepal GIS Society at Local Development Training Academy, Jawalakhel, Lalitpur from 15th to 19th November 2009.

**International GIS Day celebration on 18 November 2009**

Since 2000, Nepal GIS Society has taken a lead role on the celebration of Geographic awareness week and GIS Day in Nepal. In this year the society celebrated the day by organizing a week long GIS training for the beginners and a half day GIS conference.

**Talk Programme at NPC**

President of Society Dr. Krishna Poudel has delivered a talk on "Geographical Information System in Nepal with issues and prospects" at the NPC secretariats on Dec 13, 2009. Honorable Vice Chairman of National Planning Commission and other honorable members and high-level official of the secretariats were attended the talk programme.

National Planning Commission has nominated the president of the society as a officio member of the GIS Steering Committee

**Book Release**

Nepal GIS Society has published a book on 'Geographic Information Science and Technology; Building concept in Nepalese perspective' written by Dr. Krishna Poudel.

NEGISS has established a Documentation Unit. It has been collecting and recording the books, manuals, bulletins to disseminate the GIS information. Society has established 24 hours internet facility in office and regularly updated its activities in its own URL http://www.negiss.org.np

# Nepal Surveyors' Association (NESA)

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**Member**

### Background

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

### Objectives

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

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

### Organizational Structure

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

### Membership Criteria

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

### Activities

*On 18th Bhadra 2066 Surveyors' Day was celebreted with different programmes.*

*Workshop and interaction programme on "State Restructuring and Land Administration" was held on 5th Falgun 2066.*

*Memorandum presented to Ministry of Land Reform and Management concerning the qualification of different posts in Engineering Service, Survey Group.*

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| | | |
|---|---|---|
| Price of SOTER Data | Whole Nepal | NRs : 2000.00 |

| | | |
|---|---|---|
| Ammonia print of cadastral plans | 1:2500, 1:1250, 1:500 | NRs. 50.00 / sheet |

# The Strategies for Strengthening National Geographic Information Infrastructure in Nepal

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**Keywords:**

NGII, SDI Policy, strategies, standards, partnership

### *Abstract*

*Nepal has already initiated the National Geographic Information Infrastructure activities (NGII). For a successful implementation of a National Geospatial Data Infrastructure (NGDI), there is a need for a national policy that will provide the necessary guidelines, identify various committees to be responsible for the various aspects of the NGDI (such as standards, custodianship, sharing and partnership) and provide issues that are acting as the constraints against the take off of the NGDI. The issues must be discussed at a forum where all the stakeholders would meet to discuss on the various issues in the draft policy prior to the approval. There is also a need for an agency to be the lead agency in the development of a NGDI, for which the prevalent NGIIP can be given authority to act as a coordinator until the formation of the National Geographic Information Council. This paper highlights that each stakeholder organization must have certain strategies that work in resonance with broad SDI strategies that perform NGII development and proposes its mission, vision and some general policy statements for the development of SDI activities in Nepal. Some goals and corresponding strategies identified as an outcome of recently held evaluation research on NGII has been provided as an aid for its development.*

## 1. Introduction

Geographic Information System (GIS) activities were initiated in Nepal during the National Eighth Plan period between 1992-1997 (Chhatkuli 2002). The emergence of IT Policy in 2000 led the growth of GIS activities in the country (NPC 2001). The National Eighth Plan (1992-1997) period witnessed many sporadic creations of spatial databases and mushrooming of isolated GI systems, most of which started from independent digitization of the then existing out-of-date topographic maps therefore duplicating much of the efforts. The Ninth Plan (1997-2002) focused on the use of geographic information and spatial data by mentioning importance of GIS in many occasions (Chhatkuli and Kayastha 2005). The base paper of the Tenth Plan (2002-2007) mentioned the importance of a geographic information infrastructure and national geographic information system for an easy access and dissemination of geographic information (NPC 2002). Consequently, in the year 2002, the then Government of Nepal initiated a National Geographic Information Infrastructure Programme (NGIIP) with one of the pronounced objectives of avoiding duplication in spatial data creation and usage through the networking of different GI Systems in the country. In this way, NGIIP initiative formed a national level SDI in the country (Chhatkuli and Kayastha 2005).

National Geographic Information Infrastructure programme (NGIIP) has been launched by the initiation of the Survey Department, the National Mapping Organisation (NMO). It started functioning by launching metadata of framework data (Chhatkuli 2003). There are different stakeholders from the central government agencies as well as some district level offices situated at different parts of the country in the NGIIP network. Records from NGIIP show that hundreds of users have acquired spatial information from NGII platform so far. To see whether NGII has fulfilled user expectations, evaluation was necessary.

Therefore, a research was carried out to see the success of NGII in terms of user satisfaction perspective. An index was derived by integrating all of the measured satisfaction on weight assigned indicators to denote the level of success. It was found that the success level of NGII is below the “slightly satisfied level i.e. 1” although positive with an overall mean success index of 18% in comparison to the extremely satisfied conditions in an ideal case (100%). The research indicated that the low level of satisfaction on NGII mostly accounts to the factor ***"effort applied for national policies and technical standard"*** on which the level of satisfaction was 0.01 (almost zero in the measurement scale) which indicates that there is no such policy existing in the country that stimulates and support NGII. Similarly, indicators like availability, accessibility, means of request and completeness are in a very low level of positive satisfaction. The reliability of the system and completeness of information also show the very low level of satisfaction, in spite of their recognizance as important factors.

## 2. A time to reverse the approach for NGII

Nepalese NGII developers have done quite a lot (particularly spatial base-data generation) following the bottom up approach such as generation of national multi-resolution topographic database, metadata publication of basic topographic database and clearinghouse setup. But it lacks important aspects such as institutional and legal framework. It lacks coordination mechanism and there is no spatial information policy. These issues need to be solved through the higher level bodies of government. Data itself is not everything for SDI realisation. Therefore, it is seen that the bottom up approach of SDI realisation has a certain degree of saturation (after the data or certain technology set up), after which the process must be reversed such as top-down approach for actual realisation. 40% of respondents from the policy level explicitly remarked that "the adoption of bottom up approach" itself is responsible for the current plight of Nepalese NGII whereas some of the respondent themselves acknowledged that the time to reverse the approach has arrived. This indicates that NGII can not be fully realised only from the bottom up approach. Of course, it is useful for initializing NGII activities such as data generation in the stakeholder organisations. On the other hand, it equally needs top-down exercise such as generation of broader policy framework and bringing broader (not only confined to single organisation) strategies for NGII realisation. Bottom-up approach provides experience to the players and designers based on which spatial information policies is formulated and legal and organisational framework are set up. The proposed strategies, that support for NGII development assumes that present NGIIP under the Survey Department (NMO) should take initiative role for this in such a way that its business strategy must be aligned with that of other stakeholder organisations and the ICT strategies must be aligned with ICT strategies of each organization similar to what Henderson and Venkatraman (1999) contend on their strategic alignment models.

"Innovation like a SDI is not an entity that comes out of spontaneous creation by somebody", as stated by NRC (1993), "It is an ad hoc affair". The only important aspect is to put its component (such as data, metadata etc) in a coordinated and well arranged order on the backdrop of policy, standard, cooperation and coordination. The strategies formulated as a result of this study are for the improvement of NGII but not focused on a particular stakeholder organisation that has a stake in it. Therefore, these strategies are referred as broad strategies. It is believed that until there is a national focus, an NGII cannot be developed. This necessitates: communication between the potential partners, identification of priorities areas of different sectors and their link with NGII; development of implementation plan with consensus of stakeholders; and mutual exchange and enhancement of knowledge. Similarly, strategic organizational framework is of vital importance for NGII development. For this, development of categorical strategies and adoption of strategic alignment by each of the stakeholder organisations and strengthening of relation with similar international organizations is essential. Culture of use of spatial data in decision making process helps to promote NGII development. This can be enhanced by creating metadata and prototyping of application that can be used in the decision making process. These developments can only be realized if there is a proper guideline in terms of strategies. This is only possible if players at higher level play an active and creative role to realize NGII.

## 3. Institutional situation of NGIIP

This section searches for any existing arrangements that are key to: easy access to the national data asset components owned by different stakeholders; ensuring the maintenance of these data and its related metadata; avoidance of duplication of efforts and resources invested in data collection; development of standard in compliance to the national or international standards and identifying and developing core datasets.

### 3.1 The Policy Problems

Although the national periodic plan documents spell out gradual evolution of surveying and mapping and geo-spatial data activities in Nepal (Chhatkuli 2007), NGII in Nepal still suffers from the lack of formal policy framework to facilitate the development of SDI. Organizations do not have clear mandate for data dissemination in the policy context. Present distribution of geo-information from NGIIP as the products of Survey Department is only an extension of distribution of hardcopy information based on Article 2 ka 1 of Land (Survey and

Measurement) Act, 1963 of Nepal. As a result, unauthorised agencies may involve selling the data derived by the other organisations. The copyright legislation has not been effective for spatial data distribution and use, resulting to ad-hoc arrangement for data distribution, which is not beneficial for the government and private sector. It simply indicates that there is a lack of custodianship.

Lack of policies for institutionalisation of NGIIP and its activities, pricing and standard of spatial data, use of technology and human resource development, coordination, cooperation and use of spatial data have hindered the development of NGII, the reason for which a number of stakeholders have remain fixed in the NGII platform since the beginning of the programme. Figure 1 indicates different policy problems existing in Nepal hindering the development of a coherent NGII, as responded by different stakeholders.

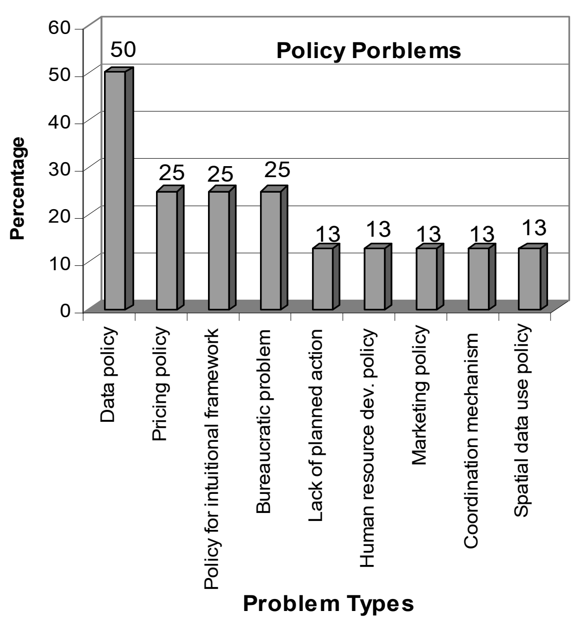


Figure 1: Indicating the existence of policy problem in NGII environment

## 3.2 Standards

Standard development and implementation for spatial data was found to be existing but for only NTDB with some limitation with respect to its content. Since duplicated data (digitized separately) has been found being provided by different agencies on their own, there are not at standards. At the same time, all the sampled user organizations are using these differently sourced data. Consequently, users are facing problem while they overlay these data acquired from different sources such as ICIMOD, NGII, KMC or DUDBC as they apply different coordinate and projection system for the data.

The existing data cannot be easily integrated (no common reference system) due to variations in projections and other data quality aspects. There are no national standards adopted on data formats and content in spite of the publication of standard for NTDB by SD. On the other hand, the standards published falls short in the context of the measure of availability of information at present (such as information from the satellite images). Most institutions develop or adopt their own local standard therefore rendering difficulties in data sharing.

This has caused serious problems for users while they run overlay operations in GIS hence causes un-satisfaction. However, in spite of the existence of differences in standard, majority of the user responded that data from NGIIP are mostly used because it is produced by NMO which have published standard and bears metadata in the clearinghouse. Standard published by SD has provided at least some degree of satisfaction in comparison to that data provided by the other organisation.

It is observed that data produced in NGIIP has been seen to be produced using the same software as being used by most of the sampled user .This has set an ad hoc standard of spatial data (vendor based format), at least solving immediate problems. Users' responses on standard among data producers shows that the available standard is not sufficient since it does not explains the data reliability, completeness, accuracy etc.

## 3.3 Organizational structure of NGIIP

The organisational stature of NGIIP can be viewed from different perspective: number of partners in NGIIP development; position of NGIIP in Nepalese administrative structure; realisation of proposed National Geographic Information Centre (NGIC); human resources; coordinating role in NGII environment.

NGIIP exists as a physical organisation for SDI activities, with the leadership of Survey Department. The organisations involved in the NGII in the initial stages were SD, CBS, MLD, MOPE, MOAC and DHO (Lahmeyer International 2005) as well as 33 Branch Statistics Offices (BSOs) scattered in the different parts of the country. Out of the main six stakeholders, MOPE does not exist as a stakeholder any more since it was disintegrated and merged with the other Ministry (Interview, Kaystha, 2008). This makes the number of stakeholders to be reduced to 5, excluding BSO offices.

Emergence of IT policy, copyright laws indicate that Nepal is practicing to enter into the IT based governance (NPC 2001). However, It has not been able to come out of the bureaucratic system (Sapkota 1997; Shukla 2005).

This is also reflected in NGII. Analysis revealed that the placement of NGIIP under the Survey Department has been controversial. Administrative position of NGIIP in the vertical structure of Nepalese Bureaucracy shows that it is below the department level, whereas its connection is with the organization from the Ministry level to the District level as shown in figure 2.

their representatives (NGIIP 2008) including personnel from NGIIP. However, these committees have not been able to formulate a single draft policy so far.

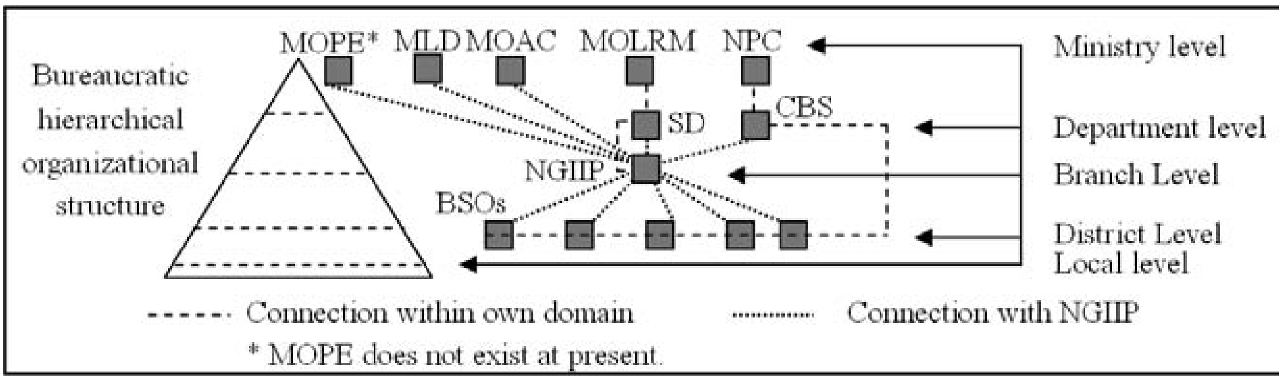


Figure 2: Position of NGIIP in the bureaucratic hierarchal organizational structure in Nepal

A close look on the notion of the respondents revealed that the given position of NGIIP below the Ministry level has deprived it to play the role as a coordinator in NGII since the bureaucratic circular prevents it to have an easy access to and communication with Department-Ministry or Ministry-NGIIP. Bearing in mind that such scenario would develop whereby NGIIP might not be able to perform the way it is expected due to its placement in a position not comfortable to the other ministry level organizations, the concept of formation of the National Geographic Information Centre (NGIC) had been proposed by NGIIP at the beginning of NGII process in Nepal Which, unfortunately, has not been able to be recognized due to varieties of reasons.

### Human resources at present in NGIIP

Information gathered showed that NGIIP has a number of experts in the geo-information field but it does not have a single expert in domain of ICT which has posed difficulties in development of mechanism for dissemination of existing information available in NGIIP. For ICT purpose, NGIIP is opting for outsourcing mechanism only as a short term solution whereas, for a long term solution, it needs its own IT people, which is lacking completely.

### Formation of different committees

Different working groups have been observed to be formed to assist the Programme Management Unit (PMU) of NGIIP. Working Groups, where all the stakeholders have

## 4. Towards the formulation of strategies for developing NGII

After the evaluation of NGII and validation of the calculated success measurement (not part of this paper), strategies for NGIIP were formulated. Firstly, eyes were given for any existing goals and strategies of NGIIP and subsequently internal and external scanning of NGII was carried out and finally strategies were formulated.

### 4.1 Present goals of NGIIP

Currently no goal and strategies have been found formulated for the development of NGIIP. However documents related to NGIIP indicates that it has been initiated with an overall objective and purposes viz. (i) With the overall objectives of developing a National Geographic Information Infrastructure in the country to strengthen the planning and resource management, NGII program was initiated (Budhathoki and Chhatkuli 2004). (ii) The specific purposes of establishment were to develop an NGII platform to facilitate data sharing among the Central Bureau of Statistics, Survey Department and participating agencies, and disseminate Population and Hosing Census 2001 results via the NGII platform(Kayastha and Chhatkuli 2005).

Currently, it is found to be working based on approved annual programme (as unanimously indicated respondent stakeholder). A budget distribution sheet has been the blue print document of actions for a given year to NGIIP. Document bearing the action plan or specifies business and ICT strategies has not been defined due to lack of active partnership for NGII development. It was observed that Lack of proper business process in the absence of strategic alignment for data sharing and establishment of good partnership mechanism has posed a threat of disintegration of stakeholders from NGIIP platform. Cases have been identified where the current stakeholders are endeavouring in an isolated fashion to establish an information system where NGIIP remains completely unknown.

### 4.2 Formulation of strategies

An SDI activity takes place in multi-stakeholder environment for which primary requisites are coordination, cooperation and partnership apart from data being possessed by these stakeholders. We ( the author and his research supervisors) therefore contend that a hierarchal framework of strategies is required having: (i) a set of broad strategies that provides a guideline for creating an environment of coordination, cooperation and partnership among stakeholders for spatial data sharing, (ii) strategies for individual organisation required for strategic alignment for an improved business process and to achieve customer satisfaction as well as to cope with changes brought about by external and internal situation. Although there are overlaps in these two ways of viewing strategies, here we select to discuss the first since the second one differs from organisation to organisation and falls outside the scope of study. In the situation that NGIIP is already present in Nepal, and also based on the information that we derived from interviews with stakeholders, NGIIP is supposed to carry out the action plan and work towards the implementation of such strategies for improving SDI activities in the country support other stakeholder organisations towards strategic alignment. It is because a coherent SDI cannot be realized if individual organisations are weak in performance due to lack of their business and ICT strategies.

#### 4.2.1 SWOT analysis

We now carryout SWOT analysis based on the information we discussed in the previous sections. We analyze the above mentioned strengths, weaknesses, opportunities and threats by putting them in the matrix of SWOT. However, we only provide the formulated strategies in the matrix of SWOT due to limitation of space.

| | Strength | Threats |
|---|---|---|
| Threats | **ST-Strategies**<br>- Use the EU funded resources for other stakeholder organization for cost recovery<br>- Adopt market orientation for making product more sellable by analyzing the user requirements<br>- Diversify the product<br>- Adopt user-convinced pricing mechanism so that it provides some degree of security to the data.<br>- Expand consciousness against piracy and duplication through the website of stakeholders<br>- Use standards and copyright and develop total quality management to secure data<br>- Increase communication between stakeholders so that they would turn towards a singular NSDI or to align NGII initiatives for all sectoral priorities<br>- Invest for refresher course to enhance the skill of the staffs on new technology.<br>- Generate prototype to convince the policy makers so that they would bring required policy as soon as possible | **WT-Strategies**<br>- Adopt customer or user orientation for enhancing customer satisfaction so that rate of transaction increase to meet the financial needs.<br>- Develop categorical strategies (long term and short term) based on the experience of business process and information at hand to avoid the effect of instability of government<br>- Convince stakeholders through regular interaction so that they are inclined singular spatial data infrastructure in the country in the national level.<br>- Use EU funded resources for cost recovery of the stakeholder organization.<br>- Simplify the work process for increasing timeliness and responsiveness. |

Continued SWOT matrix…

| | Strengths | Weaknesses |
|---|---|---|
| Opportunities | **SO-Strategies**<br>- Take a coordinating role by establishing relationship with stakeholders<br>- Define fundamental datasets that can be placed in the national directories and Identify the custodian of these datasets<br>- Support and encourage to train the staffs of other stakeholder organization in geo-informatics.<br>- Provide financial and/or and technical support to the other stakeholder organization to generate the prioritized spatial dataset<br>- Support to publish metadata of the spatial dataset lying in the stakeholders organization through the availed clearinghouse<br>- Enhance user consciousness by interacting with user forum and stakeholders and increase the number of stakeholders in the network of NGIIP<br>- Provide a framework for policies for development of spatial data policies, standard that enhances accessibility<br>- Formulate polices for standards, data sharing and distribution with the intensive interaction with stakeholders<br>- Develop implementation plan for NGII with the consent and support of stakeholders.<br>- Develop online fundamental data serving system through NGIIP<br>- Strengthen relationship with International SDI organizations such as ISDI, GSDIA and PCGIAP and extend with other to learn and observe the strategic framework they have developed | **WO-Strategies**<br>- Employ ICT staff in stakeholders organization by convincing the policy makers to accelerate the dissemination process in the event of existing human resource policy<br>- Adopt strategic alignment in stakeholder organizations by making fit of their Business and ICT strategy with organizational and ICT infrastructure by utilizing the existing (and modifying) business process and technology through user requirement study.<br>- Employ a convincing pricing model based on interaction with users and convince the policy maker for bringing a pricing policy that allows adopting flexibility in price fixation.<br>- Identify the priorities of different sectors and their link with NGII<br>- Convince and support policy makers to develop understanding and bring such a spatial policy that streamlines all stakeholders to be cooperative for data sharing and enhance use of spatial data and publish their metadata<br>- Adopt customer orientation by utilizing existing technology and freeware to develop automated system of product and service delivery and entertain the digital request for data and service.<br>- Transfer knowledge to create and update spatial information by making use of the latest technology and skilled manpower.<br>- Provide incentives to the involved staff by sending them in the refresher course and establishing an award system to the well performer.<br>- Transform NGIIP into NGIC ( with a status of ministerial or high commission level) |

## 4.3 Goals and associated strategies for Improvement of NGII

Four goals are proposed for developing NGII in Nepal. Corresponding performance measure and associated strategies has been specified below.

### 4.3.1.1 Goal 1: Succeed in getting a National focus for Developing National Geographic Information Infrastructure

### Performance measure 1:

Half yearly seminars (for 2 years) with participation of all central level government agencies, major private user organizations and publication of the outcomes

**Strategies:**

1.1 Increase communication between stakeholders so that they would turn towards a singular NSDI or to align NGII initiatives for all sectoral priorities

1.2 Convince and support policy makers to develop understanding and bring such a spatial policy that streamlines all stakeholders to be cooperative for data sharing and enhance use of spatial data and publish their metadata

1.3 Enhance user consciousness by interacting with user forum and stakeholders and increase the number of stakeholders in the network of NGIIP.

#### 4.3.1.2 Goal 2: Realize strategic organizational framework for National Geographic Information Infrastructure

**Performance measure 2:**

Measure customer satisfaction with the criteria that 80% of the sampled stakeholders (stratified sample) must have quite satisfied situation on the selected indicators

**Strategies:**

2.1 Develop categorical strategies (long term and short term) based on the experience of business process and information at hand to avoid the effect of instability of government

2.2 Adopt strategic alignment in stakeholder organizations by making fit of their Business and ICT strategy with organizational and ICT infrastructure by utilizing the existing (and modifying) business processes and technology through user requirement study.

2.3 Strengthen relationship with International SDI organizations such as ISDI, GSDIA and PCGIAP and extend with others to learn and observe the strategic framework they have developed.

#### 4.3.1.3 Goal 3: Improve existing National Geographic Information Infrastructure in Nepal

**Performance measure 3:**

80% of participating stakeholders must have their sectoral priorities, working plan and sharable data (for 37 districts) within 2 years of the work

**Strategies:**

3.1 Identify priorities of different sectors and their link with NGII.

3.2 Develop implementation plan for NGII with the consent and support of stakeholders.

3.3 Transfer knowledge to create and update spatial information by making use of the latest technology and skilled manpower.

#### 4.3.1.4 Goal 4: Improve culture of use of geo-information for planning and informed decision making

**Performance measure 4:**

Publication of metadata by 80% of the stakeholders in the platform of NGIIP.

**Strategies:**

4.1 Provide a framework for policies for development of spatial data policies, standard that enhances accessibility

4.2 Support and encourage training the staffs of other stakeholder organization in geo-informatics.

4.3 Support to publish metadata of the spatial dataset lying in the stakeholders organization through the available clearinghouse

4.4 Generate prototype to convince the policymakers so that they would bring required policy as soon as possible.

## 5. Conclusion

The discussion in this paper can be concluded as follows:

(i) Effective national policies, strategies, and organizational structures need to be established at the national level for the integration or national spatial data collection, use, and distribution and sharing.

(ii) The National Geographic Information infrastructure programme is required to continue to be the working body for NGII activities until the formation of National geographic Information Council that shall coordinate the interagency program in future. The responsibilities of NGIIP should be redefined based on the consensus of stakeholder and user organizations.

(iii) We need to expand the development and speed the creation and Implementation of standards (content, quality, performance, and Exchange), procedures, and specifications for spatially referenced digital data, and create a series of incentives, particularly among national agencies, that would maximize the sharing of spatial data and minimize the redundancy of spatial data collection.

(iv) Procedures should be established to foster ready access to information describing spatial data available within government and the private sector through existing networks, thereby providing online access by the public in the form of directories and catalogs.

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