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Khim Lal Gautam, Chief Survey Officer from Survey Department participating in "International GNSS Summer school 2018 at Tokyo Japan" from July, 30,2018 to March 4,2018, organised by Tokyo University of Marine Science and Technology and co-organised by Institute of Positioning, Navigation and Timing of Japan.

Chief Survey Officer Mr. Krishna Sapkota and Chief Survey Officer Mr. Ishwor Lal Nakarmi, participating in "2018 Boundary Affairs and Surveying and Mapping Training Program" from 22 October - 2 November 2018, Wuhan China.

Newly constructed big river pillar with riverine design at Nepal-India boundary.

Hon Minister Padma Kumari Aryal, Joint Secretary Mr Janak Raj Joshi, Under Secretary Mr Tek Prasad Luitel, Chief Survey Officer Mr Sudarshan Singh Dhami, Survey Officer Mr Sharad Chandra Mainali, Survey Officer Mr Sumeer Koirala and Survey officer Mr Bhagirath Bhatta participating in "United Nations World Geospatial Information Congress" from 19-21 November 2018, Deqing China.

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EDITORIAL

Since 2058 BS (2002 AD) Survey Department has been publishing "Nepalese Journal on Geo-informatics" which has been an important asset as well as a means to propagate professional knowledge, skills and expertise in the field of Surveying, Mapping and Geo-information. Continuing its commitment to share knowledge, Survey Department is publishing the 18th issue of "Nepalese Journal on Geo-informatics".

In last seventeen issues more than 100 articles in a variety of themes related to Surveying, Mapping and Geo-information science and its applications in different field have been published. I would like to express sincere thanks to all those incredible authors for their contributions and members of Advisory Councils and Editorial Boards of all those issues of the journal for their persistent efforts to publish the journal.

This eighteenth issue of the journal contains a wide variety of interesting and worth reading articles on different topics viz. "Remote Sensing of Nepal's Forests and Trees:Ascertaining the Front Line of Human-Induced Tree Cover Changey by Prof. Amulya R Tuladhar, Application of Geographic Information Infrastructure: In the context of restructuring the country By Er. Jyoti Dhakal, Address System in Korea By Byungyong Kwak and Susheel Dangol, Image Fusion Technique: Algorithm to Application by Prakash Ghimire & Dr. Lei Deng, Gravity for Geodetic Purpose: Geoid-Ellipsoid Separation and Orthometric Height System by Shanker KC, Coding the Administrative Units of Nepal for Data Integration and Visualization by Suresh Man Shrestha, Road Network Rating Based on Land Use of Pokhara Sushmita Subedi & Roman Pandit, Precise Point Positioning (PPP): Method and its Geodetic Usage By Timilsina, Sushmita

At this point, I am very much thankful to the Survey Department for entrusting me with the responsibility of the Editor-in-Chief for this eighteenth issue of the journal. Following the advice and suggestions of Advisory Council, we, the members of Editorial Board have been able to bring forth the eighteenth issue of the journal. On behalf of all the members of the Editorial Board, I would like to express sincere thanks to all contributing authors, members of Advisory Council and all others who have contributed for the publication of this issue of the journal.

Before I stop, on behalf of the Editorial Board, let me humbly request all of you to contribute your valuable thoughts, articles, research papers, success story for the upcoming issue of this journal.

Karuna K. C.
Editor-in Chief,
Jesth, 2076

नेपाल सरकार

मा. पद्माकुमारी अर्याल
मन्त्री
भूमि व्यवस्था, सहकारी तथा गरिबी निवारण मन्त्रालय

सिंहदरवार, काठमाडौं ।

प.सं. :
च.नं. :

शुभ-कामना

नापी बिभाग स्थापनाको ६२ औं वर्ष पुरा भएको पुनीत अवसरमा "Nepalese Journal on Geoinformatics" को १८ औं अंक प्रकाशन हुन लागेको जानकारी पाउँदा हर्षित तुल्याएको छ। पेशागत मर्यादा तथा विकासमा उल्लेख्य भूमिका खेल्ने यस प्रकारका अध्ययन सामाग्रीको निरन्तर प्रकाशन गर्ने नापी बिभागको यो प्रयास प्रशंसनीय रहेको छ।

राष्ट्रिय नाप नक्सा निकायका रूपमा कार्य सम्पादन गर्दै आइरहेको नापी बिभागले भौगोलिक सूचना एवं भू–सूचनाको उत्पादन तथा वितरणमा उल्लेख्य भूमिका निर्वाह गर्नुका साथै अन्तराष्ट्रिय सिमाको नक्सांकन, खगोल तथा भू–मापन कार्य, भूमिश्रोत नक्सांकन जस्ता कार्यहरू गर्दै आइरहेको व्यहोरा बिदितै छ। उल्लेखित कार्यहरू विशुद्ध प्राविधिक एवं बैज्ञानिक प्रकृतिका भएकोले यी कार्यहरू सम्पादन गर्दा सूचना प्रविधिको प्रयोग र समय सापेक्ष परिशुद्ध तथ्यांक एवं सूचनाहरू संकलन तथा वितरण हुनु अपरिहार्य हुन्छ ।नाप नक्साको क्षेत्रमा विकसित नवीनतम् प्रविधिको प्रयोग गर्दै समय सापेक्ष भौगोलिक तथा भू—सूचनाहरू संकलन गर्ने र ती प्रविधिहरूको प्रयोग गर्दै सेवा प्रवाहलाई प्रभावकारी बनाउने तर्फ नापी बिभागको ध्यान जान जरूरी भएको छ। यस कार्यलाई अघि बढाउन आवश्यक दक्ष जनशक्तिको विकास र प्रविधिको अवलम्बनमा यस प्रकारका पाठ्य सामाग्रीहरू उपयोगी हुने बिश्वास लिएको छु। यस बार्षिक प्रकाशनमा सूचनामूलक, अनुसन्धानमूलक, बैज्ञानिक, सेवा प्रवाहलाई प्रभावकारी तुल्याउने एवं नविनतम् प्रविधिको उपयोग गर्ने जस्ता बिषयहरू समावेश भएकोले र Geoinformation को क्षेत्रमा कार्य गर्ने अध्येता, पेशाकर्मी लगायत सम्पूर्णमा सूचना प्रवाह गर्ने छ भन्ने समेत विश्वास लिएको छु ।

अन्तमा नीति निर्माण, विकास निर्माण, योजना तर्जुमा एवं जग्गा प्रशासनका लागि आवश्यक सूचना उत्पादन तथा वितरण गरी राष्ट्रको सर्वाङ्गीण विकासमा आफ्नो क्षेत्रबाट अतुलनीय योगदान पुर्‍याउँदै आएको नापी बिभागले स्थापनाको ६२ बर्ष पुरा गरेको सु–अवसरमा सबै कर्मचारीहरूलाई हार्दिक बधाई ज्ञापन गर्दछु। बिभिन्न आरोह अबरोहको सामना गर्दै नापी बिभागलाई आजको अवस्था सम्म ल्याई पुर्‍याउन प्रत्यक्ष एवं परोक्ष रूपमा योगदान पुर्‍याउनु हुने कर्मचारीहरू लगायत सम्पूर्णमा विशेष आभार प्रकट गर्नुका साथै ६२ औं बार्षिकोत्सवको पूर्ण सफलताको कामना गर्दछु।

इति संवत् २०७६ साल जेष्ठ १४ गते रोज ३ शुभम् ।

मा.पद्माकुमारी अर्याल
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Message from the Secretary

It is my pleasure to write few words in this annual publication of the Survey Department on different aspects of Geo-informatics. I also feel very happy to recall the days I used to work in the department during the starting phase of my career. I would like to congratulate Survey Department for coming up to the 18th issue of the annual publication of the department.

During last few years, I have noticed that the department has achieved a commendable progress in the field of Surveying, Mapping and Geo-information data generation, data sharing for supporting infrastructure development, finally contributing towards overall national development. As we all know that geo-information plays a vital role in infrastructure development and this journal definitely share information on development of different geo-information and developments in this field.

I feel equally proud to see that the department has conducted the field work for the measurement of height of Sagarmatha (Mt. Everest)and is determined to publish result in the stipulated time. Besides, that, department has gaining pace in different surveying and mapping activities like updating topographical base maps, boundary survey at Nepal-India boundary, land administration services, land use mapping and LiDAR survey. I am very much impressed by the achievement made by department in this matter. I have very positive impression that the department will definitely move ahead with the developments of technology in the field of Surveying and Mapping. In capacity of Secretary of Ministry of Land Management, Cooperatives and Poverty Alleviation, I do assure full support from the ministry to the department's undertakings.

Going through the contents of the journal, I feel enlightened in a few more aspects of Surveying, Mapping and Geo-information. I strongly recommend all professionals in the field of Surveying, Mapping and Geo-information to gain benefits from the articles of the journal and also request all the professionals to contribute and share experience in the next issue of the journal.

I would like to appreciate the efforts of Advisory Council and Editorial Board of this journal to bring out the eighteenth issue of "Nepalese Journal on Geo-informatics". In the meantime, I would also like to extend heartiest congratulations to the Survey Department and its entire staff members on the occasion of 62nd Anniversary of the establishment of Survey Department.

Thank you and enjoy reading

Gopi Nath Mainali
Secretary
Ministry of Land Management, Cooperatives and Poverty Alleviation
Government of Nepal

FOREWORDS

I am delighted to be able to write a few words on the eighteenth issue of "Nepalese Journal on Geo-informatics" on the Sixty-Second Anniversary of Survey Department. Let me take a moment on this special occasion of the Sixty-second anniversary, I would like to congratulate entire staff of the Department and extend sincere thanks to those who have contributed, in the past in different capacities for the betterment of the Department in the occasion of this 62nd anniversary of the department.

It is my pleasure to mention Survey Department, the only National Mapping Organization of Nepal, has been continuously contributing in the sector of Surveying, Mapping, Geo-information Science and Earth Observation, which are very much crucial for the planned development of the country. Furthermore, the organization is contributing not only in Land Administration but also in International Boundary Management.

Some initiative taken have the potential to leave a historic legacy of the department. Initiatives taken by the department to scale the Sagarmatha (Mt. Everest) has drawn attention of the international community. We consider this initiative to be not only a matter of pride for our profession but also an opportunity to enhance our capacity to cope with the challenges that has come alongside. Furthermore, department has also initiated the activities of LiDAR survey for the first time in country. This shall be a milestone for the development of high resolution Digital Elevation Model that will support in different development activities and disaster mitigation plan and management. Department is also conducting Land Use mapping that will support in optimum use, monitoring and management of land and land resources for implementation of Land Use Policy.

One of the major activity of the department is to prepare topographical base maps which is base for planning every development activities. Department is preparing activity plans for implementing National Spatial Data Infrastructure (NSDI). In this regard, geoportal is introduced for clearing house and sharing of data and information. We are further updating applications for the clearing house. Department prepared series of topographical base of whole country some decades ago and now running with the updates of these maps. In few years department will come up with updated topographical base maps. In near future, department is also planning to densify the Continuously Operating Reference Station (CORS) over the country.

After assuming the office of the Director General, I have been trying to invest all my energy in the endeavors aimed at strengthening the Department, its staff and the profession as a whole and my entire staff of the Department from their respective positions, have been together with me in every efforts taken to enhance the Department. I do believe in team work and coordination. I am confident that we will be successful in showing the tangible results if we continue our efforts sincerely in the days to come.

This year is the year of celebration for successful completion of Mt Everest expedition for the measurement of the height of the Everest. This year we are felicitating the expedition team who did a commendable job of expedition. Survey Department will work hard to disseminate the result of the height measurement program in stipulated time.

Finally, let me express my sincere appreciation to the fellow colleagues, the members of Advisory Council, and Deputy Director General Ms Karuna K.C, entire team of the Editorial Board, specially Chief Survey Officer Mr. Susheel Dangol for their invaluable contribution in this issue who deserves special thanks for their tireless efforts in bringing this issue in the stipulated time. More importantly, I extend sincere gratitude to all the authors for their resourceful professional contribution. I would expect such kind of support and professional contribution in the upcoming issues too. At the same time, I encourage fellow colleagues from the Department to contribute to the journal by providing quality articles.

As we were aware at the first issue, a journal needs commitment, not only from editors but also from editorial boards and the contributors. Without the support of our editorial boards we would not dare to start and continue. Special thanks, also, go to the contributors of the journal for their trust, patience and timely revisions.

I am confident that this journal is proficient not only to the surveying and mapping professionals, but also to other scientific community and researchers as well.

Enjoy Reading!

Thank you!

Jesth 14, 2076 (May 28, 2019)
Kathmandu, Nepal

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Remote Sensing of Nepal's Forests and Trees: Ascertaining the Front Line of Human-Induced Tree Cover Change

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KEYWORDS

Remote Sensing, Tree cover change, Forest

ABSTRACT

Synoptic, remote sensing of the national-scale, societal response of trees and forests to human driving forces in Nepal has been a wicked problem. This problem is a complex of four ancillary issues, namely, minimum mapping unit, radiometric scatter due to terrain, modeling of human dimensions, and democratizing robust environmental analysis. Beginning with the November 2018 conference convened by the East-West Center (EWC), USA, in Nepal, the state-of-the-art and key works in this problem-solving has been reviewed in this paper. Though this technology has improved the detection of forest and tree changes due to human driving forces at earlier stages, it is still not robust enough to inform global and national policy.

1. INTRODUCTION

Remote Sensing has been used to monitor synoptic, spatiotemporal changes in tree and forest cover due to human driving forces and societal responses. It is desirable to detect such changes as early as possible, in units that can be used over large scales such as nations and globes. However, the state-of-the-art in remote sensing of forest and trees for these scales are constrained to detecting only "latter" stages of changes. These "latter stages" refer to "forests or tree cover" of woody vegetation plots over 0.5 ha, 30% crown cover, and 30 m spatial resolutions, such as the Global Forest Cover (Hansen et al., 2013), following FAO protocol (Lambrechts, Wilkie and Rucevska, 2009; FAO, 2014). However, the Forest Resources Assessment (FRA) of the Government of Nepal, stretched the lower threshold of "forests" to include woody plots with 10% crown cover at spatial resolution of 5 m (Khanal et al., 2014). But the United Nations Framework Convention for Climate Change, UNFCCC, recommends even lower threshold of 0.05-1 ha with 10-30% canopy for identifying forests and trees for global carbon sequestration assessments (Sasaki and Putz, 2009).

For detecting front-line, individual tree stands, the definite precursors of the wide-scale, tree and forest recolonization of abandoned farms and public lands over the past 40 years in Nepal, it is necessary to detect such changes in plots less than 0.5 ha, with less than 10% crown cover (Rudel et al., 2016; Fox, 2018). This has been technically possible with finer spatial scales of 5 m, 2 m and even 0.5 m of IKONOS and QuickBird satellite imageries, tested in Jumla (Uddin et al., 2015) but difficult to upscale it to national level due to various problems (Saksena, 2018; Hurni, 2018; and Smith, 2018). For these reasons, even the "best" global data for tree cover change provided by Hansen et al., (2013) have reached accuracies of only 75% (Weiss and Peterson,

2015) versus acceptable levels over 85%, achieved for national FRA (Pokharel, 2018).

2. East-West Center Conference in Nepal, Nov 29-30, 2018

Reviewing the state-of-the-art in the remote sensing of tree and forest cover change, a conference was convened by the EWC, USA, in Nepal on November 29-30 (Fox, 2018). This conference compared three Landsat datasets for Nepal from 1988 to 2017, based on their suitabilities: a) by the International Center for Integrated Mountain Development, ICIMOD; b) by Hansen et al., (2013); and c) by the EWC/OSU (Smith, 2018) with the FRA RapidEye (Pokharel, 2018) and other relevant works. The suitabilities were analysed by quantifying the rate, extent, and socioeconomic importance to understand tree transition over the last three decades of Landsat satellite data and spatial modeling. Here, it was concluded that whilst significant progress had been achieved, critical problems persisted, in the smallest spatial units that could be sampled, economically with acceptable accuracy and precision, to ascertain the earlier stages of tree response to human dimensions on mountains. These problems are analyzed and discussed and in this paper.

This Conference was convened by Jeff Fox who has been familiar with the challenges and approaches of working with Nepal forestry, community forestry and remote sensing from the 1980s (Fox, 2016). Accordingly, he had assembled a team of experts to explore how remote sensing could more effectively ascertain tree recovery and Community Forests at national scales. These experts included Alexander C Smith (Smith_a, 2018), a doctoral student of Remote Sensing and Community Forestry at the OSU who had worked on Nepal Community Forestry for his Masters and was now working on his PhD on a NASA funded grant; his Professor, Jamon Van Den Hoek, an expert on Google Earth Engine; Dr. Kasper Hurni of University of Bern, an expert on topographic corrections for Landsat Time Series database; and ecological modelers, with particular experience on Nepal tree and forest cover change linked human dimensions from EWC and NASA, Sumeet Saksena and Atul Jain. This team interacted with participants from the FRA, Deputy Director Yam Pokharel, and Community Forest Division Chief Anuja Sharma; ICIMOD's remote sensing experts, Kabir Uddin and Mir Matin, on national and regional modeling of decadal landuse land cover changes; experts on sub-regional remote sensing studies by HELVETAS for Churia (Pokharel et al., 2018) and watersheds (Shrestha, 2018), and other ground level studies of tree and community forestry change by the Institute of Forestry; and other individual researchers. I have also contributed my own NASA-funded, doctoral research experience at Clark University, on 'The Pattern and Conditions for Forest Increase over the Himalaya' using Advanced Very High Resolution Radiometer (AVHRR) (Wikipedia, 2019) using Time Series Analysis.

3. Why is this Problem Important?

Single trees and ultimately entire forest patches respond to driving forces of human dimensions from individual decision-making on whether to out-migrate or stay on farms; whether to steal fuelwood and fodder from forests for livelihoods; or come together in legal community forestry user groups; or at large, on what policies the government make and implement on forest logging, forest protection, permits for forest clearance for development of airports, transmission lines, gas pipes and roads; or to permit political disturbance overcutting during Maoist rebellion; or government sponsored forest cutting to generate votes; and finally, to fail to control population pressures for forest lands and products due to inadequate forest protection institutional machinery.

Tree dynamics which were undetectable by conventional remote sensing include the farm and social forestry trees which were coming up on the abandoned, farming landscapes due to outmigration or the reduction of population pressure for livelihoods. Such trees on farm lands, groves, roadsides or scattered shrubs would need up to 30-40 years, or more to reach a 'visible' stage as per the aforementioned FAO remote sensing protocol.

Various solutions for detecting tree and forest changes have been explored. Generally, the smaller the pixel, the more weight a few trees' crowns will have, to swing the net pixel reflectance signature to 'tree' category, especially if they cover over 50% of the pixel. Nepal recently used RapidEye (Wikipedia, 2018) satellite images with spatial resolution of 5 m and this is partly a reason for national forest increase over its 1994 forest area by 5.14% (Khanal et al., 2016). The use of complex algorithms for principal components and maximum-margin hyperplanes has enabled the discrimination of early stages, such as 10% crown cover, by reducing errors due to spatial collinearity (DFRS, 2015; Guo et al., 2015; Saksena, 2018); and similarly, due to terrain reflectance (Hurni, 2018)

Millette et al., (1995) tried to detect by remote sensing unsuccessfully, the increased incidence of tin roofs, as a measure of village affluence, over thatched huts from bare terrace surfaces, because of an excess of noise over signals in pixels. Similarly, even with sophisticated, pre-processing of remotely sensed time series data from 1977 to 2010, econometric modelers at the International Food Policy Research Institute, IFPRI, were able to explain only 56% of the total variation in village household income as a function of tree cover change (Man Li et al., 2015). With the latest cutting-edge, terrain correction pre-processing for 2001-2016 Landsat imageries, Saksena (2018) could explain upto 69% of variation in tree cover change with village level human factors.

Additionally, even the widespread Community Forestry which now cover over 2 million ha (FECOFUN President Speech, 2018) could be partially 'invisible' when they are in forest patches, less than 0.5 ha, scattered on terraces of varying terrain (Sharma, 2018), constraining verifiable estimates of net forest and tree cover by global remote sensing for the Measuring, Reporting, and Verification, MRV, protocol for seeking carbon trade dividends and compensation for the carbon sequestration by the large community forestry area (Acharya et al., 2009). According to the latest and official *Forest User Groups (FUGs) Records available in MIS, Department of Forests, Babar Mahal, Kathmandu, dated Aug 15, 2017, of the 1.8 million ha under community forests, 46 forests were <u>under 0.5 ha</u>, hence totally invisible to remote sensing; and 486 such forests were between 0.5-2.00 ha, whose measurements maybe subject to errors due to terrain and partial pixel overlay (Community Forestry Database, 2019).* Community Forests range from less than 1 ha to 4000 ha, with 60% under 100 ha and 40% under 50 ha (Sharma, 2010).

The conventional remote sensing used for forest cover analysis are appropriate for measuring large swathes of forest lands, clear-felled by loggers (Hansen et al., 2003 and Hansen et al., 2013; Roy et al., 2013) but not good for Selection Silviculture, pick and choose forest trees cut, used by encroachers and illegal cutters (Fox, 2018). When trees are mined from within forests, making them thinner or with lesser crown densities, resulting in forest degradation, even with no change in area, it is less easy to ascertain, even by remote sensing (Millette et al., 1993). It is also impractical to verify all such areas on foot (Rayamajhi and Tachibana, 2018); therefore, remote sensing has been necessary with all the needed processing.

Nonetheless, we still do not have adequate means to monitor nationwide the front-line ground effects of forest policy applications exclusively through remote sensing but have to depend on extensive ground-truthing. This was done for the four-year 2010-2014 FRA (DFRS, 2015). It reported a 5.14% increase in forest area from 1994-2014 (Khanal et al., 2016) but this public impression of forest increase discourse was obfuscated with counter-claims of deforestation of 0.83% from 2001-2016, in a June 4, 2018 news (Kathmandu Post, 2018), quoting research, using Global Forest Watch satellite database (Hansen et al., 2013) by Sujata Shrestha, et al., (2018).

This was the backdrop for the 2018 Annapurna conference. The key problem of measuring forest and tree cover change on Nepal Mountains can be broken down to four sub-problems as follows:

Problem one : Measurement of Forest and Tree Cover Dynamics

Problem two : Radiometric Errors due to Mountain Terrain

Problem three : Modeling Human Dimensions of Forest and Tree Cover Dynamics

Problem four: Democratization of Robust Remote Sensing Analysis of Forest/Tree Cover

4. Problem one: Measurement of Forest Patch and Tree Cover Dynamics

What is a "forest"? This is a vexing remote sensing problem: or what is the 'smallest visible forest spatial unit', or the Minimum Mapping Unit, the MMU, for "forest" (Saura, 2002)? When satellites were used for remote sensing, the platforms were at least 500 km above the surface of the earth, so small patches were difficult to identify (Jensen et al., 1999). Satellites can only identify or characterize an event or process if the event/process produces a measurable change (spatial, temporal, and spectral) on the Earth's surface. Satellite imagery are most often designed for systematic monitoring of condition of the Earth's surface rather than supporting visual interpretation or feature detection (Hoek, et al., 2018). The spatial resolutions of satellite remote sensing have steadily improved from the 79 m of the earliest Multi-Spectral Scanner (MSS) to 0.5 m for IKONOS, and QuickBird, but the standard is FAO/Landsat resolution of 30 m because of costs and easy availability: the exception was the 5 m RapidEye used for Nepal FRA (Pokharel, 2018). Therefore, tree and forest patches under these specifications have been "invisible" for global and national forest monitoring.

There have been several strategies to circumvent the cost and technical limitations for finer resolution remote sensing for large scale forest and tree cover change mapping. For instance, during my doctoral research at Clark University (Tuladhar, 1995), I used time series analysis of 1985-95, with 3650 daily images of 1 km spatial resolution AVHRR, to robustly enhance the discernment of woody tree vegetation, after encountering limitations in the two-date, $7000 Landsat images, for my professors' research on Nepal mountains for *Regions at Risk* (Millette, et al., 1993; Kasperson et al., 1995). Time Series with AVHRR had been successfully used to monitor El Nino vegetation effects in Africa and China so I applied this to Nepal forest to uncover a net national increase in woody vegetation, a finding later corroborated by JAFTA (2001) and Nepal FRA, 2010-2014 study (DFRS, 2015; Khanal et al., 2016). The AVHRR 1 km spatial resolution have now been bested with Moderate Resolution Imaging Spectroradiometer (MODIS) satellite imagery data at 0.5 km resolution (Hansen et al., 2003) and used for regional land cover mapping in the ICIMOD mountains (Uddin, 2018).

The amount of all the woody vegetation in a pixel would affect the amount of Normalized Difference Vegetation Index, NDVI, score for large landscape; the total amount of woody vegetation per pixel would increase or decrease its total Vegetation Index (Tuladhar, 1995). For this vegetation index, the theory was to assess the difference in energy capture from reflectance of woody vegetation versus that of other mixed or homogenous land cover types (Lillesand et al., 2014; Crowther et. al., 2015).

Other techniques include pre-processing for clouds, object-based image analysis, and hyperspectral multivariate analysis, from 4 for MSS, to 7 for TM, and 8 for Enhanced Thematic Mapper (ETM) (Guo et al., 2015; Hansen et al., 2003; Hansen et al., 2013; Uddin, 2018) that have improved remote sensing accuracy upto 75%; good, but less than the desirable accuracies of over 85%.

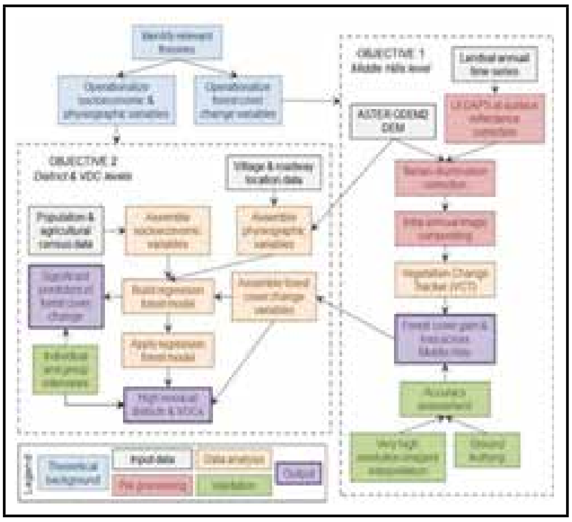
5. Problem two: Radiometric Error due to Terrain

Another wicked problem is the errors due to inadequately corrected radiometric dispersion by the mountain terrain in conventional Digital Elevation Model of the Advanced Spaceborne Thermal Emission and Reflection Radiometer, Global Digital Elevation Model, ASTER

G-DEM (Digital Geography, 2019), second generation DEM (Digital Geography, 2019), the Shuttle Radar Topography Mission or SRTM (Georgopoulos, 2015; Guo et al., 2015; Internet Archive Wayback Machine, 2019). These models, available for the globe for 30 m contours, have been unable to distinguish land covers due to a lot of noise (Bhattarai et al., 2009; Bajracharya et al., 2009). Worse, radiometric scatter is exacerbated by a Nepal's mountain specificity (Jodha and Shrestha, 2012): the tremendous diversity of terrain (Ishtiaque et al., 2017; Guo et al., 2015). To reduce terrain-induced radiometric uncertainties, spatial statistical corrections for collinearity and autocorrelations on Digital Terrain Models or DTM have been explored to produce principal components for more robust discrimination (Guo et al., 2015; DFRS, 2015); in particular, for three Nepal mountain, satellite imageries datasets of, a) ICIMOD decadal data for 1990, 2000 and 2010; b) Hansen et al., (2013) global forest cover database for 2000-2016; and c) the EWC/OSU database for 1988 to 2016, (Hurni, 2018; Table below). This revealed that differences crept in for slope class 4 to 5 (Smith_b, 2018), due to diffraction and diffuse back radiation on mountain terrain (Hurni, 2018). So a major section of the EWC study of community forestry and tree cover dynamics has been devoted to using the best trigonometric corrections of Hurni (2018) below to Fox's methodology (Objective 1 box), below:

a) **Hurni's Terrain Corrections Tested for Nepal Satellite Data from 1988-2016, Left:**

Method	Source	Equation
C-correction (C-C)	(Teillet et al., 1982)	$L_{H,\lambda} = L_{T,\lambda} \cdot \left(\frac{cos(Z) + c_\lambda}{IL + c_\lambda} \right)$
Sun-Canopy-Sensor and C-correction (SCS+C)	(Soenen et al., 2005)	$L_{H,\lambda} = L_{T,\lambda} \cdot \left(\frac{cos(s) \cdot cos(Z) + c_\lambda}{IL + c_\lambda} \right)$
Bin Tan	(Tan et al., 2013/9)	$L_{H,\lambda} = L_{T,\lambda} - m_\lambda \cdot (IL - cos(Z))$
Statistical-Empirical (S-E)	(Teillet et al., 1982)	$L_{H,\lambda} = L_{T,\lambda} - (b_\lambda + m_\lambda \cdot IL) + \overline{L_{T,\lambda}}$
Variable Empirical Coefficient Algorithm (VECA)	(Gao and Zhang, 2009)	$L_{H,\lambda} = L_{T,\lambda} \cdot \frac{\overline{L_{T,\lambda}}}{(m_\lambda \cdot IL + b_\lambda)}$
Minnaert with slope (M-S)	(Colby, 1991)	$L_{H,\lambda} = L_{T,\lambda} \cdot cos(s) \cdot \left(\frac{cos(Z)}{IL \cdot cos(s)} \right)^{k_\lambda}$



b) **Objective 1: 1988-2016 Tree Cover Change Methodology, Fox (2018): *Right***

Have these errors been tamed? Not Really. Terrain correction algorithms, despite their sophistications and power, have not captured the full range of variability of forest and tree landscapes over the entire Nepal Mountains. So, for those who cannot afford the expensive ground-truthing, certain "standard" satellite imagery have been used as Bench Marks, like Google Earth imagery (Tuladhar, 2015; Uddin, 2018; Pokharel, 2018).

6. Problem three: Modeling Human Dimensions of Forest and Tree Change

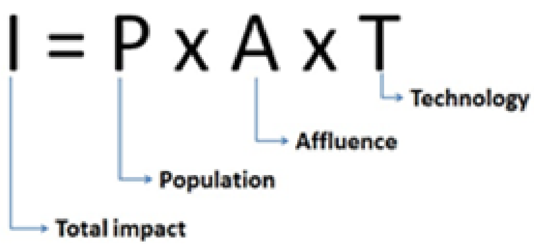
The whole rationale for studying and improving remote sensing of forest and trees is to understand the human dimensions of landscape changes (Kasperson et al., 1989). HDGEC, or the Human Dimensions of Global Environmental Change, include Human Driving Forces and Societal Response Patterns (Ehrlich and Holdren, 1971). In Third World Countries, Population (P) is the overwhelming driver (Chowdhury, 2006; UN_REDD/REDD Cell, 2014; Wang and Wu, 2019) whereas in First World, it is Affluence (A) and Technology (T) (Meyer and Turner, 1994; Rudel et al., 2016; Shrestha et al., 2018). Scholars later expanded this concept to IPATIC, to include Institutions (I) and Culture (C) (Meyer and Turner, 1994). Research on Nepal Driving forces across scales include, for instance, Bhattarai and Conway, 2008; Bhattarai et al., 2009; Pandey, et al., 2016; Ishtiaque et al., 2017; and Saksena, 2018. Scale and the determination of quantifiable, social variables for human dimensions have been challenges for these modeling (Meyer and Turner, 1994; Hansen et al., 2013; Khanal et al; 2016; Saxena, 2018; World Resources Institute, 2019).

Societal Responses come from the Hazard School (White, 1961) which use neoclassical fundamental concepts of the Rational Man and Bounded Rationality to explain why people and firms at different scales make what seems like 'irrational choices', to live in dangerous areas (Burton et al., 1978; Kasperson et al., 1995). This is because such "rational decision making" occurs in a bounded rationality of a range of choices delimited by access to information by class, region, education and other institutional factors (Allan, 1986; Brookfield, 1988; Allan, 1995; Schweik, et al., 2003). The HDGEC has used these concepts to quantitatively model these factors across scales from global, regional to national scales in Land Use and Land Cover Change, LULC, Disaster, and Climate Change Vulnerability Studies (Matin, 2018; Ishtiaque et al., 2017; Gilani, 2015; Guo et al., 2015; K.C. et al., 2012; Ministry of Environment, Government of Nepal, 2010; Turner II et al., 2002; Meyer and Turner, 1994).

Modeling human dimensions of forest and tree cover change through remote sensing presents a unique problem of spatial scale. Most national studies work with *district level* data on spatiotemporal changes in trees and forest change with social data (K.C. et al., 2012). However, the EWC/OSU has modeled at the *village level*, the link between human factors such as community forestry and outmigration with tree cover changes for 1988-2016 (Fox, 2018; Saksena, 2018). What type of social data is available at different scales is both a theoretical and a methodological challenge. For instance, population data from census is available for district, village to global and regional scales; but not governance data, presumably a major cause of success of community forestry in Nepal, relating to Institutions (I) in IPATIC, is available in georeferenced forms (Schweik, et al., 2003; Bhattarai and Conway, 2008; Matin, 2018). Further other social drivers include: socioeconomic variables of income, source of income, number of people per household, education, gender, number of livestock, etc. while biophysical and spatial variables could include aspect, slope, elevation, distance from markets (Schweik, et al., 2003; Saksena, 2018). Researchers trying to relate migration, remittance and other socioeconomic variables to empirically georeferenced tree cover and forest cover changes have found modeling difficult, with only modest R^2 and limited remote sensing accuracies (Bhattarai and Conway, 2008; Bhattarai et al., 2009; Man Li et al., 2015; Ishtiaque et al., 2017; Fox, 2018; Saksena, 2018; Shrestha, 2018). Current IPAT models fail when we try to count individual trees, instead of forest patches, as the empirical traces of societal driving forces and response processes at the pixel level, because interpolating from higher-order pixels of 1 km to 30 m spatial resolutions introduces Modifiable Area Unit Problems (MAUP) for mixed boundary pixels in addition to terrain-induced errors (Saksena, 2018; Smith_b, 2018).

7. Problem four: Democratization of Remote Sensing of Forest & Tree Cover Dynamics

Remote Sensing by satellites has traditionally been a specialist preserve, requiring specialized skills, expensive access to data, hardware and software; so it often requires government



agencies with external financial and technical support to carry out large national studies as has been the case till FRA 2014. However, this is rapidly changing. Individual specialists with access to free satellite imagery and widely available software have been able to carry out extensive remote sensing as with El Nino effects in China and Africa and Nepal Himalaya forestry change at Clark University in 1995, and, at University of Massachusetts at Boston, in 2018, (Shrestha et al., 2018). The democratization of remote sensing to non-specialists, akin to Google Earth Pro or Microsoft Office, have been greatly improved with the publicly accessible, Hansen's Global LUCC data base and Google Earth Engine which are continuously updated and upgraded global satellite imagery. Google Earth Engine is a web-based tool for interactive data exploration that provides access to over 20 Petabytes of 40 years of satellite imagery (with daily updates), with algorithms to analyze those data (as well as your own data), that has revolutionized large volume image processing to allow calculating, visualizing, and exporting EWC/OSU Nepal forest cover products (Hoek et al., 2018). The Google Earth Engine (GEE), however, still has limitations with algorithms to minimize radiometric scatter due to high mountain slopes and spatial resolutions that cannot detect the front line of individual tree level response to depopulation, outmigration, community forestry governance etc. The Global Forest Watch is more user-friendly by not requiring any coding skills to access Hansen's data base and Google Earth Engine (World Resources Institute, 2019).

Because of these known sources of errors, Nepal forestry and tree data based on global land cover analysis maybe off by as much as 30%, on top of overall accuracy of 70% (Smith_a, 2018). So the "best" solution, over other cutting-edge remote sensing analysis of Nepal, is actual ground-truthing, to identify vegetation structure and function, which Nepal government has done for FRA 2014 but global data bases cannot afford do it (Hurni, 2018). For FRA 2014, for instance, upto 50,000 + permanent, Global Positioning System (GPS) tagged plots and trees all over Nepal tested and measured by hundreds of well-trained specialists over 4 year period of remote sensing projects, at a great expense of 1.7 billion rupees of bilateral government technical support (DFRS, 2015; Pokharel, 2018). The overall accuracy was 97.9%.

8. Conclusions:

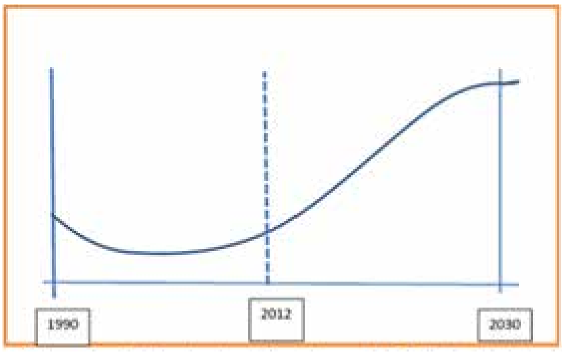
This review suggests substantial, but not satisfactory, progress in ascertaining the early stages of the human dimensions of Nepal's forest and tree change. For instance, while the discourse of Nepal's forest change was swinging from the Himalayan Theory of Environmental Degradation (THED) inspired population driven deforestation from the 1980s (Eckholm, 1976) to a net forest increase of 5.14% from 1994-2014, after FRA 2010-2014 (DFRS, 2015), it is again muddled, in the public perception, by reports of deforestation of 0.83% from 2000-2016 by Global Forest Watch (Shrestha et al., 2018). Forests Increase or Decrease? The Public is confused, although the two assessments measure two different phenomena. This confusion has been analysed as due to: a) MMU, b) Forest and Tree Crown Density definition, c) Forest Plot Size, d) Hyperspectral and Time Series Discriminant Analysis, e) Radiometric Error due to Terrain, f) MAUP, g) Ground Truthing, h) Segmented Expertise, and i) Operationalizing of Holistic Theories of HDGEC on Tree Cover Change in Nepal.

Amongst the aforementioned issues, Segmented Expertise and the Operationalizing of Holistic Theories deserve explication. Segmented expertise refers to sectors of works on forest and tree cover change that have made substantial progress but have been constrained by the lack of expertise in more holistic analysis. First, is the series of four, national-scale forest change assessments made by the Government of Nepal technicians, with the financial and technical assistance of international parties from 1964 to 2014, involving latest technology, from aerial photography, Landsat satellite imagery, GIS, using RapidEye, LIDAR and extensive field ground truthing of permanent sample plots (DFRS, 2015). These reports are considered officially authoritative though holistically, not necessarily the most robust, because the foresters who work in these have strong training and expertise in forest biology and ecology, together with ground reality experience but their mastery of remote sensing theory and skills involving the math, science, survey and computer programming skills are less than cutting-edge. This is generally true of individual foresters, botanists, or natural resource managers who have worked on landuse land cover changes with remote sensing in Universities abroad.

Unlike foresters, however, ICIMOD technicians have a surfeit of skills in computer analysis, programming, access to the cutting-edge hardware, software, online access, and institutional support for international cooperation (Matin, 2018) and they have produced highly attractive studies that fall short of analytical rigor (Manandhar, 2014; Gilani, 2015) and ground-truthing accuracy (Uddin, 2018) because technicians lack strong background in forestry, ecology, environmental science, field verification knowledge, and almost zero familiarity with holistic geographical or economic theories of global environmental change that link spatial changes in forests and trees with human dimensions such as community forestry, outmigration, remittance, despite their copious productivity (Bajracharya et al., 2009; Jodha and Shrestha, 2012; Matin, 2018).

The other sector of segmented expertise are scattered in fewer works by individual experts in pursuit of graduate degrees in geography, engineering, natural resources at foreign universities. They include Amulya Tuladhar who pursued a NASA-funded doctoral research to link the patterns and causes of tree cover change in the Nepal Himalayas in 1995 to more recent Him Lal Shrestha, who modeled forest and tree change in watersheds as a function of human dimensions to predict the changes to 2030. These studies are holistically, more robust than either the abovementioned foresters', or the computer engineers', in that they have the exposure to holistic theories *and* access to cutting-edge, remote sensing analytical tools afforded with international institutional resources. But these studies lack sustained resources for longer term, leading-edge research analysis that needs institutionally backed support to access the latest development in hardware, software, theories and trainings. This is where the EWC of the University of Hawaii has come in, for research on the 25 years of tree and forest cover change remote sensing in Nepal.

Besides segmented expertise, another confounding problem is the paucity of holistic theory and methodology. There is a need to update, upgrade and test the theories of HDGEC on Nepal tree and forest change. What is happening in national scale forest and tree change and how is that changing with time, space, and scale are mostly empirical problems of remote sensing and ground truthing? Why is this happening? Due to community forestry, outmigration, transition of subsistence agricultural economy to service-based urban market economy, econometric variables, or due to ecological resilience? All these are *possible,* partial or holistic explanations, for spatiotemporal distribution of tree cover and forest change in Nepal. Agricultural economists of the International Food Policy Research Institute tried to model outmigration and remittance with village level forest and tree cover change using remote sensed Landsat imageries (Man Li et al., 2015; and Guo et al., 2015), and cultural anthropologists linked watershed level changes in forest and tree cover change with local livelihood changes (Shrestha and Brown, 1995) or institutional governance (Schweik et al., 2003) while geographers such as Tuladhar of Clark University have drawn on HDGEC research to study spatiotemporal patterns of forest change with human dimensions of driving forces and societal responses (Tuladhar, 1995).



According to the theory of Driving Forces for Nepal, for instance, the Theory of Himalayan Environmental Degradation (THED) (Eckholm, 1976) posited that population growth was the major cause of deforestation in Nepal hills, leading to a suite of societal response in increasing scale from Man and Biosphere studies (MAB) (UNESCO, 1973) to Integrated Watershed Management studies in Jhikhu Khola over 15 years (Providoli et al., 1995), as well as large scale Resources Conservation Project (RCUP), in mid-1980s to the successful community forestry program resulting in 2 million ha or 35% of Nepal's forestry, leading to forest recovery in the hills, the societal response noted first a decline in rate of deforestation, e.g. from 1947 to 1970s, see figure of, **Overall Land Use Dynamics of Jhikhu 1947-90** (Shrestha and Brown, 1995) and then the upswing from 1970s to 1990; a trend, first documented in Jhikhu Khola, and confirmed over and over again all over Nepal in many subsequent studies (Pokharel et al., 2018; DFRS, 2018) including a national forest increase of 5% from 1994-2014, as overall population pressure on forests and trees declined with the Demographic Transition population growth rate decline from 2.25% to 1.25% from 1991-2011, and the depopulation of one-third of Nepal's 75 districts of 2 million people in last census and the gradual decline of agricultural based livelihoods to 65% of the national population.

For a more coherent theorization of the overall trajectory of environmental change in the Nepal Himalayas, Kasperson et al., (1995) studied Nepal along with 9 *Regions at Risk* of the world as a whole, and concluded that the trajectory for Nepal was not "critical", or likely collapse in the next generation, but impoverished to endangered, and likely to improve in the coming decades (see figure, from 2012-2030). They noted that economic growth and well-being was increasing, along with the increasing societal learning due to increasing signals of environmental distress; so the net degradation rate of environment was declining aided by natural ecological resilience of Nepal Mountains was improving.

The current research of EWC/OSU on 25 years of community forestry and tree cover dynamics aims to bring the latest in remote sensing technology to investigate the relative roles of outmigration and community forestry change using the most accurate data set of 1988-2016. We are now approaching an era where exclusive government discourse based on its privileged access to data and expertise can now be challenged and supplemented by independent researchers and local people with smart phones and rudimentary knowledge of remote sensing and access to powerful satellite imagery database and applications. Forest Watcher is one such

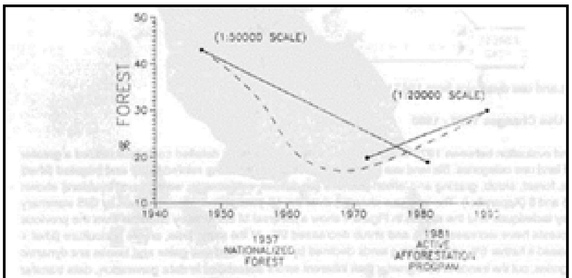


Figure 5. Overall land use from 1947 to 1990.

smartphone application developed by Global Forest Watch to enable any user to monitor and map in georeferenced accuracy any forest and tree cover change on the ground he or she can visit (World Resources Institute, 2019).

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Publications	:	50+ Journal, Proceedings, Manuals, Essays, Op-Eds, Commentary, Blogs, Social Media (Facebook, Twitter, The Nepal Digest) in International and National Media.

Price of Maps

S.No.	Description	Scale	Coverage	No. of sheets	Price per sheet (NRs)
1.	Topo Maps	1:25 000	Terai and mid mountain region of Nepal	590	150
2.	Topo Maps	1:50 000	HIgh Mountain and Himalayan region of Nepal	116	150
3.	Land Utilization maps	1:50 000	Whole Nepal	266	40
4.	Land Capibility maps	1:50 000	Whole Nepal	266	40
5.	Land System maps	1:50 000	Whole Nepal	266	40
6.	Geological maps	1:125 000	Whole Nepal	81	40
7.	Districts maps Nepali	1:125 000	Whole Nepal	76	50
8.	Zonal maps (Nepali)	1:250 000	Whole Nepal	15	50
9.	Region maps (Nepali)	1:500 000	Whole Nepal	5	50
10.	Nepal (English)	1:500 000	Whole Nepal	3	50
11.	Nepal Map (Nepali)	1:1000 000	Nepal	1	50
12.	Nepal Map (Nepali)	1:2000 000	Nepal	1	15
13.	Nepal Map (English)	1:1000 000	Nepal	1	50
14.	Nepal Map (English)	1:2000 000	Nepal	1	15
15.	Physiographic Map	1:2000 000	Nepal	1	15
16.	Photo Map			1	150
17.	Wall Map (loosesheet)		Nepal	1 set	50
18.	VDC/Municipality Maps (Colour)		Whole Nepal	4181	50
19	VDC/Municipality Maps A4 Size		Whole Nepal	4181	5
20.	VDC/Municipality Maps A3 Size		Whole Nepal	4181	10
21.	Orthophoto Map		Urban Area (1:5000) and Semi Urban Area (1:10000)	-	1 000
22.	Outlined Administrative Map A4 size		Nepal	1	5

Price of co-ordinates of Control Points

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

Application of Geographic Information Infrastructure: In the context of restructuring the country

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KEYWORDS

Geographic Information System, Application, Restructure, Delineate

ABSTRACT

Nepal has a diverse geography. The declaration of Nepal as Federal Democratic Republic Nepal has occurred recently. Transformation in administrative boundaries has undertaken. For the formulation of changes in administrative divisions, changes in different phases were involved. Committees that are formed and methods that are adapted socially, technically and administratively to map the local government units is depicted through this paper. Finally, the outcomes of restructured Nepal with its individual local level are prepared with the help of Geographic Information System.

1. BACKGROUND

The extent of Nepal ranges from 80^0 04' E to 88^0 12' E longitude and 26^0 22' N to 30^0 27' N latitude (Chhatkuli, 2004). It exhibits the geographical stretch from the highest top of the world, the high Himalayas, to hilly and plain Terai region. No other thing can fascinate more than the natural diversity of Nepal.

The administrative structure of Nepal follows a series of transformation. From the Panchayat regime to today's Federal Composition of Nepal, several changes has occurred in the number of VDCs and Municipalities. After the adoption of new federal structure with seven States (Schedule-4 (Relating to clause (3) of Article 56)), Nepal has 77 Districts, 6 Metropolis, 11 Sub-metropolis, 276 Municipality, and 460 Rural Municipality as local government units. It is illustrated in table 1. The exercise of delineating boundaries of new local government units was a cumbersome task. It was made possible through efficient use of geographic information facility.

State no.	Districts	Metropolis	Sub-metropolis	Municipality	Rural Municipality	Total local units
1	14	1	2	46	88	137
2	8	1	3	73	59	136
3	13	3	1	41	74	119
4	11	1	0	26	58	85
5	12	0	4	32	73	109
6	10	0	0	25	54	79
7	9	0	1	33	54	88
Total	77	6	11	276	460	753

Figure 1: Local government units allocation.

2. INTRODUCTION

The application of geographical data in most of the field has made the importance of geographic information higher. In order to develop information from the data for any developmental and non-developmental activities, the spatial-temporal and socio economic data is a must. We as a surveyor know well to develop information of any kind relating to the spatial context. The technologies have made us even easier on analyzing such kind of data. This has direct influence on the frequency of using geographic information to develop ideas for the decision making process.

The Geographic Information System (GIS) assists in developing information from collected geographic data. It is thus, involved from very beginning of data collection to manage, analysis and manipulate the data, and to the dissemination of the information extracted from the data. The use of technology should be done to better answer their needs and queries regarding the geographic information systems. The geospatial system has the special place to help the society in the informed decision making processes. GIS is regarded as the system to shape the world and better depict the processes going on the earth's surface, below and above the earth surface.

For the implementation of the Constitution of Nepal, the restructuring of the federal Nepal to the Local Government unit was necessary. For this historical benchmark, as per Constitution of Nepal (Article 295(3)), formed a "Commission for the determination of the Number and Boundaries of Village bodies, Municipalities, and Special, Protected or Autonomous Regions". This commission was established on the Chaitra 1st, 2072 having time period of one year. The mandate of this commission was to form the units and demarcate the boundary at the local government unit for the formulation of the federal system of Nepal. The commission followed the Terms of Reference (TOR) provided by the Government of Nepal and other jurisdiction is within the commission. The technical part of the task involved formulation of the major role in the formation of local government units of the country. With the dedication and day night hardship of the members and staffs of the commission, the scientific, delicate, collaborative, collective and highly appreciable thematic concepts and technical procedures of the commission was developed. The commission formed a technical committee to represent one district named Local Level Restructuring Technical Committee which consist of members as:

Local Development Officer	Coordinator
Officer Representative, District Administrative Office	Member
Officer Representative, District Technical Office	Member
Officer Representative, District Revenue Office	Member
Officer Representative, District Survey Office	Member
Planning, Monitoring and administrative Officer, District Development Committee	Member-Secretary
Guest Members:	
Officer Representative, District Forest Office	Guest Member
CBS Head	

Thus formed committee helped in the restructuring program of the local government units in their respective districts. As per the TOR provided to the technical committee, each district proposed numbers, names and centre for the local government units formed in their district.

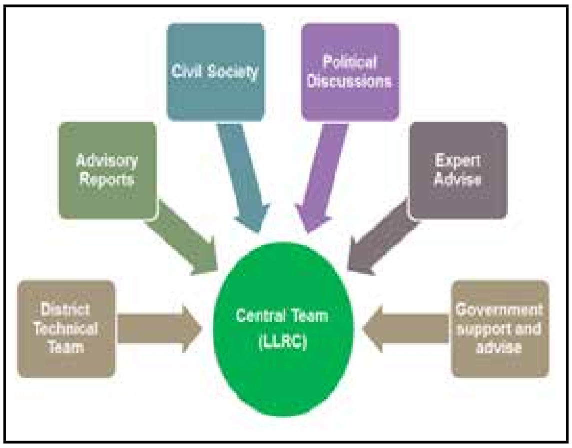

Figure 2: Stakeholders of the national responsibility of restructuring the country.

As in Figure 2, the proposal included many consolidation programs, orientation programs, and different meetings with local people, local representatives and civil society groups. The suggestions and facts provided by the people were incorporated in detailed proposal and report of the district technical committee. The reports provided by the districts were collected, studied and analyzed whether they meet the terms and conditions provided by the commission. The individual units were formed and their thematic data were incorporated in the GIS database which was made ready for mapping purposes.

3. METHODOLOGY

The initiation of the management and implication of the restructured nation requires the self-sustainable Geographic Information System for better planning and decision-making processes. Spatial information for the decision making process is very crucial. The methodology adopted for this operation is explained below:

- Data collection: The source of the geospatial data was Survey Department. The spatial data was gathered for the whole Nepal. Likewise the population data was collected from the Central Bureau of Statistics (CBS). Other utilities and public services data like health services data from the then Ministry of Health and Population, education related data from the then Ministry of Education and other respective data from respective authorities were collected.
- Data management: All the data collected from different sources were incorporated into the database of spatial data of whole Nepal. It was necessary for easy and quick information retrieval based on the geographic location of the place.
- Data processing: The primary data were processed to carry out the detailed information system. On the basis of purpose of the operation, the overall data from different fields were processed to gather the information regarding the spatial location, health service facility and education facility, access to the infrastructure, population density, population distribution, ecological belt, and previous election constituencies.
- Initial outputs: The initial outputs were the population map, land cover map, and electoral constituency's distribution map.
- Preliminary outcomes: The population map and land cover map were used for the decision making process which helped to figure out the preliminary delineation of the new local government unit boundaries in the district level. Different seminars and orientation program were carried out to provide the knowledge about the use of maps and how it can help in the informed decision making process. The optimum use of spatial data was done to delineate the administrative boundary of local level. The delineated boundary from the district level was forwarded to the central level commission technical team.
- Inspection: The delineated boundary report from the district technical committee was inspected by the commission and the technical part of the matching map details with ground details was observed and reported.

- Database matching: The data provided by the district technical committee was inspected by the technical team of the GIS Experts for the information matching.

- Verification: The verification of data and information matching was done and the field scenario was conveyed back to the district technical committee for further verification.

- Final output: After a long process of data collection to the verification the final output of the delineated boundary of the new local government units were mapped and the administrative division was demarcated. The final outcome of the system was the administrative map of the local government units with the ward boundaries.

3.1 Flow Chart

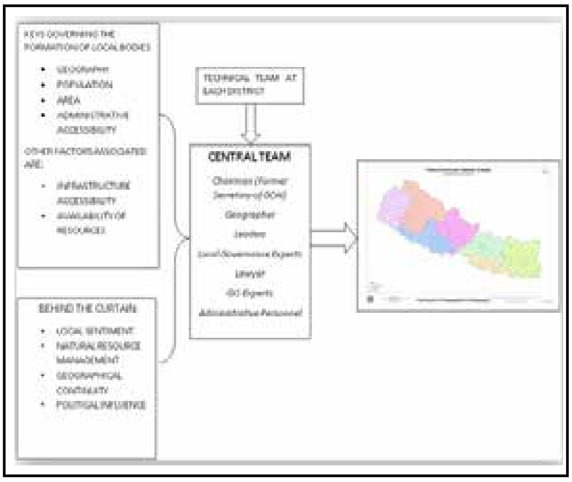

Figure 3: Flow chart of the general workflow.

From Figure 3, the general scenario shows that the major keys that governed the formation of local government are the geography and location of the place, its population and area and administrative accessibility. The other factors that helped were the infrastructure accessibility and resource availability of the respective place. The local sentiment attached with the place, resource management and geographical continuity are also other factors behind the formation of the units. These above mentioned factors are studied in detail and the technical team at each district come up with the proposal. These proposal were administered by the central team and final report proposing the local bodies were prepared.

4. OUTCOMES

The role of Geographic Information System is to provide the information about the geographic location, land use patterns, topography, socio-economic data relating the location of the place, and provide support for the informed decision making process and finally delineate the boundary and prepare respective maps. The ultimate outcome was the number and boundaries of the local government units of The Federal Democratic Republic of Nepal. Two kinds of maps were the major outcomes of the system.

- The district administrative map with the Municipalities and Rural Municipalities.

- The Municipality and Rural Municipality map with the wards.

Some of the examples are as follows:

Figure 4: Districtwise administrative sample map.

Figure 5: Administrative map showing palikas of the district Parbat.

Figure 6: Administrative map showing wards of Chattradev Gaunpalika of the district Arghakhanchi.

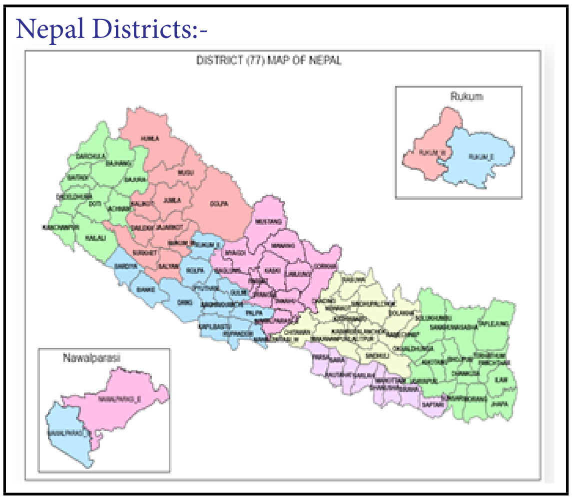

Figure 7: Nawalparasi and Rukum splitted to form 77 districts of Nepal.

In figure 7, it shows that during the formation of state, the two districts; Nawalparasi has been divided in state number 4 and 5 and Rukum has been divided in state number 5 and 6, hence the number of districts becoming 77.

5. CONCLUSION

The administrative structure of Nepal follows a series of formation. The number of VDCs and Municipalities went through several changes in recent years. Earlier when the local units were dissolved or disjointed, there was no or very limited use of Geographical Information System. This has made it difficult to prepare and manage spatial database. Therefore a very tiresome efforts has been made in building the database that we are using today. After the adoption of new federal structure, Nepal has 77 Districts, 6 Metropolis, 11 Sub-metropolis, 276 Municipality, and 460 Rural Municipality as local level (local government units). According to The Constitution of Nepal, 2072 (Schedule-8 (Relating to clause (4) of Article 57, clause (2) of Article 214, clause (2) of Article 221 and clause (1) of Article 226)) has provided different power to the local level (local government units). For exercising the given power to the people the restructuring of the country plays a vital role to help people empower themselves. The historical framework of the three tier scenario of the administrative division of the country was made possible with the help of the application of geographical information infrastructure. This also shows the need of technology and informative way in the decision making process. Application of GIS for this delineation has made this operation scientific and systematic which will be helpful in better understanding the restructuring of the nation.

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गाउँपालिका, न. त. (२०७३). स्थानिय तह पुनर्संरचना प्राबिधिक सहयोग समितिको कार्यशर्त तथा कार्यविधि (परिमार्जन सहित) ।

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Address System in Korea

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KEYWORDS

addressing, address system, urbanization, urban policy

ABSTRACT

Address is basic information to find location as a code and an abstract concept for representing a location on the Earth's surface. It is also used in many areas such as public administration, legal and official areas, land titling etc. In Korea, address is recognized as the base information of life for the people as well as the key information of activities for organizations and companies in nationwide. Korea's address system used land parcel numbers which was given to each piece of land for identification since 1918, which was before the introduction of the road name address system. The aim of the study is to find out how Korean address system has changed and how to manage, maintain, and use the address information in Korea.

1. INTRODUCTION

Address are one of the most common ways to unambiguously determine an object for purposes of identification and location. Address reference systems vary from country to country according to their policy, economy, society, culture etc. For example, in the field of intelligent transport systems, an address can be considered as a simplified location system (as opposed to a coordinate reference system), where points of interest and post codes are addressing information applicable for in car navigation. In addition, addresses are used for a wide variety of purposes: postal delivery, emergency response, customer relationship management, land administration, utility planning and maintenance, to list a few. There are many stakeholders involved in addressing system (activities involving addresses): for assigning the address (local governments, postal operators, etc.); for using addresses in various ways (customer service providers and electronic business, local and national governments, utility service providers, election commissions, etc.); and finding the address (citizens, delivery and emergency response service providers, etc.) (Coetzee and Bishop, 2009; Coetzee and Cooper, 2007).

Geographically, address is basic information to find location as a code and abstract concept expressing a location on the Earth's surface (including postal address). It is used in many areas such as a public administration, a legal, documents, land title etc.

The aim of this study is to introduce the new Korea address system, so called Road Name Address and to present the benefit of new address system.

2. PROBLEM STATEMENT

In Korea, address is recognized as the base of life for people and activities for organizations and companies. Korea's addressing system had used parcel numbers given to each land piece for land identification since 1918 before introduction of the road name address system. But there are many difficulties to find exact location, because the parcel number was given irregularly. To improve this, Korea government promulgated the Road Name Address Act in 2011 which was the first step to follow the international standardization in address systems.

Two addressing systems has been used in 2014. The one is parcel number address system which was based on administrative areas and (jibeon) parcel numbers, while the other one, which replaces the parcel number addressing system from Jan 2014, uses a road name and building number in order to identify unique locations.

With progress in industrialization and urbanization, arrangement of parcel number addresses got disordered and parcel sub-numbers increased. This made it more difficult for people to find locations. Parcel numbers are assigned to land parcels. However, size of parcel vary from few square meter to millions of square meters. In many cases, a single parcel number is unequal to a single building since multiple buildings belong to one parcel number. This made it difficult to mark an accurate location of a place. The continuity of parcel numbers were often broken because parcel numbers were assigned based on the date of land alteration. In Seoul, a meager 18.6% of parcel numbers remained in sequence and continuous. Due to the absence of address signs in most buildings, people could not locate places with parcel number addresses though they were close to the places. With people using building and landmark names to find locations, instead of using parcel number addresses, various types of address information had been in mixed use.

To improve this inconvenience, the road name address system was implemented to find place easily. In this system, it was required to assign names to every road and install road name plates, give numbers to every building and install building number plates so that each building has a unique address.

3. ADDRESS SYSTEM IN WORLD

The United States has adopted an address system by street system, and the provincial government delegated to the city or county by the provincial government of the street name address, For Washington, the streets parallel to the roads passing east-west and north-south through the center of the city centered on the Capitol are defined as Street, and non-parallel roads are designated as Avenue. In the case of road addressing, first, horizontal lines parallel to the baseline of north and south are assigned sequentially 1, 2, and 3 Arabic numerals in the east-west direction from the road near the baseline, and horizontal lines parallel to the east-In the order of A, B and C in both directions, Buildings are numbered in the order of an odd number in the south and an even number in the north in the case of a building facing east-west roads. In the case of a building facing the north-south direction, the right side is given an odd number and the left side is given an even number. The building number is in block units, but the number of buildings within one block should not exceed 100.

United Kingdom has is no statute related to the mark of the address. The name of the road is decided by the local government committee. The building number is given by the post office. The UK is a long-established natural road network structure that gives road names in a variety of ways. Road names include roads, streets, avenues, lanes, row, etc. to give a variety of names meaning roads. Rural areas use the address system by zip code area without establishing road sections.

France road name address system is based on the "Regulations on Address Indication" is delegated to the local government by the provisions of the Law on Local Autonomy, and the name and address of the street are decided by the Parliament. Depending on the size of the road, nanes are given as Boulevard, Avenue, Rue, Allee, Impasse, Place du Square etc. The building number is assigned to the odd number on the left and the even number on the right according to the road section. The base number is given at intervals of 15m.

China road name address system is operated by the government administration, the nomination is standardized and issued by the local government, and the road name plate is managed by the Public Security Bureau. The road network is divided into the line type and the zone type, and the hierarchy of the road is composed of weekly leading, secondary trunk road and ordinary road. The road name is the road reflecting the history and the street name is given based on commercial meaning. In the newly developed areas. The starting point and the end point of the road are set from east to west and from north to south depending on the direction of the road. The address notation is made up in the order of name, residence name, road name and building number. The building number is odd numbered on the left side, the area is numbered in English “S” (kwak, 2014)

4 ROAD NAME ADDRESS SYSTEM

4.1 Promotion of road name address

Promotion of the road name address started in 1996 by the National Competitiveness Enhancement Planning Group to give directions to the Ministry of Interior. In 2006, the Act on the Expression of Road Names, etc. was enacted and promulgated. Enforcement Ordinance of the same Act and Rule of the same Act was enacted in 2007. Its name was changed to Road name address law in April 2009. According to the law, the new address system was implemented on three phases. In the first phase, road name address project conducted as a pilot project to introduce new address system by road system. In the second phase of the project, systematic management of city information and the introduction of computerized system to search the address through internet and to provide location information service was conducted. The third phase of road name address system focuses on the development of additional functions such as tourist guide, real estate transaction, including geographical information, to promote the informatization of the local area and build the information system of citizen center (consumer) to provide information on all buildings and land, including road names, for information sharing with the public sector such as the system and fire emergency command system. As a result of pilot project, Korea government found some problems in the legislation. For this reason, legislation for road name address system was reviewed by Road Name Supporting Group and finally amended “Road Name Address Act was enforced in 2009. Based on the Act, 160,000 roads across the country were assigned road names and all 6.5 million buildings were given numbers, and their corresponding road nameplates and building number plates were installed. The Act also obligated the government to gather people’s voices when assigning road names and notify road name addresses to about 34.7 million individual users from March through June, 2011. But the actual enforcement was started in 2014 due to a social customs(Go, 2013).

4.2. Road name Address system

This is the method of expressing the address of the building by the road name, base number, building number, and detailed address. A road name is assigned to a road, and a building number is regularly assigned to a building in accordance with the road, and the road name, building number, and detailed address

In consideration of straightness and continuity, the road section should be set in the direction of west → east, south → north. Road names are street numbers from east to west, north to south, building numbers to the left are odd numbers, and even numbers are assigned to the right.

Road name is the name given to each section of the road. According to the road classification standard, name are given as Dae ro (more than 40m or 8 cars), Ro (4 to 12m or 2 to 7 lanes), Gil (other roads). Building number is odd number on the left, even number on the right.

4.2.1 Road name Addressing method

The serial number system is a road name system using the serial number according to the order of branching from “road name + serial number + road” to “road” branching from “Dae ro / Ro”, The basic number system is a road name system based on the base number of branching to “road” which is branched from “Dae ro / Ro” to “road name + base number + road”. “Number Road” and “road” are recognized in a similar way, but they actually have different meanings and different locations.

In the other numerical method, use the serial number that matches the regional characteristics in the Ro / road of a certain area, and give it to Sajik 1 Gil, Sajik 2 Gil, Baek Song 1 Gil etc. In case of additional branching, the road name addressing is added to the 'Road' branching from the 'Road' by A, B, C, D of the basic numbering method or the serial numbering method

4.2.2 Building numbering method

The building number is given on the basis of a large road when a doorway comes in contact with two roads. However, it can be selected if the building owner wants it.

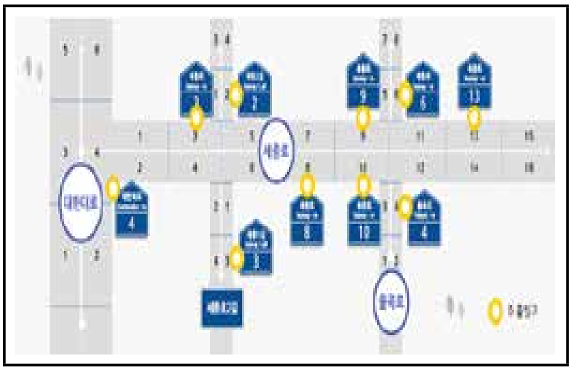

Figure 1 Building numbering 1

If there are several buildings in one section or a dependent section on one section, use the " - " to indicate the building's sub attachment.

Figure 2 Building numbering 2

An underground shopping mall located on the roadway marks the " Underground (Jiha) " in front of the building number.

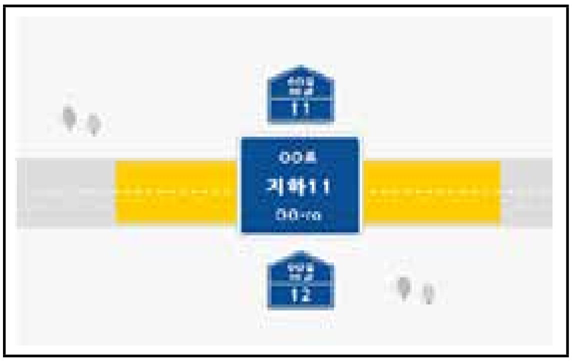

Figure 3 Underground numbering

The detailed address is the dong, floor, and ho information displayed behind the building number of the addresses. The address is given to buildings renting houses, such as commercial buildings and residential buildings. If the building's dong, floor, ho are classified separately, indicate 'Dong', 'Floor', or 'ho'. If the meaning of the floor is included in the ho, 'Floor' is omitted. Also, connect the words 'Dong' and '-' instead of 'Ho' and read 'Dong' and 'Ho' when reading.

4.3. Update of road name address information

Korea Address Information System(KAIS) is a system that manages the Lifecycle of addresses related to the national public law that are granted, changed and abolished the road name addresses given by Article 2 of the Road Name Address Act. When a road name or a building is given or changed, a legal address is created by notifying the corresponding owner or occupier and notifying the corresponding street name address. The announced address will be collected in real time and provided on the road name address homepage (www.juso.go.kr). The purpose of operating this system is to support the address business of local autonomous entities such as road name address creation, change and abolition

The KAIS system consists of spatial information such as roads and buildings, and property information such as road names and building numbers. In order to efficiently express geospatial information, land use, lot number and topographical information are used in conjunction with cadastral maps and topographic maps. Information related to land movements and the name of the building is automatically linked with the land register. When a new address is created, the postal code is created in conjunction with the postal business headquarters to manage the street name and postal code together to KAIS system. Also KAIS provides location information of the electronic map to the fire department, police, etc. through spatial information and attribute information, road name address and postal code, and provides a road name code for searching and managing the address. Provide fast and stable road name address conversion by providing mapped data of road name address and lot number address for efficient address transition to organizations managing branch-based addresses. Also it provides a standard API that can check the road name address corresponding to the lot number address corresponding to the road for citizen use. According to government report, road name address system effect to establish infrastructure to strengthen national competitiveness and to build location system optimized for emergencies such as Firefighting, crime prevention, disaster and other emergency situations, etc. Especially providing free supply of road map is to reduce location-based service market by 49.5 billion won. In addition, It is possible to find the location by road name address, saving time by 30 ~ 50% * compared to lot number (MOIS, 2014).

5. CONCLUSION

Address becomes one of key information to find exact location in Korea. There are many remarkable outcomes for few decades in Korea. such as semiconductor, cars, wireless devices, etc. Changing address system is one of big social issue until now but unchanged fact is impossible to find exact location by parcel based address. As mentioned above, the road name address have positive aspect to find location without maps and any devices. So that the road name address system came out as a only solution. This paper introduced the road name address system in Korea. But there are still some difficulties in address such as expressway rest area, buildings on the river, building over the road, underground market, and parking lot in mega building.

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Image Fusion Technique: Algorithm to Application

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KEYWORDS

Image Fusion, Resolution, AOI (Area of Interest), Supervised Classification, Accuracy Assessment

ABSTRACT

This paper highlights the image fusion technique with two images (one before flooding and another after flooding), thereby classifying the major land use categories in the flooding area. In July 2003, strong flooding occurred in Huai River, Anhui Province - China which caused serious harm to people's life and property. In order to reduce the loss, the detection of the flood inundated area and their land use categories need to be identified. Using multi-temporal images, during image fusion; the lacking information in one image is completed by another image. It substitutes missing information in one image with signals from another sensor image. The IHS sharpening technique is one of the most commonly used techniques for image sharpening. Different transformations have been developed to transfer a colour image from the RGB space to the IHS space. SAR image and TM multispectral image having different resolutions are fused giving higher resolution. The fused image is classified using unsupervised image classification technique with desired no of classes. The resulting classified image further divided into two categories only, namely disaster and non disaster area. Still, main task relies on how to categorize the disaster area into different land use classes and about their accuracies. The original image before flooding is classified using maximum likelihood classifier with desired number of classes. The maximum likelihood classifier performs its best due to the assumption of normal probability distribution of pixels, calculating probability density function for each pixel for each class and assigning them to the class where its occurrence is highest. So, when overall classification accuracy and KHAT statistic is good enough, final classification is made. The previously classified image with two categories and newly supervised classification are overlaid with proper transparency setting to get different land use categories.

1. INTRODUCTION

Image fusion is the process that combines information from multiple images of the same scene (Sreelekshmi, 2016). This approach of combining multi temporal images is concerned with increasing either spatial or radiometric details in resulting images. Image fusion enables us to integrate imagery of different spatial resolutions (Firouz et. al., 2011). Huai River in China is taken as study area where the SAR image and TM multispectral image having different resolutions (Table1) and taking in different time are analyzed using image fusion technique to highlight flooding information. SAR image is available in gray scale but TM multispectral in multiple bands. It is applied for remote sensing Image fusion/Resolution merge is the process of combining high resolution panchromatic image with low resolution multispectral image to get high resolution multispectral imagery (Sreelekshmi, 2016). To transform RGB space into IHS space to represent the information as Intensity, Hue and Saturation, IHS technique is one of the most commonly used image fusion techniques for image sharpening (Firouz et. al., 2011). It has become a standard procedure in image analysis for colour enhancement, feature enhancement, improvement of spatial resolution and fusion of disparate data sets (Pohl & Van, 1998). The fused image need to be classified using unsupervised classification. It is better to choose class number greater than the available band number which can give sufficient classification result based on the different spectral bands. Similarly, supervised image classification is performed for original TM multispectral image with major categories of River, Water, Plant, Farmland and Buildings. For accuracy assessment of the ML (Maximum Likelihood) classification was determined by means of a confusion matrix (sometimes called error matrix), which compares, on a class-by class basis, the relationship between reference data (ground truth) and the corresponding results of a classification (Lillesand et. al, 2004). The original TM multispectral image is overlaid into the unsupervised classified image having two classes namely disaster and non disaster. The land use categories in disaster area is determined.

1.1 Data/Image Used

Two images were taken for the analysis of disaster area near Huai River, China. One image is TM multispectral with combination of TM543 used as reference. It has pixel size (resolution) of 28.5*28.5 meter. A multispectral image consists of several bands of data. For visual display, each band of the image may be displayed one band at a time as a grey scale image, or in combination of three bands at a time as a colour composite image. It is the image taken before the flooding occurred.

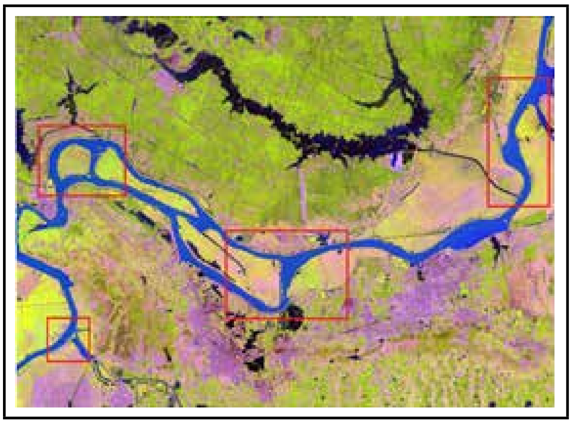

Figure1: TM543 (Multispectral) image

Similarly, there was another image which was taken after the flooding occurred. The SAR image is used here to show the flooding information having higher resolution than TM multispectral i.e. 20*20 meter. A panchromatic image consists of only one band. It is usually displayed as a grey scale image which is brightness of a particular pixel proportional to the pixel digital number which is related to intensity of solar radiation reflected by the targets in the pixel and detected by the detector. Thus, a panchromatic image may be similarly interpreted as a black-and-white aerial photograph of the area. The different red rectangles in two images indicates the major destroyed area before and after flooding.

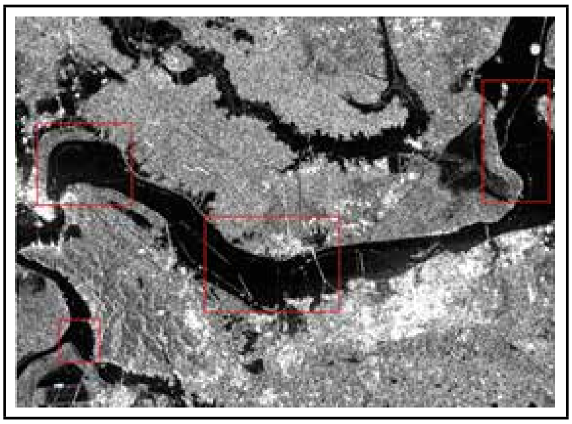

Figure2: Radarsat SAR image

1.2 Meta data

The detail information about the coordinate system and images is listed below:

Table1: Coordinate details of both image

XY Coordinate system	WGS_1984_UTM Zone_50N
Angular unit	(0.01745) Degree
Linear unit	(1.00) Meter
False Easting	500000 Meter
False Northing	0 Meter
Scale factor	0.9996
Central Meridian	117° E
Datum	D_WGS_1984

Table 2: Image details

Name	Format	Acquire Time, Resolution	Bands
SAR	TIFF	2003-07-14 (20*20m)	C
TM5 TM4 TM3	IMG	2002-09-22 (28.5*28.5m)	SW-IR Near-IR Red

1.3 Study Area

The image covers the range of 32° 34’ 30"N to 32° 49’ 30"N latitude and 116° 42' 00" E to117° 07' 00" E longitude as study area. The river is located in the southern east part of China, at the middle of Anhui province. The background map is the base map of China Online Street Warm access through Arc GIS 10.5 as shown in Figure3.

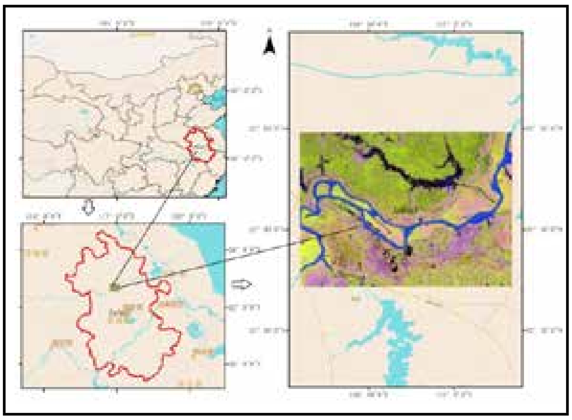

Figure3: Location of study area

1.4 Software used

During this research, the ERDAS Imagine 2014 software was used as image processing software and Arc GIS 10.5 was also used during final map composition and layout preparation.

2. METHODOLOGY

2.1 Visual Interpretation

Two image layers clearly show that after flooding more land is destroyed by course of river. There are many possible schemes of producing false colour composite images. However, some scheme may be more suitable for detecting certain objects in the image. Two different images can be viewed in parallel using swiping tool in Erdas Imagine 2014 software. That is useful for visual interpretation of images to check which part is destroyed more and which is less as shown in Figure4.

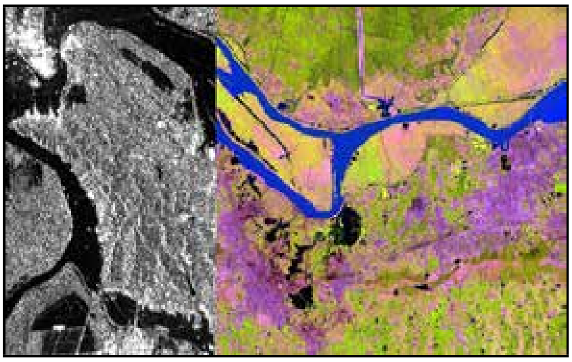

Figure4: Swiping of two images

A very common false colour composite scheme for displaying multispectral image is shown below:

R = (NIR band)
G = (Red band)
B = (Green band)

For the extraction of the destroyed area and to categorize them into land use classes, false colour composite was performed. In that performance, Red band was replaced by NIR band, Green band by Red band and Blue band by Green band respectively. After false colour composition, band of TM Multispectral image was assigned to SAR image and appeared yellow colour as the flood area (disaster area) as shown in Figure5 below.

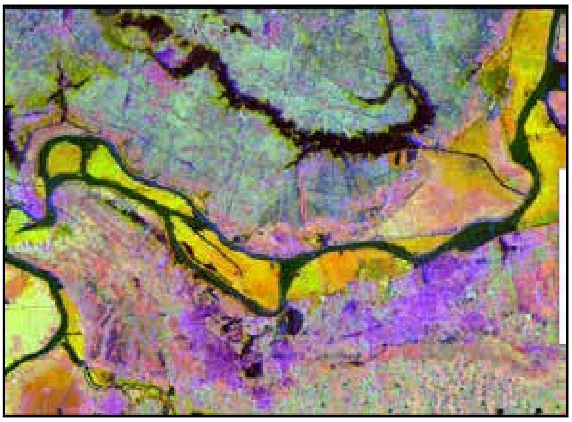

Figure5: Highlighted yellow colour as disaster area

2.2 Image Fusion

IHS method consists on transforming the R,G and B bands of the multispectral image into IHS components, replacing the intensity component by the panchromatic image, and performing the inverse transformation to obtain a high spatial resolution multispectral image (Bhaskarrajan, 2014). To obtain the land use categories in the flooding area, first need to the fuse the image. The following steps further explains about the Image fusion.

- Perform image registration (IR) to PAN (Panchromatic) and MS (Multispectral), and resample MS.
- Convert MS from RGB space into IHS space.
- Match the histogram of PAN to the histogram of the I component.
- Replace the I component with PAN.
- Convert the fused MS back to RGB space

The image fusion gives improved image in the sense that is combines both SAR and TM multispectral bands. The following figures shows after image fusion.

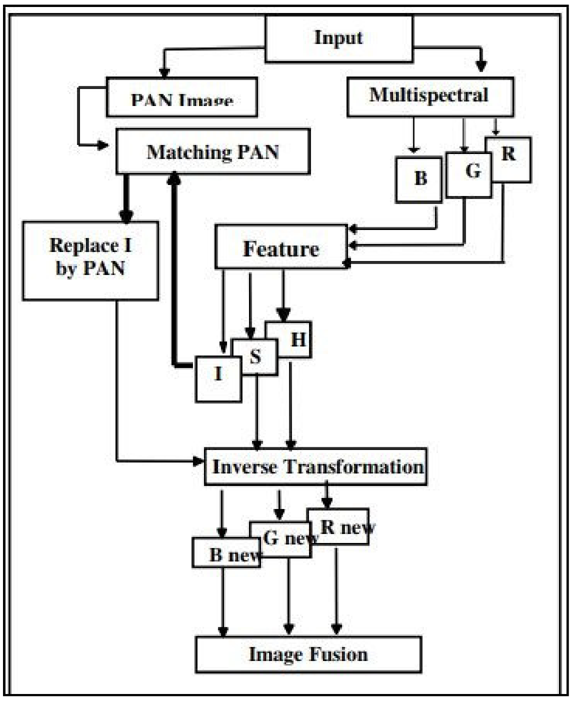

Figure6: Image Fusion Steps (Firouz et. al, 2011)

Literature proposes many IHS transformation algorithms have been developed for converting the RGB values. Some are also named HSV (hue, saturation, value) or HLS (hue, luminance, saturation). (Figure6) illustrates the geometric interpretation. While the complexity of the models varies, they produce similar values for hue and saturation. However, the algorithms differ in the method used in calculating the intensity component of the transformation. The most common intensity definitions are:

$$I = \frac{(R+G+B)}{3} \quad (1)$$

$$V = Max(R,G,B) \quad (2)$$

$$L = \frac{\max(R,G,B)+\min(R,G,B)}{2} \quad (3)$$

The first system (based on V), also known as the Smith's hexcone and the second system (based on L), known as Smith's triangle model (Nunez et.al., 1999). The hexcone transformation of IHS is referred to as HSV model which derives its name from the parameters, hue, saturation, and value, the term "value" instead of "intensity" in this system. (Sangwine&Horne,1989).

The Intensity Hue Saturation (IHS), Principle Component Analysis (PCA), Brovey Transformation (BT) and Wavelet transformation (WT) are contemporary image fusion techniques in remote sensing community. However, they often face colour distortion problem with fused image (Te-Ming et. al, 2001).

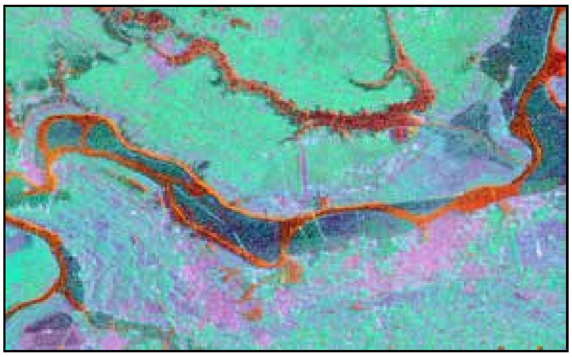

Figure7: IHS Fused Image

2.3 Fused Image Classification

For disaster area acquisition, unsupervised classification method is performed with 10 classes. These classes were divided into two categories "Disaster area" and "Non-disaster area". Making "Non- disaster area" of 9 classes as no colour and for "Disaster area" with red colour, the visualization seems like (Figure8) below. Similarly, the corresponding layer is added in the previous image which confirms the red area belongs to flooding area (Figure9).

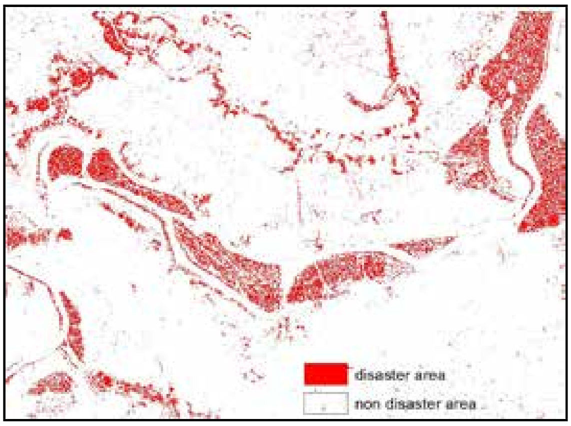

Figure8: Flooding(red), Non-Flooding(white) area

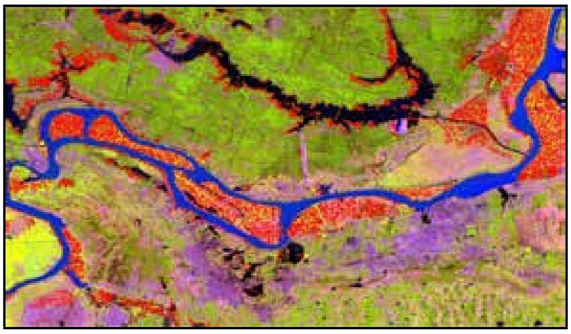

Figure9: Overlaid flooding area in original image

2.4 TM Image Classification and Accuracy

In the original TM multispectral image, five kinds of training samples were selected by artificial means: Huai River assigned as blue colour, water as black, buildings as red, farmland as yellow and plant as green colour.

The classification was carried out using maximum likelihood classifier. Selection and distribution of Area of Interest (AOI) is made in uniform way to represent them from all sides of the image so that the accuracy increases. Accuracy assessment of the ML (Maximum Likelihood) classification was determined by means of a confusion matrix (sometimes called error matrix), which compares, on a class-by class basis, the relationship between reference data (ground truth) and the corresponding results of a classification (Lillesand et. al., 2004).The training samples were evaluated using supervised classification and unsupervised classification. The results were verified through error matrix with overall accuracy, user accuracy and producer accuracy and the classification result with highest overall accuracy is adopted as good enough. At first, supervised classification accuracy was only 75 % and again classification was carried out and got 85% accuracy which is chosen as best.

$$KHAT = \frac{N\sum_{i=1}^{r} Xii - \sum_{i=1}^{r}(X_{i+} * X_{+i})}{N * N - \sum_{i=1}^{r}(X_{i+} * X_{+i})} \qquad (4)$$

Where,

r - number of rows in the error matrix

Xii- number of observation in row i and column i (the diagonal cells)

Xi+ Total observation of row i

X+i Total observation of column i

N - Total observation in the matrix

KHAT statistics (Equation 4) is a measure of the difference between the actual agreement between reference data and the results of classification, and the chance agreement between the reference data and a random classifier (Lillesand et.al, 2015). In this case the value of KHAT is found to be 0.79 which indicates that classification is 79% improvement from random assignment of pixels.

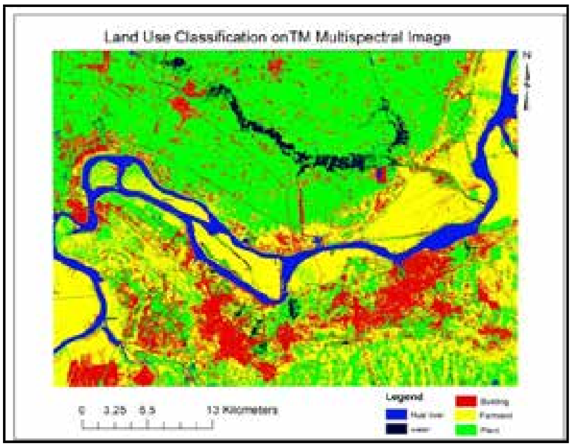

Figure10:Supervised Classification (Land Use)

Thus obtained classified image is overlaid with previous classification having two categories with proper transparency setting to get land use categories.

3. RESULT

Out of total study area (215.10 Square KM), 11.078 Square KM (5.15%) area lied into flooding/disaster/risky area. The black background colour is assigned for the "Non Flooding" area and different colour are assigned for different categories in the disaster area showing building to red, farmland to yellow, plant to green (Figure11).

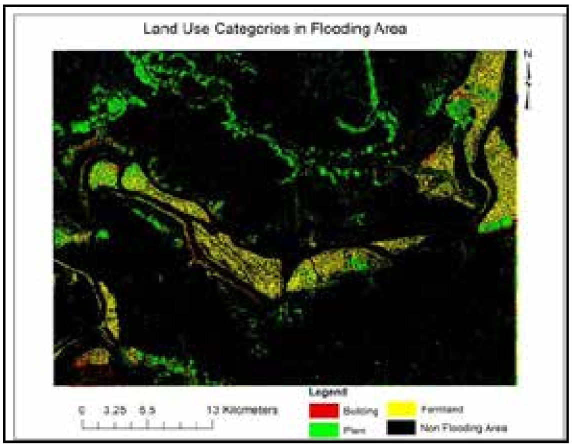

Figure11: Final land use map in flooding area

The final thematic map shows that in flooding area, most of the land use categories are farmland. Few of the buildings are in the risk area but most of them are in safe side. In the upper part of the study area, most of the plant are in the flooding area rather than farmland and build-up area.

4. CONCLUSION

From above discussion following conclusion is made with following subtopics.

4.1 Image fusion

Image Fusion techniques make it possible to emphasize and visualize certain features more clearly than they are in individual images. For example, highlighting change in certain area (like flooding), only SAR image and TM multispectral image is not possible and requires image fusion. It is fast, efficient and shows the information clearly. In this paper, the Modified HIS method is chosen because from different literatures, it is described as most widely used method. Because in this technique, the IHS (Intensity, Hue and Saturation) space are converted from the Red, Green and Blue (RGB) space of the Multispectral image. The intensity component I is replaced by the PAN. Then the reverse transform is applied to get RGB image as an output. So, although there were other methods like Principle Component Analysis (PCA), Brovey Transform (BT) and Wavelets Transform (WT) Modified IHS method can be used for image fusion, change detections and image enhancement in better way.

4.2 Classification and Accuracy

Both classifications (supervised and unsupervised) were performed but supervised classification with maximum likelihood method is better one. During classification, testing accuracies (overall, producer, user) and checking KHAT statistics value informs about the classification situation. When overall accuracy, producer accuracy and user accuracy approach to 100% and KHAT statistic tends to be 1 it shows excellent classification but here is 85% and 0.79 respectively which is satisfactory. Decision on making final classification depends on these accuracies and statistics. So for image classification maximum likelihood classification with supervised classification performs best.

5. RECOMMENDATION

This highlighted area in the map should be marked as risky area/vulnerable area by the government thereby making aware for people. Some safety measurement and early warning system is necessary near this area. As a new research approach, different image fusion techniques like PCA, BT and WT can also be used for same area and cheeking their different result. Some more research can be performed for making comparative analysis in different image fusion techniques for different sources and types of data.

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Gravity for Geodetic Purpose: Geoid-Ellipsoid Separation and Orthometric Height System

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KEYWORDS

Gravity, Geoid, Orthometric Correction, Gravity Reduction, Topographic-Isostatic Anomalies

ABSTRACT

Gravity plays very crucial role in geodetic issues as gravity field determines the shape of the earth. This paper reviews – beginning from defining the gravity, various applications of gravity in geodesy and in other fields, nature of gravity field of our terrain, instruments of gravity measurement, and techniques of gravity survey. This paper first gives information about gravity networks in Nepal, presents an equation to compute orthometric correction (OC) from height obtained from levelling. Gravimetric geoid-determination method is explained here with various gravity reduction methods and topographic-isostatic gravity reduction method is recommended for N- separation computation as this method results gravity anomalies near to zero.

1. INTRODUCTION

Any object on the surface of the earth feels two kinds of force – attraction of gravitation from earth and centrifugal push because the earth is rotating. The combined/resultant attraction of both gravitational acceleration and centrifugal acceleration is termed as gravity. Gravity is then attraction of the earth to unit mass and expressed as acceleration due to gravity. The SI unit of gravity is m/s2 but the unit used in geodesy is Gal unit. 1cm/s2 = 1Gal. The geodetic works such as geoid determination purpose and orthometric correction need to measure gravity value upto milliGal (mGal) to microGal (μGal) accuracy.

The attraction is 978 Gal at equator and 983.2 Gal at pole, 0.53% greater than that of equator and average value is of 980 Gal around the surface of the Earth. The uneven density of Earth's crust causes the variation of gravity around the earth's surface. Longer the distance of an object from center of the earth, weaker the gravity, thus gravity changes according to elevation. And because of the rotation of the earth on its axis, gravity changes according to latitude of a point.

Talking about nature of gravity field of Nepal, terrain of Nepal is one of the most complex geography of the planet. The latitudinal extent of Nepal is 26°N to 30°N. The country has three main physiographic region: plains (Terai), hills and mountains (Pahad) and Himalayan region. The elevation varies from lowest 60m at Terai to 8848m, the highest peak in the world. Terai is fairly level ground so not much of gravity variation occurs, hills are undulating topography and mountains and Himalayas are highly undulating terrain so gentle to extreme variation of gravity can be expected. Geodesist Niraj Manandhar quotes on his article titled "Geoid of Nepal from Airborne Gravity Survey" that more than 400mGal gravity variation is seen while moving from Indian plains to Tibetan plateau. Another fact is that the Himalayas are above the fault line of Indian plate and Eurasian plate and Indian plate is slowly creeping under the Eurasian plate as such gravity variation is expected.

2. APPLICATION of GRAVITY

There are various application of gravity information. This paper focus on use of gravity for geodetic purpose. The gravity is used to determine deflection of vertical, which is used to reduce the baseline length of triangulation points at surface to elliposoidal surface, thus needed in first order triangulation net. The height difference from spirit levelling doesn't equal to the actual orthometric height difference. The level height difference from levelling combined with gravity measurement yields true physical heights. The gravity anomalies are used to compute geoid-ellipsoid separation, and the gravity anomalies are computed from gravity measurements, thus needed for geoid definition of region.

The gravity reveals the subsurface density variation which is useful for exploration for oil, gas, and minerals. Geotechnical engineers use gravity information whether the subsurface voids exists below the planned nuclear building site. Different geological formations in Earth have different density structures and hence different gravity signals. Geophysicist use gravity information to study internal mass distribution of Earth's crust. Gravity field of the earth gives clue to evaluate orbits of satellites.

3. MEASUREMENT of GRAVITY

The measurement of gravity on or above the surface of the earth is called gravimetry. The instrument to measure gravity is gravimeter. Gravimeters are basically of three types based on principle they operate.

- Pendulum gravimeter
- Spring balance gravimeter
- Free-fall gravimeter

When a gravimeter measures/gives directly the value of gravity at a point independent of gravity values of any other point, then this is the absolute measurement of gravity and value is called the absolute gravity. When the gravity is determined relative to base gravity station whose gravity value is already known or determined, then this is called relative gravity measurement and relative gravity value.

Pendulum gravimeters were extensively used for 300 years till middle of the 20thcentury. The physical pendulum is used as gravimeter implementing formula of mathematical pendulum which use the length of the pendulum and swing period to result the value of g. Gravimeters based on principle of pendulum can be used as both absolute and relative gravimeter. The accuracy achieved was better than 1mGal upto 0.1mGal.

Since 1930 gravimeters based in principle of spring balance developed and most used for relative gravimetry measurement at present. LaCoste & Romberg (LCR) gravimeter implements the principle of astatic spring to determine the gravity value relative to base station. Most used relative gravimeters are LCR and Worden gravimeters. The accuracies achieved is 0.01mGal (10µGal). Even better accuracy of 1µGal can be obtained when used as stationary gravimeters.

The gravimeters based on principle of free-fall are used as absolute gravimeter. Time taken for an object to fall a certain vertical distance is used to get the value of g. Interferometric distance measurement and electronic time recording is implemented to develop free-fall gravimeters. JILA absolute gravimeters, FG5 absolute gravimeters are available for absolute gravity measurements and accuracies is in range of 1-10μGals.

4. NATIONAL CONTEXT OF GRAVITY SURVEY

The department of survey has conducted several gravity survey in different time period in cooperation with different foreign organization with the purpose of establishing national geodetic datum, national gravity network, absolute gravity measurement for crustal movement studies, topographic mapping, nationwide geoid definition. At present Survey Department is working towards defining geoid model of Sagarmatha region.

4.1 Gravity Survey during 1981- 1984

Ministry of Defense UK (MoDUK) established base gravity station network of Nepal comprising of one fundamental gravity base station named KATHMANDU J, 45 gravity base stations, and 375 gravity detail stations located at airports, government buildings, and road accessible places. Fundamental gravity base station KATHMANDU J established at Tribhuvan International Airport (TIA) as a part of International Gravity Standardized Net 1971 (IGSN1971)- the gravity value of this station was transferred from BANGKOK in 1981. The gravity value of same station was also transferred from Srilankan IGSN71 station 029691 COLOMBO was made as a check.

4.2 Absolute Gravity Measurement in 1991

Survey Department and Universtiy of Colorado, Boulder and National Geospatial Agnecy (NGA) USA measured absolute gravity value of Fundamental Absolute Gravity Station (FAGS-1) established at Nagarkot Geodetic Observatory using Joint Institute for Laboratory Astrophysics (JILA) gravimeter with microgal accuracy. Other gravity stations: Nagarkot GPS, Kathmandu airport, Simara airport, and Simara GPS were established transferring gravity value from FAGS-1.

4.3 Gravity Survey in 1993 by ENTMP (Eastern Nepal Topographic Mapping Project)

47 relative gravity stations mostly in hilly area where levelling information lacks were established using FAGS-1 of Nagarkot and gravity base station KATHMANDU J and Simara J as reference gravity stations. These 47 gravity stations and existing 30 gravity stations combined with GPS observations over same gravity stations and with spirit levelling information – a geoid model was developed to orthometric height information for the preparation of topographic map of eastern region.

4.4 Gravity Survey in 1997 by WNTMP (Western Nepal Topographic Mapping Project)

This project utilized data from GPS, spirit levelling, surface gravity information from past gravity survey, EGM96 with new gravity observations at 52 GPS stations and “NEPAL97” geoid was developed by Finnish Geodetic Institute.

4.5 Airborne Gravity Survey in 2010

Survey Department conducted airborne gravity survey within the national boundary in cooperation with DTU-Space, Denmark and NGA USA collecting the gravity information of whole country for the first time. Lacoste Romberg- S type gravimeter and Checkan- AM gravimeter were installed in aircraft with GPS receivers on both onboard aircraft and ground for positioning purpose. The gravity station at Kathmandu airport and at Nagarkot was used as reference station. The accuracy achieved was 3.3mgal for collected gravity data. Geoid thus developed was of accuracy of 10-20 cm.

4.6 Gravity Survey at Present

With purpose of measuring height of Sagarmatha after 2015 April major earthquake on its own effort, Survey Department is determining orthometric height of a Sagarmatha peak using ellipsoidal height from GNSS survey combined with geoidal undulation value of a peak. This geoid-ellipsoid separation at a peak will be extracted from geoid around Sagarmatha region. For that gravity stations are being planned at spacing of 10km and the work is carrying out. Another approach that Survey Department adopting to get height of Sagarmatha peak is trigonometrical/triangulation levelling. The data from trigonometrical/triangulation levelling need to be refined using gravity information of surrounding.

While carrying out gravity survey of any region for any purpose, first absolute gravity survey is carried out at least on two points to establish base gravity station which then have gravity value and then relative gravity survey of all other points relative to those base gravity station is carried out. In our context, base gravity stations are established during ENTMP and WNTMP including Nagartkot FAGS-1, KATHMANDU J, SIMARA J etc. Those absolute gravity stations can be used as base station to carry out relative gravity survey. But it has been more than 30 years that gravity value of those stations measured and gravity has characteristics of temporal variation. There have been shift of masses due to April 25, 2015 major earthquake causing change in gravity. So values could be no longer true. This puts the requirement of new absolute gravity measurement and then only relative gravity survey.

At present, in context of our country, we need to conduct gravity survey for two geodetic purpose: geoid determination of country and orthometric correction (OC) of heights obtained from leveling. For geoid determination purpose, gravity stations are distributed gridwise basis. Such points are distributed sparse in fairly level ground such as in Terai, dense in undulating regions such as in Pahad and much denser networks of gravity points in highly undulating mountainous regions. In case of gravity measurements to determine OC of leveling heights, gravity is measured at every PBMs. Relative gravity survey is conducted for gridwise surface gravity points for geoid computation and for PBMs of leveling relative to base station.

5. ORTHOMETRIC CORRECTION

What's wrong with heights obtained from precise levelling? Spirit levelling is used to determine height difference between points situated at a distance. Spirit levelling assume level surfaces are parallel- but when levelling is carried out in long run- the level difference as measured by differential levelling does not exactly equal to actual orthometric height differences. When a levelling is carried out in close circuit following different level route, the sum of level differences must be zero but it doesn't. This is because of non-parrallel nature of equipotential surfaces. Equipotential surfaces become close to each other where gravity is strong and distant where gravity is weak. Hence to define the unique height of a point which is orthometric height, the level difference (measured height difference) obtained from levelling must be corrected with orthometric correction (OC). So the levelling combined with gravity measurements with mathematical modelling yields true orthometric height of point. So gravity need to be measured at every PBMs of level alignment.

Peter Vanieck mentioned in his book that while levelling in Alpine road from Biasca to St Bernardo of distance 50km climbing from elevation of 300m to 2000m, the OC computed is 23cm which is 30 times larger than the tolerance limit for precise levelling. Mader (1954) experienced while levelling from 754m altitude to 2505m altitude, the orthometric correction is about 15cm per 1km of measured height difference.

C. Hwang developed the equation to compute OC to be applied to measured level difference to get orthometric height difference between any two PBMs. According to him, if point A is sufficiently close to point B in horizontal distance (below 2km), following equation provides the OC:

$$OC_{AB} = \frac{1}{g_B}\left[\frac{(g_A + g_B)}{2} - \overline{g_B}\right]\Delta n_{AB} + H_A(\frac{\overline{g_A}}{\overline{g_B}} - 1)$$

Where

OC_{AB} is the orthometric correction to be applied.

g_A is the gravity value measured at point A

g_b is the gravity value measured at point B

$\overline{g_A}$ is the mean gravity value along the plumbline through point A

$\overline{g_b}$ is the mean gravity value along the plumbline through point B

Δn_{AB} is the measured level difference between A and B

The mean gravity value $\overline{g}$ along plumbline through point is computed by following equation:

$$\overline{g} = g + 0.042H^M \qquad (2)$$

Where g is the gravity is value at a point (PBM) and H^M is height from levelling without applying OC. Since our PBMs of national leveling alignment is situated at distance of 2km and gravity can be assumed to be linear function of height as well as horizontal distance, above equation of determining OC applicable in our case. Helmut Mortiz mentioned that it is sufficient to measure gravity values at distance of some kilometers with the purpose of computing OC.

6. GRAVITY MEASUREMENT and GEOID DETERMINATION

Though there are various approach of geoid determination, one approach is gravimetric geoid determination using gravity. The gravity can be measured through terrestrial gravity measurement, airborne gravity measurement and spaceborne gravity measurement. This paper discusses computation of N separation using surface gravimetry data.

GNSS survey combined with geoidal undulations gives the orthometric height. The latitude and longitude gives the horizontal position of a point and the carefully measured ellipsoidal height in addition with geoid-ellipsoid separation information yields physically meaningful orthometric height with following equation:

$$H = h - N \qquad (3)$$

Where H is the height above geoid called orthometric height, h is height above ellipsoid surface called geometric height and N is the geoid – ellipsoid separation.

GNSS survey technology has become popular, timely, precise, and cost effective. As Geodeist Niraj Manandhar tells in his article titled "Concept towards cm-geoid for Nepal and GPS to replace conventional levelling using airborne gravity" that vertical component from GNSS survey paired up with geoid information can replace costly, tedious, and cumbersome spirit leveling as well as providing the elevation information where leveling seems inaccessible and cannot be carried out. This puts out having knowledge of N- separation is must.

Gravity anomalies which is the difference between observed then reduced gravity value to sea level and theoretical/normal gravity value, are input to Stoke's formula, which generates N- value, vertical distance between geoid and ellipsoid. Before computing the anomalies, the surface gravity value is reduced to sea level using free-air reduction approach, Bouger reduction approach, and topographic-isosatic reduction approach.

Free – air reduction is carried out such that gravity station is assumed to hang in free air above certain height from sea level. The gravity value is reduced certain height down to sea level then the difference between free-air reduced gravity value and normal gravity value yields free-air anomalies. The Bouger reduction takes care of attraction of masses between geoid and surface gravity station, the reduction of surface gravity value by subtracting the attraction of Bouger plate and combined with free-air reduction yields the Bouger reduced gravity value. The deviation of Bouger gravity value at sea level form normal gravity value is called Bouger anomalies. Bouger reduction can be more refined by taking terrain deviation from Bouger plate and applying terrain correction to get the refined Bouger reduction and thus anomalies. Theory of isostasy reveals that there exist some kind of mass deficiency under the mountains below sea level and mass surplus at ocean. The reduction of gravity value by taking consideration of attraction of compensating mass below sea level is called isostatic reduction. When gravity value at surface is reduced such that the attraction of topography above sea level and attraction of compensating masses along with free-air reduction, then such reduction is called topographic-isostatic reduction. The equation of topographic-isostatic reduction:

$$g_{TI} = g - A_T + A_C + F \qquad (4)$$

Where

g_{TI} is topographic – isostatically reduced gravity value

g gravity value at surface

A_T attraction of topography

A_C attraction of compensation

F free-air reduction

Then topographic-isostatic anomlies is given by

$$\Delta g_{TI} = g_{TI} - Y \qquad (4)$$

$$\Delta g_{TI} = g_{TI} - \gamma \qquad (5)$$

According to Helmut moritz, topographic – isostatic anomalies are best suited to compute geoidal separation/ N-computation.

7. CONCLUSION and RECOMMENDATIONS

Gravity varies in magnitude and direction both around the surface of the earth and should be measured and refined for geodetic problems solving. Nepal has rugged terrain beside Terai region. Gravity survey should be carried out covering and distributed all over the country to get the nationwide gravity model. The absolute gravity stations established in past must be reobserved because of temporal varying nature of gravity. All the levelling networks that we have must be orthometrically corrected using above mentioned equation as gravity field can produce larger magnitude of OC compared to tolerance of precise levelling. For gravimetric geoid-determination approach using data from surface gravimetry topographic-isostatic anomalies should be used.

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Published Papers/Articles	:	1

Obituary

All the officials of Survey Department pray to the almighty for eternal peace to the departed soul of the following officials of the department and this department will always remember the contribution they have made during their service period in this department.

Naresh Kumar Shah
Surveyor,
Survey Office Jhapa
2075/06/18.

Guman Sinha Basnet
Asst. Surveyor,
Survey Office Dharan
2075/02/30

Binod Kumar Mahato
Asst. Surveyor,
Survey Office Siraha
2075/12/08

Toran Bahadur Rai
Office Assistant
Survey Office Jhapa
2075/03/04

Aita Lal Mali
Office Assistant
Survey Department
2075/07/10

CALENDAR OF INTERNATIONAL EVENTS

15th South East Asia Survey Congress
Date: 15-18 August 2019
Country: Darwin, Australia
Website: http://seasc2019darwin.com.au/

27th CIPA International Symposium
Date: 1-6 September 2019
Country: University of Oulu, Finland
Website: https://www.cipa2019.org/

Geo-Information for Disaster Management
Date: 3-6 September, 2019
Country: Prague, Czech Republic
Website: http://www.gi4dm2019.org/

57th Photogrammetric Week
Date: 9-13 September, 2019
Country: University of Stuttgart, Germany
Website: https://phowo.ifp.uni-stuttgart.de/

Workshop and Summer School on the Evaluation and Benchmarking Sensors, Systems and Geospatial Data in Photogrammetry and Remote Sensing
Date: 16-20 September 2019
Country: Warsaw, Poland
Website: http://ptfit.sgp.geodezja.org.pl/workshop2019

Photogrammetric Image Analysis 2019
Date: 18-20 September 2019
Country: Munich, Germany
Web site: http://www.pf.bgu.tum.de/isprs/pia19

8th FIG Workshop on Land Administration Domain Model (LADM2019)
Date: 1-3 October, 2019
Country: Kuala Lumpur, Malaysia
Website: http://www.isoladm.org/LADM2019Workshop

Sensors and Models in Photogrammetry and Remote Sensing
Date: 12-14 October, 2019
Country: Tehran, Iran
Website: https://geospatialconf2019.ut.ac.ir/

40th Asian Conference on Remote Sensing
Date: 14-18 October 2019
Country: Daejeon, Korea
Website: http://www.acrs2019.org/

4th Symposium of the Committee on Space Research (COSPAR) Small Satellites for Sustainable Science and Development
Date: 4-8 November 2019
Country: Herzliya, Israel
Website: http://www.cospar2019.org/

Geodecision 2019 meeting. Geodecision for Sustainable Communities
Date: 9-11 November 2019
Country: Porto, Portugal
Web site: https://www.mygeodecision.com

15th International Conference on Location Based Services
Date: 11-13 November 2019
Country: Vienna, Austria
Website: https://lbsconference.org/

International Conference on Geomatics in the Big Data Era
Date: 15-17 November 201
Country: Guilin, Guangxi, CHINA
Website: http://2019geoinformatics.csp.escience.cn

3rd International Scientific Conference Applied Geomorphometry, GIS and Remote Sensing in Earth Sciences and Environment
Date: 20-24 November 2019
Country: Beirut, Lebanon
Web site: http://if3g.unioneag.org/

Pacific GIS & RS Conference
Date: 25-29 November 2019
Country: Suva, Fiji
Website: http://www.picgisrs.org/

FIG2020 Working Week
Date: 10-14 May 2020
Country: Amsterdam, The Netherlands
Website: http://www.fig.net/fig2020/

XXIVth ISPRS Congress Imaging today, Foreseeing tomorrow
Date: 14-20 June 2020
Country: Nice, France
Website: http://www.isprs2020-nice.com/index

CODING THE ADMINISTRATIVE UNITS OF NEPAL FOR DATA INTEGRATION AND VISUALIZATION

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KEYWORDS

Map, Data, Integration, Codes, Administrative Units, GIS

ABSTRACT

The value of data increases by multifold if they are presented in spatial context. For the meaningful use of data, the data table and the spatial component, the map, should be processed and prepared in such a way that they can be integrated easily. Common identification code for data and map units (point, line or polygon) is the key to this integration.

1 INTRODUCTION

For any development tasks to be formulated, scheduled, implemented and monitored, people need information. Nature is the ultimate source of all kinds of information. Almost all information is there with her, we just have to discover them for our needs. The information discovered should be passed to others so that they can use that information for the benefit of the society.

Developments in the field of electronics, for example fax (facsimile) machines, video cameras, CD players, printing press, personal computers, digitizing devices, softwares etc. have been the characteristics of the last few decades.

Organizational communication is important in every business. People in organizations need to communicate to coordinate their work and to inform others outside the business about their products and services. All these developments in the modes of communication have helped map – makers to produce more effective maps, a graphic method of information communication and sharing.

In this communication process a large variety of professionals are involved. For example, map makers, data producers, planners, decision makers, and map / data users to list a few. No single organization can accomplish all these tasks on its own. So, there is a need to design a mechanism to integrate the information from a wide range of sources so that we can produce meaningful products on which the planning and further actions can be based.

1.1 Maps

We live on the Earth, one of the several planets of our solar system. The earth is almost a perfect sphere with a radius of about 6,366 Km. The surface of the earth consists of different natural and man-made features like forest, lakes, mountains, urban areas roads and so on. The earth is so big that we can't see it at her completeness at one glance. To perform different activities of our needs, the features of the earth must be portrayed into a small form so that we can visualize a large part of the earth.

One of such small forms of the earth is a GLOBE. The globe is one of the most perfect representations of the earth. But the globe is not convenient to use for different purposes. For example, it is practically very difficult to perform linear measurements on a globe. The size of the globe would be very big, if we want to show more information on it. The radius of the globe would be about 64 meters to represent the earth at the scale 1:100 000. It takes a lot of space to store the globes. The globes are not convenient for carrying from one place to another. Since, the globes are generally made of metals or plastic, it is not convenient to add additional information on it.

So, it is more practical to represent the features of the earth onto a flat surface like a paper. This process of representing the features of the earth's surface onto a flat surface involves conversion from the curved surface into flat surface. *The reduced and generalized, in a scientific way, representation of the whole or a part of the earth onto a flat medium (generally a paper) is called a MAP*. With the development in the fields of Computer and Information Technology, Geographical Information System, Surveying and Mapping Technologies, professionals have started to make, disseminate and use maps in digital forms.

Map making is a very professional, time and cost consuming task. So, generally, the base maps are prepared by a National Mapping Authority of the Government, for example, Survey Department in Nepal. The latest series of topographic base maps (1992 – 2001) at scales 1:25,000 and 1:50,000 have been digitized to create National Topographical Database in digital form. On the basis of this database, Survey Department has generated digital database at scales 1:100,000, 1:250,000, 1:500,000 and 1:1,000,000. The database at scale 1:1,000,000 is freely available from the Department's web site. Apart from other data layers, this 1:1,000,000 scale database consists of an administrative boundary layer.

1.2 Map as an interface to data

Maps have been used for centuries to visualize and understand the ground reality. Map users understand different natural and artificial phenomena on the basis of appropriate maps. Different information such as distances, directions, volumes, areas, interrelationship between two or more phenomena can be derived from a map.

Maps contain different types of spatial data. Spatial data refer refers to objects or phenomena having specific location in space. Spatial data can be divided into two categories viz. geometric and attribute data. The first refers to the geometrical aspects (location and dimension) of the phenomenon and the second refers to other, non-geometrical aspects. For example, district wise population density map of Nepal. In this case, the boundary lines defining the given district are the geometric component and population density is the attribute component of the given spatial data.

Maps are made, in essence, from different data sources viz. geometric data about the ground features and attribute data related to different feature units. Surveying (ground surveying or remotely sensed surveying) and existing maps are major sources for the geometric data. Attribute data are collected by different agencies viz. organizations responsible for census, forest, agriculture, education, health and so on. In this way maps act as an interface to visualize the data in much more meaningful way.

1.3 Usages of maps

Consciously or unconsciously we use maps in our daily life. When somebody asks us about how to go to certain place, we first of all make a mental map in our brain and direct that person on how to reach there.

These days use of open source web maps has been a common practice. These maps are generally prepared by international professional organizations/groups in collaboration with government organizations and interest groups.

Almost all people use maps. Maps are very useful for different types of engineering works. Engineers construct different structures first on the maps. Different calculations can be done in maps. For example, we can calculation of length, area and volume. Some other map users are a vehicle driver, a scientist, a teacher, tourist, planners and decision makers, emergency service provider etc.

2 CURRENT ADMINISTRATIVE STRUCTURE OF NEPAL

According to the Constitution which came into effect on Sept 20, 2015, Nepal has 7 provinces with 77 districts. In due course of time 753 local units (6 Metropolitan Cities, 11 Sub-Metropolitan Cities, 276 Municipalities and 460 Rural Municipalities with 6,743 wards in total) were formed. So, the wards are the smallest administrative/political units in Nepal. Each ward consists of a few settlements.

The boundaries of these local units are not marked on the ground. Mostly, the natural and man-made features (ridges, rivers, roads etc) represent the boundaries. In many cases, especially in case of areas declared as "designated areas" (National Parks, Hunting Reserves, Conservation Areas), there are confusions on the boundaries. The boundaries of the settlements are not yet mapped in Nepal.

3 INTEGRATING DATA WITH MAPS

Basically, the process of combining data from different sources to create a unified view may be called data integration. Data integration always results in a value added product, saves time, creates environment for better collaboration between different organizations and assist in the knowledge-based and informed decision making process.

Mostly, the data and derived information are published in tabular form. For the decision makers and planners, it is neither easy nor comfortable to visualize, analyze and decide on the basis of such data in tabular form which lacks spatial component.

By integrating data with maps, one can derive more accurate insights, clearly see the spatial distribution of the data, compare with other relevant data and can generate information in spatial context based on which more reliable, reasonable and practical plans can be designed for the betterment of the society.

3.1 Data collection

For national, provincial and district level planning purposes, different government agencies collect data throughout the country. National Planning Commission, Central Bureau of Statistics (CBS), Ministry of Education, Science and Technology, Ministry of Health and Population, Ministry of Agriculture and Livestock Development, Ministry of Industry, Commerce & Supplies, Election Commission and so on collect the data required to fulfill their organizational mandates. The Census data are collected by the Central Bureau of Statistics (CBS) once in a decade.

The Census data are generally aggregated in ward level. Most of the other data are aggregated by the local units and districts.

3.2 Coding the mapping units

The key to integrate the data with maps is to establish national codes for administrative units, linear and point features represented in maps and use them throughout all agencies collecting data and making maps.

In order to integrate the tabular data with the map, one needs to relate the row of data in tabular form to a specific unit in the map data. This is done by assigning a common code to the row of data in tabular form and corresponding unit in the map data. The common code may be text, number or alphanumeric. More practical way of coding is to assign numbers to all units. Due to lack of uniformity in names of geographical and man-made features, it is not practical to use such names as common codes.

3.3 Usefulness / benefits of codes of mapping units

In absence of common code for the mapping units, one has to rearrange the data table or map data to make the data integration possible. And it takes a lot of time and man-power. Having common codes for mapping units, we can easily use data collected by any other organization and it is one of the main ideas of the principle of data interoperability and cost saving.

4 CODING ADMINISTRATIVE UNITS AND OTHER FEATURES IN THE PAST

Until the recent past, different agencies were using different codes for the then districts and lower level administrative units. For example, Survey Department and Central Bureau of Statistics were assigning different codes for districts of Nepal.

Attempts were made to use common codes and as a result a "National Standard" was developed and published. But, in practice it was not followed. The reason may be that the different agencies found it comfortable to work with the codes practiced in their own organizations.

Apart from the administrative units, Survey Department has developed a list of feature codes for all point, line and polygon features presented in the base map of Nepal. The feature code list is available at www.ngiid.gov.np maintained by Survey Department. But, the codes for individual point, line and polygon features are yet to be worked out.

5 CODING ADMINISTRATIVE UNITS OF NEPAL

Now, the administrative structure has been changed. Accordingly, their codes have to be revised. A new coding system suitable for the current administrative structure should be designed.

The Central Bureau of Statistics (CBS) has already developed a new coding system according to current administrative structure. Each local unit is given a five digit number, for example, for Dharan, the code is 11301. The first digit represents the province number (1 – 7), next two digits represent the district number and last two digits represent the local unit number.

According to the system adopted by Central Bureau of Statistics for the numbering of districts, firstly, districts are numbered from 1 in each state and as much as possible the numbering starts from the district of north east side of the state and continues in "S" direction. Then the geographic code of a district is manipulated as an alignment of state geographic code and district serial number. For example, the serial number of Taplejung district is 01 and it falls in state 1, then its geographic code will be 101. Same principle is adopted for local units in each district. Figure 1.

There is no hard and fast rule for coding administrative units. However, considering our eye rhythm during writing and reading, we print written materials with the words arranged horizontally left to right. To read this material, the eye moves left to right along a line of type and then sweeps to the left and down to the beginning of the next line. This suggests the coding process to start from left to right along a line and down to the beginning of the next line. This may be one of the agenda for discussion among the concerned agencies.

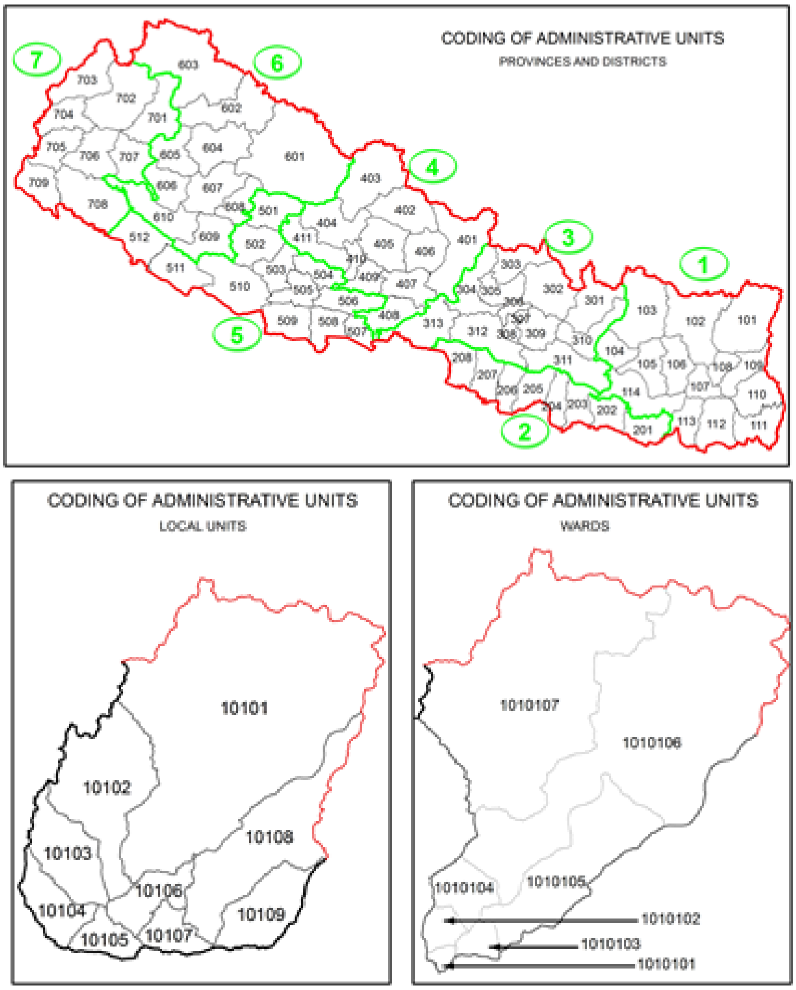

Figure 1 Coding administrative units of Nepal

6 DATA VISUALIZATION

Primarily the data are collected in pre designed forms – in hardcopy or digital format. Eventually, the collected data are arranged in tabular form – database table.

Generally, the human brain perceives information more clearly and quickly in the form of maps, charts and graphs than in the form of table or reports. In broader context, individual data has very little meaning. For example, the population of Kathmandu Metropolitan City is just a figure. But, when the populations of all Local Units are considered, it gives information on different aspects of population. And one can identify the areas which need attention.

After proper data integration, one can visualize the data in the form of map, charts, and graphs. Maps are more effective tool for visualization and proper understanding of the data. One can see the trend of the data including spatial component. With the in-built tools in the GIS softwares like ArcGIS, QGIS, we can analyze and visualize the data as per our requirement.

7 CONCLUSION

Mapping and data collection are highly professional tasks and the government allocates a huge amount of resources for their creation. This national investment should be used at optimum level so that the information can be used for the pre-directed national development.

Developing a common code for mapping and data collection units along with the standardization of mapping and data format are the keys to make the data integration possible.

Coding of the mapping units should be widely discussed among all concerned agencies and a system agreed upon by all concerned agencies should be brought into practice.

8 RECOMMENDATIONS

1. Map producer, Survey Department and data producers should work in close coordination so as to produce more meaningful products.

2. National Standards on coding of mapping features should be revised to reflect the current changes in the administrative structures of the country. For this, all the stake holders may sit together for meaningful discussion.

3. The National Code should be complete as far as possible. For example, the codes of administrative units developed by The Central Bureau of Statistics (CBS) may be extended to incorporate wards and settlements by adding two digits for wards and two (or three) more digits for settlements.

4. The National Code should also incorporate other features like highways, airports, headquarters, and designated/protected areas and so on.

5. The National Code should be passed by the Mapping Committee and enforced throughout the country.

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Price of Aerial Photograph

Data	size	NRs. Rate	remarks
Aerial Photo (Scan Copy)	23cm X 23cm	350	
Diapositive (Scan Copy)	Different	350	
Aerial Photo Index	Different	100	

Price of District Level Land Use Digital Data

Data	Unit	Rate	remarks
Present Land Use	Per sq. Km.	5	
GIS Data for Land Resource	Per sq. Km.	5	Except Land Use Zoning Data
Profile	per piece	200	

Price of Local Level Land Use Digital Data

Data	Unit	Rate	remarks
Present Land Use	VDC/Municipality	300	
GIS Data for Land Resource	VDC/Municipality	300	Except Land Use Zoning Data
Profile	VDC/Municipality	200	
Soil Map Data	VDC/Municipality	300	

GIS data for land resource map is available for 20 districts of terai region, Illam and Dhankuta District

Price of Digital Topographic Data Layers

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

S.N	Data	Price
1	Seamless Data whole Country	Rs. 300000.00
2	Seamless Data (Layerwise- whole country)	
2.1	Administrative Boundary	Free
2.2	Building	Rs. 15000.00
2.3	Contour	Rs. 65000.00
2.4	Transportation	Rs. 60000.00
2.5	Hydrographic	Rs. 70000.00
2.6	Landcover	Rs. 87000.00
2.7	Utility	Rs. 2000.00
2.8	Designated Area	Rs. 1000.00
3	1:1000000 Digital Data	Free
4	Rural Municipality (Gaunpalika) unitwise- all layers	Rs. 1000.00

Image Data:

Digital orthophoto image data of sub urban and core urban areas mintained in tiles conforming to map layout at scales 1:10000 and 1:5000, produced using aerial potography of 1:50000 and 1:15000 scales respectively are also available. Each orthophotoimage data at scale 1:5000 (covering 6.25Km2 of core urban areas) costs Rs. 3,125.00. Similarly, each orthophotoimage data at scale 1:10000 (covering 25 Km2 of sub urban areas) costs Rs 5,000.00.

Price of SOTER Data	Whole Nepal	NRs : 2000.00.

Road Network Rating Based on Land Use of Pokhara

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KEYWORDS

Road Network Rating Analysis, Land Use, Volume Capacity Ratio, GIS

ABSTRACT

Road Network Analysis considering land use has high potential uses in our country, where the coordination between land use and transportation planning is lacking in many aspects. This research proposes road network analysis based on land use for the current road network of old Pokhara city, one of the urbanizing cities that have led to the rapid urbanization recently. The road network in this city needs to be evaluated to develop efficient and better transportation facility. This study uses Geographic Information System(GIS) to create network database and analyze the current road network based on land use pattern and road attribute, identifying the worst area for transportation supply. This study further evaluates the road network with network volume capacity ratio of the same road section. Rating analysis along with network volume capacity evaluation has provided clear understanding of the links of road network on ward no 8 of Pokhara city having problem with traffic coordination. Among the major roads of the ward 8, Nayabazar road section is found in an unacceptable Level of Service (LOS) but other roads along with the highway passing are within the acceptable limit of LOS.

1. INTRODUCTION

Road Network evaluation considering land use has high potential uses in our country, where the coordination between land use and transportation planning is lacking in many aspects. Road planning deals with the definition of circulation infrastructure pavements, roads and terminals. It also covers the physical and operational characteristics of public transport (Vasconcellos, 2001). Road Network Analysis has been quite interesting topic in recent times. Many researches have been conducted in the field of road network optimization and overcoming the traffic problems such as congestion. Road Network Analysis with land use system includes all activities that are performed so as to determine the saturation capacity of network and predict the links that have issues, which creates traffic related problems such as congestion.

Sun, *et. al*., (2015) analyzes the interactive relationship between land use and traffic system. Feasibility judgment of planning scheme is implemented based on land attribute, represented by urban floor area ratio and road area ratio. Whereas Sai, *et. al*., (2015) presents brief practical review on the road network in the urban areas that constitutes of the essential infrastructures for the development of the city and also to meet the demands of the people and uses GIS based road network configuration and performs the behavioral model to improve the existing road infrastructure and also suggest the improvements over the existing infrastructure. Research conducted on Jeddah city (Al-Enazi, 2016) uses several GIS functions, also used in this paper including network analysis and overlay analysis using ArcGIS 10.2. The priority results are utilized in evaluating congestion points according to roads direction, which helps a planner in re-assigning roads directions to mitigate congestion points at all parts of Jeddah city.

This study considers the current road characteristics with the parameters road area ratio, road density and urban volume rate from the land use pattern as basic parameters to analyze current road network considering a case study of the ward boundary of the old Pokhara city. This study further analyses the current network, whether the current road is critical or not in the matter of volume capacity and also shows the link between land use pattern and road network for the effectiveness of the system.

2. RESEARCH METHODOLOGY

2.1 Study Area

Pokhara, a beautiful and historical town of Nepal which was made town municipality in 1962. Designation of Pokhara as the headquarter of Western Development Region of Nepal in 1972, contributed to upgrade Pokhara Municipality in the present status of Metropolitan City in 2017 with 33 wards. Being the regional headquarter of western region and the second tourist center after Kathmandu, it has attracted a large population from the surrounding areas. It accounts for the highest growth rate of population among the designated towns in the country. Pokhara city is selected as the study area rather than the whole Pokhara Metropolitan city because of its rapid process of urbanization and fast change in land use. According to the national population census information, total population of Pokhara sub metropolitan city is projected for the year 2017AD, for detail ward wise population projection.

2.2 Methodology for Data Analysis

This research will follow four step procedures analysis, giving full consideration to the advantages and disadvantages of each step evaluation method, and the result will conclude towards a single evaluation method.

2.2.1 Analysis based on Land use

This analysis method includes creating the land use map and land cover map along with determining road characteristics, buildup types and identification of the important areas that contribute trip generation.

Land use of Pokhara City

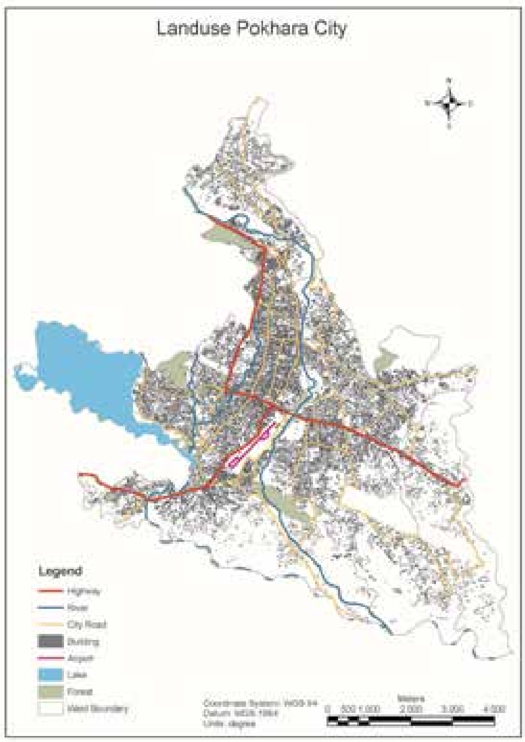


Figure 1: Land Use Map of Study Area

a) Urban Volume Rate

$R_1 = C_{building} / C_{land}$; where R_1 = Urban Volume Rate; $C_{building}$ = Urban Building Area (m^2); C_{land} = Urban Land Area(m^2)

b) Road Area Ratio

$R_2 = C_{road} / C_{building}$; where R_2 = Road Area Ratio; C_{road} = Urban Road Area (m^2); $C_{building}$ = Urban Building Area (m^2)

c) Road Density

$R_3 = 1000 \times A_{road} / P_{Population}$; where R_3 = Road Density / 1000; A_{road} = Area of Road (Km^2); $P_{population}$ = Population in Area (m^2)

2.2.2 Analysis based on Road Attribute

Road characteristics are defined by lots of characteristics. The predominant characteristics that influence the traffic flow such as lane condition, parking condition, road pavement, traffic signal, no of intersection, etc. are found to be in less variation than the number of intersection per length which is used as a rating parameter to obtain the road network map using GIS.

2.2.3 Analysis based on Service Area of different facilities

GIS map indicating important areas that contribute trip generation will consider different facility such as:

- School
- Hospitals
- Parks
- Museum
- Government Offices
- Oil Store
- Shopping Complex
- Bus Park
- Auditorium Hall
- Etc.

Service area map created by using the network analysis tool by using ArcGIS is analyzed on the basis of ward area which has most influence on the service area from different facilities. As such we can give more meaningful conclusion to the rating done on the basis of land use and the road attribute.

2.2.4 Analysis of the road on the critical ward with the network volume capacity ratio

The major road in the critical ward selected is further evaluated on the basis of network volume capacity ratio. Traffic volume count is done in order to find out the traffic volume at the peak hour.

IRC (1994), road network capacity is further calculated for different links based on the road width (carriageway).

$S = 525 \times W$ where, S = Saturation flow (Vph); W = Width of approach road (m)

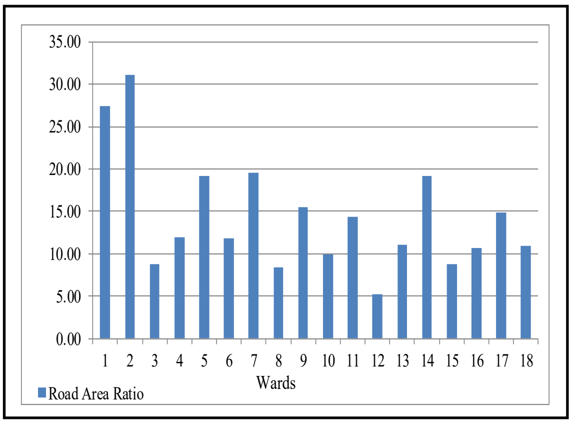
3. RESULT AND DISCUSSION

3.1 Analysis based on Land Use

Two parameters were used for the analysis of the land use and the road network, i.e. road area ratio and road density per population data which were extracted using GIS. While the next parameter urban volume rate is used to provide more meaning to the rating obtained from the combine ranking of the two parameters, i.e. road area ratio and road density per population.

3.1.1 *Road Area Ratio*

For the calculation of the road area ratio the parameters which are needed are calculated separately for each ward and the road area ratio for each ward is calculated individually.

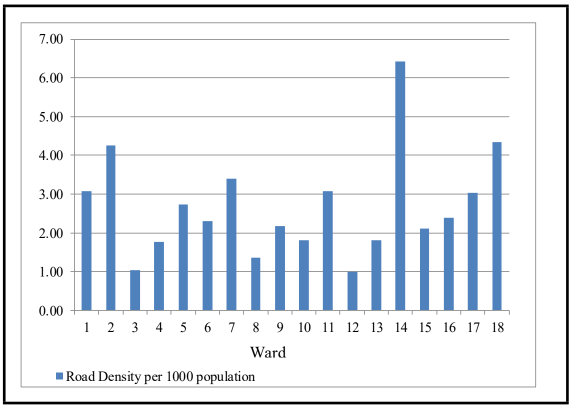


Bar 1: Road Area Ratio

From the analysis of Bar 1; ward 1 and 2 have the highest road area ratio which means that these wards have sufficient roads to serve the area than other wards. Whereas ward no 3, 8 and 12 have low road area ratio which concludes insufficient or serious shortage of transport supply as the ratio means lower road network to serve the large built up area.

3.1.2 Road Density per population

For the calculation of the road density per population the parameters which are needed are calculated separately for each ward and the road area ratio for each ward is calculated individually.



Bar 2: Road Density per Population

Also from analysis of Bar 2; ward 2, 14 and 18 have the highest road density per population which means that these wards have sufficient roads to serve the population living in these areas than other wards. Whereas ward 3, 8 and 12 have low road density per population, which concludes insufficient or serious shortage of transport supply to meet the demand of population living in these area.

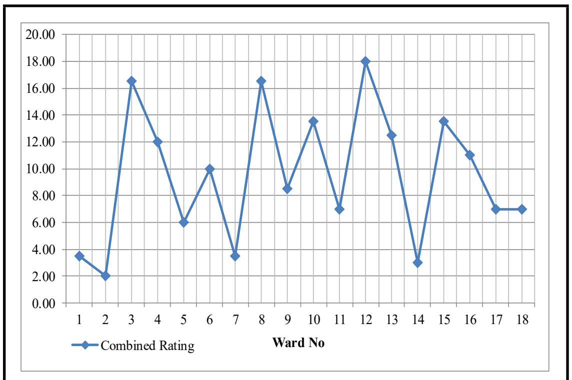
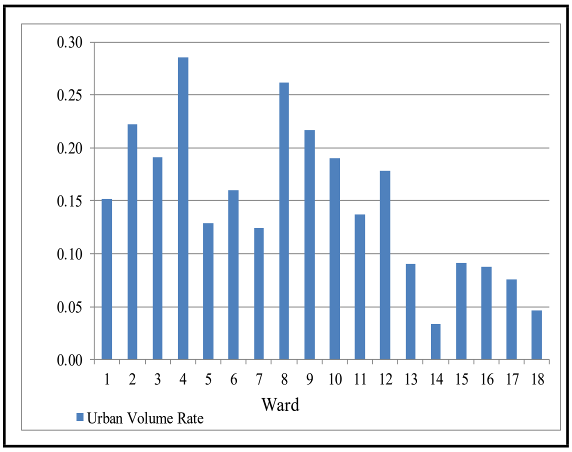


Figure 2: Combined Rating

From combined rating obtained as per the methodology by using road area ratio and road area per population we can see that ward no 3, 8 and 12 are facing serious shortage of the transport supply. So the results show that the road network in these areas should be analyzed further.

3.1.3 *Urban Volume Rate*

Though Urban Volume Rate is not used for the rating of the ward on the basis of roads considered of the wards, it is used further to interpret the ranking done by using road area ratio and road density per population such that it provides a meaningful conclusion.



From the result of the combined rating ward no 3, 8 and 12 area are the areas having the shortage of the road supply. Combined rating alone doesn't provide much more information about the shortage of transportation on these areas. Here the urban volume rate comes to aid on the above conclusion whether the demand of the transportation is high or not in these areas. From Bar 3; ward no 4 and 8 are having relatively high urban volume rate which concludes that the demand of transportation is high. If we compare both results from combined road area rating and urban volume rate, we can see that ward no 8 is having both serious shortage of transportation.

3.2 Analysis based on Road Attribute

The road network that lies in Pokhara city is mapped with the bounding boundary which is the ward boundary of the Pokhara sub metropolitan city. The minor links have been ignored for mapping as the flow pattern on these links is uncertain. Every such link is connected to the major link such that the effect of these links has been considered.

The road network considered is identified along with its attributes which will lead to the analysis of road network and will represent the supply factor of the road network. From the analysis based on road intersection ratio per length it can be concluded that the roads having higher road intersection ratio per length will certainly have unbalanced demand and supply than the road having lower intersection ratio per length.

3.3 Analysis based on Service area

Service area includes the major areas/ infrastructures that contribute the trip generation and affect the traffic flow on the road network. Therefore study of service area provides meaningful and effective analysis for the above results. For this analysis, the major service centers are identified and are plotted and by the network analysis, the service area is determined for 5 mins and 10 mins drive areas taking the ward boundary.

Based on service area analysis done by using network analysis tool from GIS for different facilities, it can be summarized that the service area is concentrated on the center area of the study area which are ward no 4, 7, 8 and 9 which shows the road network that lies in these wards will interact more to traffic supply and demand.

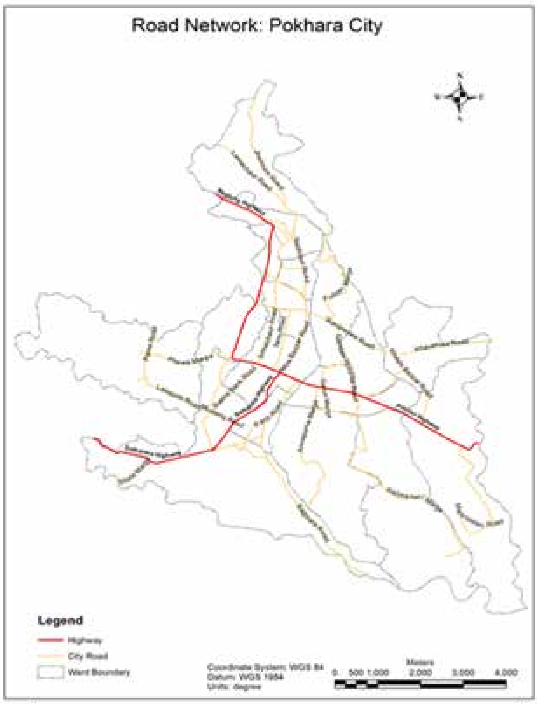


Figure 3 : Road Network Map of Study Area

3.4 Network Volume Capacity ratio

The proportion of vehicles in a traffic stream is very important parameter to determine the network volume capacity and gives general idea of traffic condition. Analysis of traffic composition gives the idea of supply and demand condition. So, it is crucial to know the traffic composition of various sections. Vehicle class percentages on different segments of the study area are shown below. It is found that motor cycle has the highest percentage in the traffic stream.

1.1.1.1 *Flow Volume of Traffic*

Due to the non-lane based traffic condition, traffic does not move in lane. Such traffic is analyzed on the basis of total width of approach and hence, the option of vehicle counting is adopted. Flow volume is calculated independently for each observed hour. All counted vehicles are added in terms of PCU to get peak hour PCU per hour.

The highest value among each observed data is taken to analyze the critical condition. Table below gives PCU per hour at considered road section along with peak hour factor with peak flow volume.

Also the major highways are taken into consideration as the highways also pass through ward no 8. For the secondary data used to determine the traffic flow volume, refer Table 2.

1.1.1.2 *Estimation of Volume Capacity Ratio*

Volume Capacity Ratio (V/C) is estimated by the ratio of the volume of the traffic in PCU/hr during peak hour and the capacity of the road. As explained in the methodology the capacities of the roads that have been considered are calculated as per the width of the effective carriageway. For relative index summary of the V/C ratio, refer Table 3.

Table 1: Peak Hour Traffic volume

	NayaBazar Road			***New Road***			***Simalchaur Road***		
	Day 1	**Day 2**	**Day 3**	**Day 1**	**Day 2**	**Day 3**	**Day 1**	**Day 2**	**Day 3**
Peak hour PCU/ hr	1,945	1,947.5	1,976.5	2,328	2,349.5	2,408.5	670	649	673
Peak Factor (K)	0.905	0.95	0.967	0.85	0.89	0.958	0.9	0.95	0.92
Critical PCU / hr	2,148	2,052	2,044	2,732	2,646	2,512	742	682	732
Adopted Critical PCU / hr	2,148			2,732			742		

Table 2: Peak Hour Traffic Volume of Highway

S.N	**Road Section**	**Peak hour PCU/ hr**			**Adopted Critical PCU / hr**
		Day 1	**Day 2**	**Day 3**	
1	Baglung Highway (II)	958	451	468	958
2	Prithivi Highway (I)	641	677	667	667
3	Siddhartha Highway (III)	446	451	468	468

Table 3: Volume Capacity Ratio of Roads

S.N	**Name of Road**	**Length (m)**	**Carriageway (m)**	**Traffic Capacity (PCU/hr)**	**Traffic Volume (PCU/hr)**	**V/C**
1	NayaBazar Road	1,650.77	7	3,675	2,148	0.58
2	New Road	1,550.94	14	7,350	2,732	0.37
3	Simalchaur Road	1,500.26	5	2,625	742	0.28
4	Baglung Highway (II)	1,450.64	7	3,675	958	0.26
5	Prithivi Highway (I)	4,789.41	7	3,675	667	0.18
6	Siddhartha Highway (III)	2,769.13	7	3,675	468	0.12

From this research most of roads taken into consideration lie in LOS 'A' as V/C < 0.35, except New Road which lies in LOS 'B' as 0.35<V/C < 0.55 and Nayabazar road which lies in LOS 'C' as 0.55<V/C < 0.77 as recommended by HCM. But the NRS suggests that LOS 'B' can be used for the design capacity of roads. So we can conclude that the road infrastructure of Nayabazar road which has LOS 'C' needs to be upgraded.

4. CONCLUSIONS

Land use pattern shows the rising urbanization as the land use pattern is mostly concentrated by the buildup in the core areas, which certainly does have adverse effect on traffic coordination leading to the unbalanced supply and demand of road network. This research carried out the analysis based on land use pattern along with the effect of service area and road attribute taking the ward boundary of the old Pokhara city. After determining the worse ward area, the study further narrow down the analysis to the road within the critical ward area by determining the road volume capacity ratio.

Analysis of land use map and service area map shows ward no 8 as a worse ward which on further analysis of roads within the ward on the basis of network volume capacity concludes that the ward is having supply and demand shortage of transportation. As the road area ratio is 8.38 and road area per population is 1.37 which is minimum relative to other wards and also this ward has urban volume rate 0.26 which is relatively high with respect to other wards, this ward seems to have shortage of transportation supply and lots of interaction of traffic on the road network. Also roads that lie in this ward when further analyzed with roads attributes show that the major roads such as New Road, Nayabazar road, Simalchaur road and Prithivi Highway are having poor intersection per length rating. The analysis based on network volume capacity for the major roads of ward no 8 shows that among the major roads, Nayabazar road section is not in the acceptable LOS i.e. V/C ratio 0.55<V/C < 0.77 but other roads along with the highway passing are within the acceptable limit of LOS i.e. V/C < 0.55 and are running in free flow condition. Therefore the research can conclude that the current road capacity is not the only reason to create imbalance between supply and demand of transportation but the current available road network is insufficient to meet the demand and supply of transportation in the current ward.

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Precise Point Positioning (PPP): Method and its Geodetic Usage

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KEYWORDS

Extended Kalman Filter (EKF), International GNSS Service (IGS), Multi-GNSS Experiment (MGEX), International Terrestrial Reference Frame (ITRF)

ABSTRACT

Combining the precise satellite positions and clocks correction with dual-frequency GNSS receiver, PPP is able to provide position solutions at centimeter- decimeter level. PPP can be regarded as a global positioning approach because its position solutions referred to a global reference frame. As a result, PPP provides much greater positioning consistency than the differential approach in which position solutions are relative to the local base station or stations. Due to this, today PPP has been the demand of large number of market.

1. INTRODUCTION TO PPP

1.1 Background

Point positioning methods has been used for quite long period now. From the use of analogue methods to digital and in the increasing order of the accuracy, positioning methods are being used for various purposes. Earlier it was mainly focused on surveying, mapping and navigation only. But today precise positioning technique has been the demand of every market. From the application of precise positioning in agriculture, timing, infrastructure development, disaster control, aviation to recreation, its demand and importance has been increasing.

Before taking the deeper insight on PPP, it is essential to have an overview on other GNSS techniques. The figure 1 shows the graph of accuracy for different GNSS techniques that we use today in their relation with the baseline. In the graph we can see that positioning by RTK seems to have higher accuracy among other GNSS techniques. But, with increase in length of baseline, its accuracy decreases sharply. Similar is the case with DGNSS. Being a regional Augmented System, SBAS technique have uniform accuracy for upto the baseline length of 1000km only. But the accuracy of PPP technique here seems is independent with the increase in the baseline.

1.2 Introduction

Precise Point Positioning (PPP) from its name one can say it’s a point positioning technique that renders precise location. PPP technique uses single dual frequency receiver for positioning. Unlike differential positioning techniques it does not require access to observations and correction data from one or more close reference stations that are accurately-surveyed. PPP just requires precise orbit and clock data, computed by a processing center with measurements from reference stations.

PPP is a global precise positioning service which requires the availability of precise reference satellite orbit and clock products in real-time using a network of GNSS reference stations distributed worldwide. PPP technique can be carried out in any parts of the world with access to satellite and internet.

Combining the precise satellite positions and clocks with a dual-frequency GNSS receiver, PPP is able to provide position solutions at centimeter- decimeter level. Therefore we can take PPP as a complete package of Precise Orbit and Clock information + User Satellite Tracking information + Error Modelling.

1.3 Working Principle of PPP

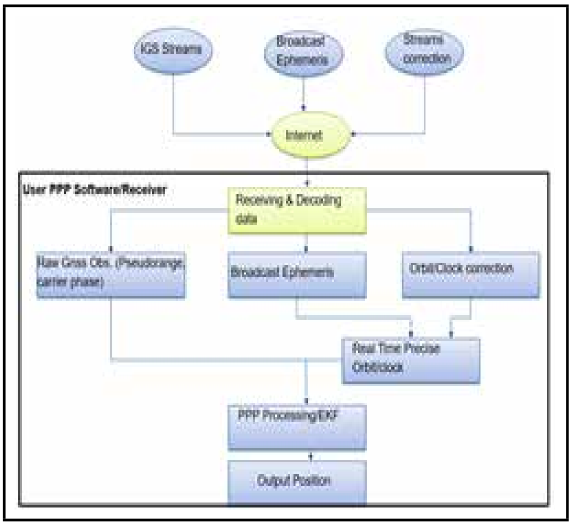

Figure 1: Working architecture of Real Time PPP

This diagram is an example of how Real Time PPP works. The input for PPP are both the undifferenced first-order ionosphere-free linear combination of multi-GNSS code and the carrier-phase measurements. The raw form of streams of IGS, Broadcasted ephemeris and correction data are available via internet to the receiver with PPP software. The receiver then receives these information and decode it to Broadcast ephemeris and clock/ orbit correction. Now with the combiniation of these along with the Raw GNSS Observation (Pseudorange, carrier phase) received on a GNSS receiver we get Real Time Precise Orbit/clock. This is then subjected to further processing and filtering. The filtering technique used for PPP is EKF (Extended Kalman Filter) for noise removal. Finally with the removal of outliers and noise with these processing we get out position data along with correction data in the real time.

1.4 Correction model and strategies

PPP being a GNSS technique uses GPS/ GLONASS/BDS/GALILEO constellation. Therefore, the availability of satellite must be ample for its observation.

Extended Kalman filter (EKF) is an extended version of Kalman filter which is employed to process GNSS measurements i.e raw pseudorange and phase observations are processed to produce the estimates of position. The Extended Kalman Filter is the optimal way to fuse observations of different random variables that are Gaussian distributed.

MGEX-IGS precise orbital and clock products (Derived from real-time streams+ broadcast ephemeris) are used to eliminate satellite orbit and clock errors.

For Receiver antennae phase center, PPP uses absolute antennae phase center model for correction of offset between receiver antennae reference mark and antennae phase center.

GNSS technology is based on very stable and accurate clocks on board the satellites and in the ground receivers. Their synchronization is of the utmost importance for a proper operation of the system. However, the time transfer between satellite and ground receiver is affected by relativistic effects. In order to address this issue "factory offset", is applied to satellite clocks prior to the satellite vehicle (SV) launch. The proper time, i.e. the time maintained by the atomic clocks on-board the SVs, used for the signal generation, has to be aligned to GPS Time (in case of GPS).

The total delay in the line of sight in troposphere is derived as the sum of the hydrostatic and wet delay in zenith direction multiplied by respective mapping functions, and a gradient correction. The tropospheric model consisting of the Saastamoinen vertical propagation delay model and the Niell mapping function is commonly used to account for the tropospheric wet and dry components.

IERS Convention is used mainly for correction for other effects due to solid earth tides and ocean tides.

1.5 Advantages of using PPP

Unlike differential methods PPP do not need any reference station. Use of single receiver is sufficient. Therefore the use of sophisticated instrument at the base is reduced in this technique. With this the number of manpower is also reduced which will definitely lead to the decrease in the cost of project. Thus with PPP we get quality data with reduced cost. And with the reduced cost and increased quality, PPP provides a cost effective solution.

PPP can be regarded as a global position approach because its position solutions referred to a global reference frame. As a result, PPP provides much greater positioning consistency than the differential approach in which position solutions are relative to the local base station or stations. Due to this, PPP has been the demand of large number of markets including agriculture, timing, infrastructure development, disaster control, aviation etc.

1.6 Special Issues related to PPP

It is necessary to address special issues that are related to PPP. When operating in differential mode, it is in many cases possible to fix the carrier phase ambiguities to their correct integer values. This is possible due to sufficient cancellation of satellite and receiver hardware biases through the differencing process. However, working with undifferenced observations, as in PPP, it is not possible to resolve the carrier phase ambiguities. The carrier phase ambiguities always has to be estimated in the adjustment in a so-called float solution. Due to burden of carrier phase ambiguities, PPP being a float solution, needs a certain time span of continuous observations to meet high accuracy requirements

Coordinates estimated with PPP will be in the same global reference frame as the satellite orbits. It is referred to the IGS realization of recent International Terrestrial Reference Frame (ITRF) at the time of observation. However, in most mapping applications especially for engineering surveying tasks the user would like to transform the ITRF coordinates into local or regional frames. Therefore there arises the questions while working in national or regional level.

PPP is totally based on the IGS products, satellite clock corrections and earth orientation parameters, a number of different products for its processing. These all are combined in different aspects to give out the position of a place but these products differ in different characteristics regarding latency, update rate, sample interval and accuracy.

2. PPP-GEODETIC USAGE

We have seen that many static reference station of precise point has been destroyed by natural and artificial causes. They require a lot of cost and effort to rehabilitate and reform. This would not be a problem if we have a single homogenous global framework but there exists numbers of local system in the world and they are not homogenous to give one global homogenous system.

We have always faced the limitations in the number of baseline points in the area with high economical potential. Many infrastructural projects has to undergo additional cost for point positioning at the beginning of the project. Due to these implications, the use of PPP in geodesy as in measurement or earth and earth objects seems vital.

2.1 Online Services - PPP

Today we have number of online services that provides the post processing facilities to process the observation of PPP. Many online services provide the possibility to upload RINEX (Receiver Independent Exchange Format) observation files to let them process fully automated on a server. The results are returned via email or ftp just within a short while. Here are the list of few such services which provides post processing services for both kinematic and static modes of PPP technique.

- CSRS-PPP by Natural Resources Canada (NRCan)
- GPS Analysis and Positioning Software (GAPS) by University of New Brunswick (UNB)
- Automatic Precise Positioning Service (APPS) by Jet Propulsion Laboratory (JPL)

2.2 PPP for Nepal

PPP has proven to provide sufficient accuracy for establishment of controls in real time and non-real time mode. Its application can be useful to Nepal. In a scenario where Nepal is still facing problems with the unknown changes in its control point network distributed nation-wide, using the application of PPP can not only help in rehabilitation of disturbed points with desired accuracy but also can be very useful in understanding the actual shift of the country in larger scale. The advantages of using PPP is the use of accurate satellite and clock correction and its reference with IGS stations. These correction today are readily available for PPP receivers via internet And there are many free online services as mentioned above which can be used for processing of observation file for higher accuracy.

PPP can be beneficial not only in establishing controls but also for monitoring small changes in land masses. Integration of PPP with network RTK technique can lead to improved positional accuracy and performance especially for engineering jobs, particularly reducing the convergence time.

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email	:	qust04sharma@gmail.com, sushmita.timilsina@dos.gov.np

ARTICLES IN PREVIOUS ISSUES

Journal 1 (Published in 2059B.S)

1. National Geographic Information Infrastructure : A perspective view
By Rabin K. Sharma

2. National Geographic Information Infrastructure Programme to support National Geographic Information System in Nepal
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3. Need of licensing in Surveying profession in Nepal
By Buddhi Narayan Shrestha

4. Georefrencing Cadastral maps in the pretext of Digital Cadastre
By Durgendra M. Kayastha

5. Innovation in Aerial Triangulation
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6. Status of Land Reform, Legislation, Policies, Programmes and its implementation in Nepal
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7. Database generalization and production of derived maps at 1: 100 000 and 1: 250 000 scales using NTDB in NGII context
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1. A Study on Digital Orthophoto Generation of Mount Everest Region
By Prof. Dr. Michael Hahn, Toya Nath Baral & Rabin Kaji Sharma

2. Land Management And Human Resource Development Policies In Nepal
By Hari Prasad Pokharel & Mahendra Prasad Sigdel

3. Topographical Survey Branch WithRemote Sensing
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4. An Overview On Time Series Of Geodetic And GPS Network Of Nepal
By Niraj Manandhar, Maheshwor P. Bhattarai

5. Global Positioning System On Cadastral Survey Of Nepal
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6. Orthophoto Mapping: A Fundamental Data LayerFor Urban GIS in NGII in Nepal
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7. Towards Strategic Planning For Building Land Information System (Lis) In Nepal
By Arbind Man Tuladhar, Krishna Raj BC & Nama Raj Budhathoki

8. Updating Geographic Information Using High Resolution Remote Sensing Optical Imagery
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1. National Geographic Information Infrastructure in Nepal for Strengthening Planning and Resource Management
By R.R. Chhatkuli

2. Global Positioning System and Strengthening of Geodetic Network of Nepal
By Krishna Raj Adhikary & Shree Prakash Mahara

3. A Perspective View on Space Application in Nepal
By Rabin K. Sharma & Babu Ram Acharya

4. Traffic problem in Kathmandu and Use of GIS in Urban Traffi c Management
By Anil Marasani & Jeni Rajbamshi

5. Building Geographic Information Infrastructure at National Level: Nepalese Experience
By Nama Raj Budhathoki & R.R. Chhatkuli

6. Survey Department in the Forum of International Activities: A Brief Overview
By Rabin K. Sharma

7. Digital Conversion of Analogue Cadastral Maps of Kathmandu Metropolitan City
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8. Issues on Land Management and Land Fragmentation
By Rabin K . Sharma

9. Assessment of Accuracy of IKONOS Image Map,Traditional Orthophoto Map and Conventional Line Map of Kathmandu Valley: A Pilot Study
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2. Human Resource Development Policy in Space Technology Sector in Nepal
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3. Registration of 3rd Dimension: the Context of Nepalese Cadastre
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4. Spatial Data Infrastructure for Prosperous Nepal
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7. One Plus one is more than two- The making of the Population and Socio-Economic Atlas of Nepal
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2. Maximizing Benefits of Space Technology for Nepalese Society
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5. Technical Deficiencies and Human Factors in Land Disputes: In the Context of Nepalese Cadastral Surveying
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1. A Proposed National Surveying And Mapping Policy In Nepal
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2. Assessment of the Digital Cadastre in Nepal from the Cadastre 2014 Vision
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4. Cadastre In Nepal: Past And Present
By Krishna Raj Adhikary, Dev Raj Paudyal & Prakash Joshi

5. Customer satisfaction model and organisational strategies for Land Registration and Cadastral Systems
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7. Evaluation of Topographic Mapping Possibilities From Cartosat High Resolution Data
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8. Evaluation of various filter kernels for extraction of linear features from satellite imagery
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9. From Cadastral Survey Plan To Geographic Information Infrastructure: Fifty Years Of Evolution Of Geo-spatial Data Policy In Nepal
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10. Land Administration (In A Nutshell)
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11. Less Means More - NTDB: At Scale 1:100 000
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12. Monitoring Land Cover Change In Kathmandu City Using Spatial Metrics And Remote Sensing Techniques
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13. NSDI Initiatives in Nepal : An Overview
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By Nab Raj Subedi &Raja Ram Chhatkuli

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By Nab Raj Subedi

18. Tissot Indicatrix: A Means To Map Distortion Analysis
By Bishnu Bahadur Karkey

19. Twenty-five years in Nepal-india Border Demarcation
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20. नक्शा राष्ट्रको सुरक्षा, विकास र जनताको लागि पथ प्रदर्शक हुन नारायण कृष्ण न्हुछे प्रधान

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1. Concepts towards cm-geoid for Nepal GPS to replace conventional leveling using airborne gravity
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2. Effects of Urbanization on River morphometry: A case study for Nag River Urban Watershed using Geomatics Approach
By Pinak Ranade and Y.B. Katpatal

3. Geomatics Engineering Education in Nepal
By Dr. Bhola Thapa

4. Institutional and Legal Aspects in Land Disputes: the Context of Nepalese Cadastral Surveying
By Ganesh Prasad Bhatta

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6. Professional Organizations of Geoinformatics in Nepal
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4. Land use land cover change in mountainous watersheds of middle Himalayas, Nepal
By Basanta Raj Gautam and Paban Kumar Joshi

5. Need of professionalism in geomatics profession for the development of sustainable system
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6. Role of geo-potential models in gravity field determination
By Niraj Manandhar and Rene Forsberg

7. Theory of error and least square adjustment: Application in coordinate transformation
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8. Updating of topographic maps in Nepal
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2. Assessment of Groundwater Recharge Using GIS
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3. Involvement of Survey Professional Organizations in International Activities
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By Prof. Stig Enemark
5. Land Policy Issues in Nepalese Context
By Gandhi Subedi and Raja Ram Chhatkuli

6. Optimizing Orientation by GCP Refinement of Very High Resolution IKONOS Satellite Images
By Madhusudan Adikari

7. Surface Gravity Information of Nepal and its Role in Gravimetric Geoid Determination and Refinement
By Niraj Manandhar

8. The Strategies For Strengthening National Geographic Information Infrastructure in Nepal
By Nab Raj Subedi

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2. An Approach to Determine Coordinate Transformation Parameter for Nepal GPS Network
By Kalyan Gopal Shrestha

3. Impacts of Climate Change and Remote Sensing Technology in its Mitigation Options through Forest Management
By Rabindra Man Tamrakar

4. Spatial Analysis: An Assessment of the Road Accessibility
By Madhu Sudan Adhikari

5. Study of Geodetic datum of Nepal, China and Pakisthan and its transformation to World Geodetic System
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6. Survey Department at the Cross Roads
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1. Bye-Bye EQ2015,11:56AM
By Kalyan Gopal Shrestha

2. A Review of Geodetic Datums of Nepal and Transformation Parameters for WGS84 to Everest 1830
By Niraj Manandhar

3. Connecting space to village SERVIR Himalaya at work for bringing earth observation to societal benefits
By Birendra Bajracharya

4. Education and Research Enhancement in Land Administration Sector at Kathmandu University
By Subash Ghimire

5. Flood Hazard Mapping and Vulnerability Analysis of Bishnumati River
By Susheel Dangol, Arnob Bormudoi

6. Land Records Information Management System
By Mr. Hira Gopal Maharjan

7. Nigeria-Cameroon Border Demarcation
By Prabhakar Sharma

8. S in Geoinformatics Profession
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9. Spatial Structure Of Urban Landuse In Kathmandu Valley
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1. A Secure Service Oriented Architecture Based Mobile SDI Model For Mineral Resources Management In India
By Rabindra K. Barik, Arun B. Samaddar, Shefalika G. Samaddar

2. Capacity Building In Geo-Information Sector(A Case Of Kathmandu University)
By Subash Ghimire

3. Community Land Governance And Its Conflicting Theories
By Sanjaya Manandhar & Dr. Purna Bahadur Nepali

4. Comparison of Different Resolution Satellite Imageries For Forest Carbon Quantification
By H. L. Shrestha

5. Data Acquisition For Search, Rescue And Relief Operation In Affected Areas Caused By Natural Disaster
By Rabin K. Sharma

6. Exploring Spatial Data Sharing Factors And Strategies For Catchment Management Authorities In Australia
By Dev Raj Paudyal, Kevin Mcdougall, Armando Apan,

7. Identifying Spatial Scale And Information Base: An Essential Step For Watershed Management And Planning
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8. Necessity Of Disaster Mapping Unit In Survey Department: The Context Of 2015 Gorkha Earthquake And Disasters In Nepal
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10. Role Of Land Professionals And Spatial Data Infrastructure In Disaster Risk Reduction: In The Context Of Post 2015 Nepal Earthquake: General Review
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11. Towards A Modernized Geodetic Datum For Nepal Following The April 25, 2015 Mw 7.8 Gorkha Earthquake
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12. Parcel Fragmentation And Land Consolidation
By Bharat Singh Air, Dr. MotiLal Ghimire

13. Immediate Recovery Vision For Geo-Information Sector In The Context Of Post 2015 Earthquake Reconstruction
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2.Concept in Determining the Height of Mount Everest (Sagarmatha)
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4. Utilizing Geo-information for Mountain Community
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7. Applicability of Stream Order Data for Morphometric Analysis and Sub-watershed Prioritization
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9. State and Public Land Management: Issues of Encroachment and Protection Technique
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10. Identifying Suitable Areas for Urban Development in Rampur Municipality of Palpa District, Nepal
By Ashim Babu Shrestha, Dr. Shahanawaz, Dr. Bhagawat Rimal

11. United Nations/Nepal Workshop on the Applications of Global Navigation Satellite Systems *By Niraj Manandhar (Geodesist), Er. Susmita Timilsina*

Journal 17 (Published in 2075 B.S.)

1. Pixel to Picture and Picture to Person
Rabin K. Sharma

2. Geoid Determination and Gravity Works in Nepal
Niraj Manandhar & Shanker K.C.

3. Positional Accuracy of Online Geocoding Services: Case Study of Bhaktapur District
Er. Amrit Karmacharya

4. Status of Land Tenure Security in Nepal
Harisharan Nepal & Anil Marasini

5. The Importance of RRR In Cadastral System
Sanjaya Manandhar, Bijaya Kumar Manandhar, Pradeep Sapkota Upadhyaya-PhD, Tanka Prasad Dahal

6. Spatial Distribution and Temporal Change of Extreme Precipitation Events on the Koshi Basin of Nepal
Sanjeevan Shrestha & Tina Baidar

7. Cadastre 2014: Performance of Nepal
Susheel Dangol & Ganesh Prasad Bhatta

8. GNSS Practice In Survey Department
Sushmita Timilisina, & Bibek Nepal

Nepal Geomatics Engineering Society (NGES)

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Executive Committee

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Er. Prem Thapa

About NGES

Nepal Geomatics Engineering Society (NGES) is a non-profit organization formed to function as an umbrella for all Geomatics Engineers of Nepal. Geomatics Engineering program for the first time was launched in 2005 AD by Purbanchal University, in 2007 AD by Kathmandu University and in 2012 AD by Tribhuvan University. Till date, there are more than 400 geomatics graduates in Nepal working in different sectors.

Geomatics as a new global profession can be used as a special tool in planning, policy building and decision making. In order to explore and enhance the role of Geomatics engineering in nation building through cooperation among the geomatics graduates and professional practice, the geomatics pioneers of Nepal recognized the importance of a society and hence formed Nepal Geomatics Engineering Society in August 26, 2015.

As driven by the society's regulation, the executive committee is paying its full strength to develop cooperation among geomatics professionals through various professional and recreational activities.

NGES organized a program for exchanging the **greetings of Tihar and Chhat festivals** on November 3, 2018 as its first program after the formation of current executive committee on 26 October, 2018.

Friendly Futsal tournament on November 24, 2018. Nine teams participated in the event which is one of the yearly event being organized by NGES

President and Members of NGES participate in **UNWGIC** in China

NGES voluntarily supports Dhurmus Suntali Foundation in Construction Survey of **Gautam Buddha Cricket Stadium** in Chitwan.

Career Counselling (Session with NGES) to Geomatics Students of WRC /TU

Global Surveyors' Day - March 2, 2019 was a mega event for the professionals and academia of Geomatics in Nepal. The program on the initiation of NGES was jointly organized by NGES, NeSA, NSPRS and NICS. Two day long program included friendly futsal tournament, Map competition, Inspirational speech, Panel discussion on five different generations on Surveying and Mapping in Nepal (5Gs) and Networking Sessions. Minister of Land Management, Cooperatives and Poverty Alleviation – Hon. Padhma Aryal was Chief Guest of the program.

Nepal Surveyor's Association (NESA)

NESA CEC
Secretariate

Mr. Ambadatta Bhatta
Acting President

Mr. Saroj Chalise
General Secretary

Mr. Prakash Dulal
Secretary

Mr. Durga Phuyal
Secreatry

Mr. Sahadev Ghimire
Treasurer

Mr. Dadhiram Bhattarai
Co-treasurer

Mr. Hari Prasad Parajuli
Member

Ms. Jyoti Dhakal
Member

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Vice President
Eastern Development Region

Mr. Tanka Prasad Dahal
Vice President
Central Development Region

Mr. Gopinath Dayalu
Vice President
Western Development Region

Mr. Ramkrishna Jaisi
Vice President
Mid-Western Development Region

Mr. Karansingh Rawal
Vice President
Far-Western Development Region

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

Background

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

Objectives

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

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

Organizational Structure

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

Membership Criteria

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

Activities

- Nepal Surveyor Association, in collaboration with Nepal Geomatics Engineering Society, Nepal Remote Sensing and Photogramettric Society and Nepal Institution of Chartered Surveyor celebrated 2nd Global Surveyor's Day.

Nepal Remote Sensing and Photogrammetric Society (NRSPS)

Executive Committee Officials

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2nd Global Surveyor's Day 2019

On April 21st March 2019, second Global Surveyor's day was organized by Nepal Geomatics Engineers Society, Nepal Surveyor's Association, Nepal Institution of Chartered Surveyor and Nepal Remote Sensing and Photogrammetirc Society. President of NRSPS gave welcome speed during the opening ceremony and chair the closing ceremony. The program marked five different programs like map competition, panel discussion, prize distribution for the winners of footsal competition organized on the occasion of the day.

"ENCOURAGE APPLICATION OF REMOTE SENSING TECHNOLOGY"

Basic Remote Sensing Training

Kathmandu Forestry College (KAFCOL) in collaboration with Nepal Remote Sensing and Photogrammetric Society (NRSPS) organized seven days training on basic remote sensing from 3rd March to 9th March 2019. President of the society participated during the closing ceremony to distribute certificates to the participants during closing ceremony of the training.

President attended the Programme of NICS

On Fagun 17, 2075, **Nepal Institution of Chartered Surveyors (NICS)** organized its 10th Annual General Assembly in which the **Chief Guest** was **Mr. Gopinath Mainali**, Secreytary, Ministry of Land Management, Cooperatives and Poverty Alleviation. **Mr. Rabin K. Sharma**, President, NRSPS was invited to represent the Society and also gave him an opportunity to speak a few words in the event.

President attended the Programme of NICS

On Kartic, 18, 2075, president of society attended 10th Annual General Assembly of Kavreli Survey Samaj (KSS) as a special guest to represent (NRSPS) and presented a paper entitled Survey Profession - License.

Call for papers

The editorial board requests for papers related to geo-information science and earth observation for the publication in 19th issue of the Nepalese Journal on Geoinformatics.
Last date of submission is 30th March 2020.
For more information, please contact editorial board

Survey Department

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Instruction and Guidelines for Authors Regarding Manuscript Preparation

- 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 Microsoft Word by email.
- Editorial Board has no obligation to print chart/ figure/table in multi colour, in JPEG/TIFF format, the figure/picture should be scanned in a high resolution.
- Authors are also requested to send us a written intimation that the same articles is not sent for publication in other magazine/journal.

Page size: A4

Format: Single line spacing with two columns.

Margin: upper 1", left 1.15", right 1", bottom 1".

Length of manuscript: The article should be limited upto 6 pages including figures and references.

Body text font: Times New Roman "11".

Title: The title should be centrally justified appearing near top of 1st page in Cambria, "20" point (Bold).

Authors Name: Authors name should be in Times New Roman "10" with Upper and lower casing, centrally justified. There should be a gap of one lines with 11 pt between the title and author's name.

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Keywords: Four to five keywords on paper theme

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Abstract: Single line spacing after keywords, limited to around 300 words in Italic, Times New Roman "10".

Major heading (Level 1) should be flushed with the left margin in Times New Roman "10" bold font and with Upper casings. Color Dark blue. Numbering 1

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Placement of photographs/tables: Photographs or tables should be pasted in appropriate place of manuscript pages with caption in their positions in Times new Roman "10" with Upper and lower casing.

Equations: All equations should be in Times New Roman, "11" and italic with consecutive equation numbers placed flush right throughout the paper.

References: References should be listed in alphabetical order at the end of paper in following sequence and punctuation. Author's last name, Author's initials, (Year of publication). *Title of references article in italic,* name of book or journal, volume number, country or city, name of publisher etc.

Citation: All papers are to be cited like (Rajabifarad, 2012), (Dangol & Kwak, 2014), (Zebenbergen, *et. al*., 2018). Upto two authors, the last name should be cited for both and if more than two, then cite it as *et. al.*.

(Primary) Author's Information: The author should provide

Name, Academic Qualification, Organization, Current Designation, Work Experience (in years),

Published Papers/Article (Number) and scanned copy of author's passport size photo.

Chief Survey Officer Mr Sushil Narsingh Rajbhandari and Director (IT) Mr Govinda Paneru participating in "Capacity Building Program for ICT-based Land Management Systems" Seol, Korea, October, 2018

Chief Survey Officer and leader of the Everest expedition Mr Khim Lal Gautam, Survey officer Mr. Rabin Karki, Surveyor Mr Suraj Singh Bhandari, Surveyor Mr Yuvaraj Dhital and internation Mountain guide Mr Chhiring Jangbo Sherpa set for Everest expedition for the measurement of the height of Mt Everest with GNSS receiver and GPR instruments

Chief Survey Officer Mr. Sudeep Shrestha, Survey Officer Mr Prakash Dulal and Accountant Mr. Surya Neupane together with Team no 5 of Topographical base map update program during their inspection program of all nine teams of base map update and seven teams of land use pilot program and data handover program

Temporary CORS station established at Lobuche for Everest height measurement program

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

Available Maps and Data

- Geodetic Control data
- Aerial Photographs
- Topographic Base Maps
  - Terai and middle mountain at the scale of 1:25,000
  - High hills and Himalayas at the scale of 1:50,000
- Land Use Maps
- Administrative and Physiographic Maps of Nepal
- Digital Topographic Data at scales 1:25,000 & 1:50,000
- Cadastral Plans
- Orthophoto Maps
- Orthophoto Digital Data
- SOTER Data
- Topographic Digital Data at scales 1:100,000 1:250,000 1:500,000 1:1,000,000

Available Services

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

Price of some of the publications of Survey Department

- List of Geographical Names, Volume I to V – NRs 600/- per volume.
- The Population and Socio - Economic Atlas of Nepal (HardCopy) NRs.2,500.00 (In Nepal), €200.00 (Outside Nepal)
- The Population and Socio - Economic Atlas of Nepal (CDVersion) NRs.250/-

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