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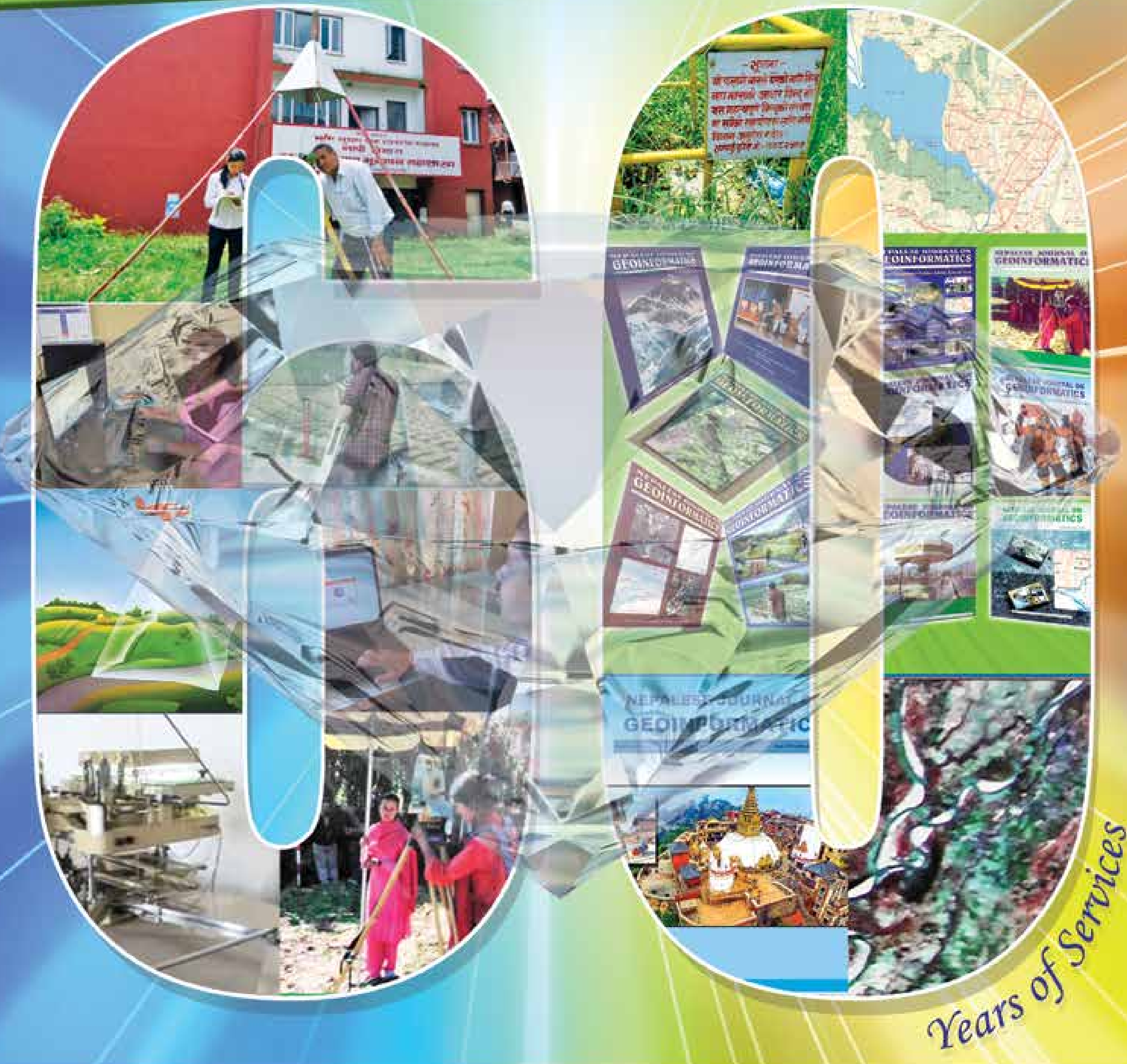

Annual Publication of Survey Department, Government of Nepal

Courtesy Meeting with the Minister for Agrarian and Spatial Planning of the Republic of Indonesia Hon' Ferry Mursyidan Baldan by the then Secretary of Ministry of Land Reform and Management Mr. Mohank Krishna Sapkota and Director General (then DDG) of Survey Department Mr. Ganesh Prasad Bhatta, during the study visit to National Land Agency of Indonesia (BPN) from June 27 - July 1, 2016

Mr. Ganesh Prasad Bhatta taking the seat of Director General, Survey Department on March 26, 2017,

Mr. Suresh Man Shrestha, Deputy Director General, participating in “”International Workshop on Geospatial Data Management and Quality Control” held at Tianjin, China from 12-16 December, 2016.

Inaugural session of Regional Workshop conducted by Survey Department at Nepalgunj, Banke, March 2-3, 2017, Chief Guest, Secretary, Ministry of Land Reform and Management, Mr. Krishna Prasad Devkota

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Features

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Cover Page
Diamond at background and 60 numeric value with different surveying and mapping related images.

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EDITORIAL

Nepalese Journal on Geoinformatics is an important asset as well as a means to propagate professional knowledge, skills and expertise. It has documentation on more than hundred topics including a wide spectrum of different aspects of surveying, mapping and geoinformation which can be easily accessed online or offline.

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

At this point, I am very much thankful to the Survey Department for entrusting me with the responsibility of the Editor-in-Chief for the sixteenth 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 sixteenth 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. Last but not the least, I feel privileged and honored to work as the Editor-in-Chief.

Suresh Man Shrestha
Editor-in Chief
Jesth, 2074

नेपाल सरकार

मा. डा.गोपाल दहित
मन्त्री
भूमिसुधार तथा व्यवस्था मन्त्रालय

फोन नं. : ४२११७६०
फ्याक्स नं. : ४२११६४५

निजी सचिवालय
सिंहदरवार, काठमाडौं ।

प.सं. : ०७३/७४
च.नं. :

नेपाल सरकार भूमिसुधार तथा व्यवस्था मन्त्रीको निजी सचिवालय सिंहदरवार, काठमाडौं

मिति :- २०७४/०२/०७

विषय :- <u>शुभकामना</u> ।

देशको आर्थिक तथा सामाजिक विकासको लागि नापनक्शाको महत्वपूर्ण भूमिका रहेको हुन्छ । विकास आयोजनाहरुको योजना तर्जुमा र कार्यान्वयनको लागि समेत नाप नक्शाले ठूलो भूमिका खेलेको हुन्छ । कृषि क्षेत्रको संरक्षण, वनसम्पदाको विकास, नगर तथा ग्रामिण क्षेत्रको विकास, विकास आयोजनाहरुको निर्माण, खनिज पदार्थको अन्वेषण, प्रशासनिक तथा सामाजिक सुव्यवस्था कायम गर्नेदेखि व्यक्तिगत सम्पत्तिको सुरक्षाको निमित्त समेत नापनक्शाको जरुरत पर्ने अनुभव हामी सबैले गरेकै छौं । जनताको जग्गा जमिन माथिको हकलाई सुरक्षित गर्न र जग्गा प्रशासनलाई भरपर्दो र विश्वसनिय बनाईराख्न शुद्ध र तथ्य परक भूमि लगतको आवश्यकता पर्दछ । यी तथ्यहरुको मनन गर्दै नेपालको क्रमबद्ध नापनक्शा गरी नक्शा र श्रेष्ता तयार पार्ने उद्देश्यले वि.सं. २०१४ सालमा नापी विभागको स्थापना भएको थियो ।

नापी विभागले क्रमश: देशको आर्थिक तथा सामाजिक विकासका निमित्त आवश्यक पर्ने कित्तानापी बाहेकका अन्य नक्शा तथा भौगोलिक सूचनाहरु समेत देशमै उत्पादन गरी सर्वसुलभ बनाउने र यस क्षेत्रमा कार्यरत देशका अन्य सरकारी सार्वजनिक निकायसँग समन्वय गरी नापनक्शा तथा भौगोलिक सूचना उत्पादनमा एकरुपता कायम गर्ने प्रमुख जिम्मेवारीका साथ भूमिसुधार तथा व्यवस्था मन्त्रालय अन्तर्गत रही नेपालको राष्ट्रिय नापनक्शा निकायको भूमिका निर्वाह गरिरहेको छ । विज्ञान र प्रविधिमा भएको तिव्र विकाससँगै शुरुमा मुख्यतया कित्तानापीमा मात्र सीमित नापी विभागको कार्यक्षेत्र, भूमिका र चुनौतीहरु फराकिलो हुँदै गएका छन् । नवीनतम पद्धति र प्रविधिको उच्चतम प्रयोग गर्दै नापनक्शाको कामलाई प्रभावकारी रुपले संचालन गर्न र सेवाग्राहीलाई सन्तुष्टि प्रदान गर्न नापनक्शाको क्षेत्रमा काम गर्ने नापी विभागमा कार्यरत कर्मचारीहरुको अति महत्वपूर्ण भूमिका रहेको हुन्छ।नापनक्शाको क्षेत्रमा सेवाग्राहीहरुले प्रभावकारी, सक्षम र चुस्त सेवाको अपेक्षा राखेका छन्। नापी विभागले आफ्नो स्थापनाको ६० वर्ष पूरा गर्दा नापी विभागका सेवा तथा सूचनालाई जनताले आफ्नो घरमै हेर्न र प्राप्त गर्न सक्ने अनलाइन सूचना प्रणाली देशव्यापी बनाउन पद्दति र प्रविधिमा समयानुकूल परिवर्तन गर्दै कर्मचारीहरुमा व्यवसायिक रुपान्तरणको खाँचो टड्कारो रुपमा देखा परेको छ ।

अन्तमा, नापी विभागले आफ्नो स्थापनाको ६० वर्ष पूरा गरेको अवसरमा मनाउन लागेको हिरक महोत्सवको अवसरमा नापी विभागमा कार्यरत सम्पूर्ण कर्मचारीहरुलाई हार्दिक बधाई तथा शुभकामना व्यक्त गर्न चाहन्छु । साथै नापी विभागले प्रकाशन रुपमा Nepalese Journal on Geoinformatics बार्षिक जर्नल प्रकाशन गर्न लागेको जानकारी पाउँदा अत्यन्तै खुशी लागेको छ । उक्त जर्नलको सोह्रौं अंकको लोकार्पण गर्ने अवसर मलाई प्रदान गरेकोमा नापी विभाग परिवारप्रति हार्दिक धन्यवाद व्यक्त गर्दै आगामि वर्षहरुमा समेत यस प्रकाशनले निरन्तरता प्राप्त गर्न सकोस् भन्ने शुभकामना व्यक्त गर्दछु ।

डा. गोपाल दहित
मन्त्री
भूमिसुधार तथा व्यवस्था

नेपाल सरकार

मा.यशोदा कुमारी लामा

राज्यमन्त्री

भूमिसुधार तथा व्यवस्था मन्त्रालय

फोन नं. : ४२००६३१
फ्याक्स नं. : ४२११६४५

निजी सचिवालय

सिंहदरवार, काठमाडौं ।

प.सं. : ०७३/७४
च.नं. :

मिति :- २०७४/०२/०७

विषय :- शुभकामना ।

वि.सं. २०१४ सालमा स्थापना भएको नापी विभागले आफ्नो स्थापनाको ६० वर्ष पार गर्दा नापनक्शाको क्षेत्रमा महत्वपूर्ण उपलब्धी हासिल गर्दै आएको छ । एकसरो रुपमा देशको सम्पूर्ण क्षेत्रको कित्तानापीको काम समाप्त गरिसकेको छ भने पुनः नापीको शुरुवात गरिसकेको छ । यस्तै देशको स्थलरूप आधार नक्शाको प्रकाशन र डिजिटल डाटाबेसको निर्माणलाइ नापी विभागको महत्वपूर्ण उपलब्धीको रुपमा लिन सकिन्छ । यसका साथै समय समयमा प्रकाशनमा ल्याईएका प्रशासकीय नक्शा तथा अन्य विषयगत नक्शाको महत्वलाई पनि कम आँकलन गर्न मिल्दैन ।

समयको लामो अन्तरालमा जमिनमा स्थापना भएका विकास निर्माणका संरचना, जग्गाको खण्डिकरण, भूउपयोगितामा परिवर्तन आदि समेतका कुराहरुलाई समावेश गरी विकास आयोजनाको आवश्यकतालाई पुरा गर्ने उद्देश्यले आधुनिक र वैज्ञानिक भूमि लगत तयार गर्न नापनक्शाको कार्य दोहोराउँदै जानुपर्ने हुन्छ । बढ्दो जनघनत्व र शहरीकरणले गर्दा जग्गाको मूल्य र महत्व परिवर्तन भईसकेको हुनाले जग्गाको नापनक्शा उपयुक्त आधुनिक प्रविधि अपनाई शुद्धताका साथ गर्नु नितान्त आवश्यक देखिएको छ ।

स्थापनाकाल देखि आजको अवस्था सम्म आइपुग्दा प्रविधि रुपान्तरण, पेशागत विकास तथा नापनक्साको क्षेत्रमा भएको विकासका दृष्टिकोणले नापी विभागले महत्वपूर्ण प्रगति हासिल गरेको मान्न सकिन्छ । तथापि एक्काइसौं शताब्दीको वर्तमान परिवेशमा सूचना तथा संचार सम्बद्ध एवम् नापनक्शा सम्बद्ध प्रविधिको क्षेत्रमा भैरहेको द्रुततर विकासले पारेको प्रभाव र नापनक्शा सम्बन्धी सेवासुविधाहरु सरल, सहज, छिटो छरितो, गुणस्तरीय एवम् किफायति तवरवाट प्राप्त गर्ने सेवाग्राहीहरुको चाहनालाई परिपूर्ति गर्न नापी विभागलाई एक सक्षम र सबल संगठनको रुपमा विकास, विस्तार र परिस्कृत बनाउंदै लैजानुपर्ने आवश्यकता छ ।

अन्तमा नापी विभागले बार्षिकरुपमा प्रकाशन गर्दै आइरहेको Nepalese Journal on Geoinformatics को सोह्रौं अंकमा शुभकामना व्यक्त गर्न पाउदा ज्यादै खुशी लागेको छ । जर्नल प्रकाशनमा योगदान पुरयाउनु हुने सबैमा हार्दिक धन्यवाद व्यक्त गर्न चाहन्छु । नापी विभागले आफनो स्थापनाको ६० बर्ष पार गरी मनाउन लागेको हिरक महोत्सवको अवसरमा नापी विभागका सम्पूर्ण कर्मचारीहरुलाई हार्दिक बधाई तथा शुभकामना व्यक्त गर्दै आगामी दिनमा नापी विभागको थप प्रगतिको कामना गर्दछु ।

यशोदा कुमारी लामा
राज्यमन्त्री
भुमिसुधार तथा व्यवस्था

Government of Nepal

Ministry of Land Reform & Management

(.................................. Section)

Singh Durbar, Kathmandu

Ref. No. ....

Date: ....

Sub:-

Message from the Secretary

I would like to congratulate Survey Department and its entire staff on the 60th Anniversary of its establishment, and express happiness on its untiring services to the nation in the field of surveying, mapping and other geospatial activities. I was overwhelmed with pleasure, when I came to learn that the Department annually publishes a journal named "Nepalese Journal on Geoinformatics" and its sixteenth edition is to get released. I feel honored to express my warm wishes in this edition of the journal.

Surveying and mapping activities being undertaken by the Department in the field of surveying, mapping and geospatial sector are much appreciable despite the technological hindrances and geographical diverseness of the country. Establishment of national geodetic control network, completion of cadastral survey, and production of topographical base map series of the whole country are the remarkable landmarks of the department. I remember the department's immediate response to the devastating Gorkha earthquake of 2072 B.S. by making required geospatial data freely available, carrying out deformation study to see the impacts of earthquake on geodetic control network, and making rehabilitations of geodetic control network and other efforts as needed at the time. I do believe that the Department will stand competently at the time of urgent need of such kind in the future as well.

I have an impression that the Department is striving to move ahead along with the advancement of technology to meet the need of the society. There is a need of ensuring the availability of the geospatial data of users' need and hard work is required to improve the system of service delivery from the district level offices. The Department also has to make necessary efforts to improve the level of trust from the general public. I am confident that the current management of the Department is fully aware of the things need to do for the better future and is to move ahead accordingly. In capacity of the secretary of its parental Ministry, I do assure the fullest support from the ministry to its every endeavor ahead.

In the occasion of diamond jubilee celebration of the department, I would like to convey my regards to all the enthusiastic, energetic and untiring hands who played key role in the development of department till now and I hope to see much more development in the coming days too.

Lastly, I wish to appreciate the efforts of Advisory Council and Editorial Board of this Journal to bring out with quality articles and information. I believe, this Journal will be successful to disseminate what it was meant for and wish for its long lasting continuity in the years ahead. Once again, my heartiest congratulations to the Survey Department and entire staff for the 60 years of continuous service to the nation and best wishes for the future.

Thank you.

Krishna Prasad Devkota
Secretary
Ministry of Land Reform and Management

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FOREWORDS

It gives me immense pleasure to present the Sixteenth issue of the "Nepalese Journal on Geoinformatics" on the Sixtieth Anniversary of Survey Department, the National Mapping Organization of Nepal. Let me take this opportunity to congratulate entire staff of the Department for their hard work. I would also like to extend sincere appreciation and due respect to all the former colleagues of the Department who have completed their service, for their invaluable and lifetime contribution in the past sixty years in bringing the department to this level.

The Department was established with the objective of carrying out cadastral survey for preparing the land records (cadaster) including the first registration of land property throughout the country. In the first few years of its establishment, the Department carried out cadastral surveys in some part of Kathmandu Valley and terai region but none of the records were used. Promulgation of Land (Surveying and Mapping) Act in 2019 B.S.[1] was the first legal instrument that laid foundation for cadastral surveys. The importance of systematic cadastral survey was only realized after the implementation of land reform program in 2021 B.S. This was because area based land records were essential to implement the issue of land ceiling, as one of the main objectives of the then land reform program was to impose land ceilings on land holding. The systematic cadastral survey commenced soon after the implementation of land reform program attained nationwide coverage in 2055 B,S,, leaving few village blocks and areas having political boundary disputes.

In order to strengthen the capacity of its technical staff, the Department established Survey Training Center in 2025 B.S, currently known as Land Management Training Center, which attained a departmental status in 2057 B.S. The center has been conducting various trainings in order to build capacity of the human resources available to us. Additionally, it

1 B.S.: Bikram Sambat; 56 years 8 months and 16 days ahead of A.D.

has also been running academic courses in association with Kathmandu University.

Over the years, the department has been making efforts in incremental basis to expand its sphere of activities and to improve the quality of services it provides. Establishment of Geodetic Survey Division in 2028 B.S. was an important footstep in this line. The Division carried out geodetic survey and astronomical observation. Nationwide network of horizontal control points, levelling network, gravity survey, among others are the major achievements to the date.

Establishment of Topographical Survey Division in 2030 B.S. was the other major footstep in extending the scope of the Department. Nationwide coverage of topographic map series, production of various kinds of administrative, land resources and thematic maps are the major achievements to the date. At the same time, the Division is actively involved in the technical activities related to international boundaries.

In order to enhance the efficiency and effectiveness of the cadastral survey, the Department established Cadastral Survey Division in 2039 B.S. and afterwards cadastral survey is being carried out under the supervision of this Division.

With the growing application of geospatial data, in recent years, various organizations are producing maps and geospatial data of their need. In this context, it is essential to ensure non duplication of government resources and efforts for the similar kind of geo-products, and also there is a need to develop norms and standards for the same. In this context, the Department has established National Geographic Information Infrastructure Division very recently, in 2073 B.S. This Division aims to coordinate the activities related to national spatial data infrastructure. It will soon bring a modality for data sharing among the public and private organization, develop norms and standards for geospatial data production, formulate geospatial data policy, launch clearinghouse and publish metadata of different geo-products produced from partner organizations, among others. Before the establishment of this division, related services were provided through then National Geographic Information Infrastructure Project since 2059 B.S. Digitalization of the topographic base map series, production of orthophoto maps of urban areas, production of generalized data of smaller scale from the topographic base data, and production of Population and Socio Economic Atlas based on the national census of 2058 and 2068 are some of the major achievements of the project. These all products are available for the users.

The Department is constantly working on improving its service delivery and satisfying the geo-data users by promptly addressing their needs. Preparation of administrative boundary as per federal structure, reducing the price of topographic data, offering free of charge data (administrative boundary layer and data of the resolution 1:1,000,000 mapping scale) are some of the recent efforts in this line. The Department has some dream projects planned for the days to come. Measurement of the height of the Mt. Everest, establishment of Continuously Operating Reference Stations (CORS) throughout the country, updating of topographic map series, developing high resolution Digital Terrain Model (DTM), developing online system of service delivery, and modernizing cadastral surveying practices are some of them. As an immediate step towards materializing these projects, the Department has begun its efforts to explore the necessary funding and other technical assistance.

The Department also has a role in regularizing the surveying and mapping activities in the country, as provisioned in the Land (Surveying and Mapping) Act, 2019. According to the act, all the maps and geographic information produced by different organizations should be based on the specification approved or issued by the Department. Permission from the Department is mandatory for carrying out the surveying and mapping activities in the country by any organization other than the Department. Additionally, the Department issues licenses to the Survey Professionals in the country. Efforts are underway to amend the legal provisions to issue licenses of different categories. The Department, being the leading organization in the field of surveying and mapping, is also constantly working on the professional development in the country. Affiliation with various international professional organizations has given international recognition to the Department.

On the special occasion of the sixtieth anniversary, I would like to acknowledge the contributions of all the current and former staff to bring the Department to this level. Without their hard work, strong determination and wonderful contributions, I would not have been able to boast about our achievements so far. Let me use this proud moment to extend special respect to the former head of the department: Colonel Mr. Tilak Bahadur Rayamajhi, Mr. Netra Bahadur Thapa, Major Mr. Kulbir Singh, S.P. Mr. Tek Bahadur Rayamajhi, Mr. J.R.G Harrop, Mr. Arjun Bahadur Basnet, Mr. Bekhalal Shrestha, Mr. Buddhi Narayan Shrestha, Mr. Ram Naresh Singh, Mr. Punya Prasad Oli, Mr. Narayan Bhattarai, Mr. Baburam Acharya, Mr. Toya Nath Baral, Mr. Raja Ram Chhatkuli, Mr. Rabin Kaji Sharma, Mr.Krishna Raj B.C., Mr. Nagendra Jha, Mr. Madhusudan Adhikari for their dynamic leadership over the past sixty years. I do assure that I will follow the footprints laid out by my predecessors and work harder to bring the Department even at higher level.

Lastly, let me express my heartiest appreciation to all the fellow colleagues, the members of Advisory Council, and entire team of the Editorial Board for their invaluable contribution to make the publication of this issue possible. Special thanks are due to Deputy Director General Mr. Suresh Man Shrestha, the Editor-in-Chief, and Chief Survey Officer Mr. Ram Kumar Sapkota, member of the Editorial Board, for their tireless efforts in bringing this issue in the stipulated time. More importantly, I would like to 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. Please, consider this issue as a souvenir on the sixtieth anniversary.

Enjoy reading!!

Thank You!!

Jesth 14, 2074 (May 28, 2017)
Kathmandu, Nepal

Ganesh Prasad Bhatta
Director General,
Surevy Department

MESSAGES FROM FORMER DIRECTOR GENERALS

I am glad that Survey Department is going to celebrate its Diamond Jubilee Celebration. Survey Department, as the central organization of Nepal Government for Surveying, Mapping and Geo-informatics activities, is marching ahead for the last sixty years starting initially from the Chain Survey to the present days Satellite Survey. It has achieved so many tangible results that mapping activities are expanding day by day in Nepal. I wish it could travel much more ahead in the days to come. In connection to the modern days activities, it will expand its digital dimension to meet the requirements of the reliable and accurate digital maps and data to be used for the purpose of economic development of Nepal, especially for hydro-power generation, construction of roads and irrigation channels, rural development and formulation of smart cities etc. As everybody knows, all the related activities could not be performed only by the government organizations to meet the growing demand of the nation. In this context, I believe Survey Department will groom the private sector surveying mapping agencies and professionals which will help to meet the need of maps and charts of the nation for overall development purposes.

It is my great honour to express best wishes to the Survey Department for making the Diamond Jubilee Celebration successful. May the department flourish with the new and energetic leadership to provide mapping services on time to the nation. I wish a very successful commemoration of the event of the department.

Buddhi Narayan Shrestha (2044-2049)
Former Director General, Survey Department
Winner of Madan Puraskar

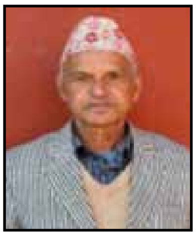
It is my great pleasure to make feeling on the Sixtieth anniversary of Survey Department. As long as the status of Nepal, it's matter of course and satisfaction, Survey Department is much more advancing towards Geomagnetic and conversional digital technology.

So, I take this opportunity and would like to congratulate to Director General and his personnel for their achievements and sustainability of Survey Department.

Thanks!!!

Ram Naresh Singh (2049-2051)
Former Director General, Survey Department

MESSAGES FROM FORMER DIRECTOR GENERALS



Brown woolen clad Indian plane tabler in hills and survey signals in tarai are my memories of childhood. As a consultant surveyor, DGPS survey, LiDAR survey or total station survey of small areas, surveying in cliff, cross section survey etc are normal surveying practice now. Surveying and Mapping is the foundation and basic infrastructure of national development and nation building. It includes astronomy and geodetic survey, cadastral survey and land administration, topographical and land resources survey and mapping. Survey Department has significant contribution in generation of topographical map series, resource maps, Geodetic Network, Nationwide Cadastral Coverage and NSDI Initiatives. However, various revolutions, and earthquakes and crustal dynamic disturbed our past development efforts of surveying and mapping and present politicians have less priority on it. Meanwhile Constitution of Nepal devolves the cadastral survey in Municipal level.

I wish young surveyors who are educated and diligent will contribute new development of survey technology and assist in expediting the sustainable national development enhancing the high morality of the geomatic profession.

Punya Prasad Oli (2052-2054)
Former Director General, Survey Department

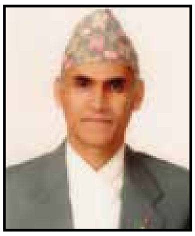
I am grateful to extend my best wishes to Survey Department and the staff on its Diamond Jubilee. This is the only National Mapping Agency of Nepal that carries out the official surveying providing the most accurate and up-to-date geographic data, relied on by government, business and individuals. I feel proud to be the Director General of the Department for six years as I have associated with the Department for 30 years in my professional career. During the journey of sixty years, the Department has evolved as the leading organization of surveying, mapping and geospatial data production in the country. Nationwide coverage of cadastral survey, topographic map series, geodetic control network, land resources maps, and various kinds of other mapping products are some of the milestone achievements of the department. These products and services offered by the department are significantly contributing in overall development and governance of the country.

On the celebration of sixtieth anniversary, I would like to unite all concerned to promote Geomatics as a synergism of various disciplines so that it becomes a part of the information management and reliable decision making process. Lastly, I express happiness over Department's achievements to the date and wish all the success in its future endeavor.

Happy Anniversary!!

Babu Ram Acharya (2055-2061)
Former Director General of Survey Department and
Ex Secretary of the Government of Nepal

MESSAGES FROM FORMER DIRECTOR GENERALS



The sixty years of Survey Department has been a period of great upheavals in the science and technology of surveying and mapping. It was even a greater pleasure to personally witness these upheavals as an insider during the last 42 years of career in the profession. I, as a survey and mapping professional, feel proud on this diamond jubilee celebration that the evolution of geospatial science and a growth of survey department as a cadastral survey office to a national mapping agency is great achievement during the sixty years of its birth. Survey department is still in transition phase from conventional mapping to modern mapping techniques. There is a mismatch between the technology, people's demand, capacity and state priorities.

I wish survey department will try to make best possible balance during the year of Diamond jubilee celebration.

Toya Nath Baral (2061-2064)
Former Director General, Survey Department

Congratulations to all the staff of Survey Department for celebration of its Diamond Jubilee. It is my great pleasure to be a part of sixtieth year programme of the department. In the journey of sixty years of department, it has achieved so many tangible results. Analyzing the previous achievements, the department should felt pride that it has laid down some bricks in the process of nation building. As our trend is such that we do not highlight the positive results rather we criticize about the negative aspects only. So, it is the right time to spread message regarding the achievements so far made by the department. Recently, the leadership of the department is in the hand of young generation surveyor. Therefore, there is expectation that the department will move ahead with new dimension and new approach to support development activities of Nepal.

Finally, I believe that the department will launch new programmes which will benefits to the staff, stakeholders and the country. I also wish for the success of the tenure of Mr. Ganesh Prasad Bhatta, the incumbent Director General of Survey Department.

Rabin Kaji Sharma(2065-2066)
Former Director General, Survey Department

MESSAGES FROM FORMER DIRECTOR GENERALS

It gives me immense pleasure to greet my colleagues at the Survey Department and the Surveying and Mapping community in Nepal on the Diamond Jubilee celebrations of Survey Department this year. Having joined Survey Department when it was still young and full of enthusiasm and witnessed through its growth to maturity and wisdom it is such a beautiful feeling to share. I did share a review how Survey Department developed from a cadastral survey office to a National Mapping Organization and to a hub of National Spatial Data Infrastructure in its Golden Jubilee ten years back. I have seen more development in the ten years then after. Survey Department has made its strong technical and academic presence in the country as well in the international arena. With the state restructuring envisaged in the Constitution of Nepal, Survey Department is in a state of challenge as well an opportunity to restructure itself better.

With the experience and collective wisdom the Department has garnered, I earnestly hope that the current leadership and colleagues at Survey Department would be successful in taking forward the Department and the profession to greater heights. My best wishes and warmest greetings on the occasion of the Diamond Jubilee!!

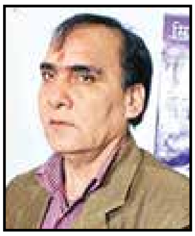
Raja Ram Chhatkuli (2066-2068)
Former Director General, Survey Department

It is indeed a matter of great joy and pride for me that Survey Department, where I spent almost all of my professional life, is celebrating its Sixtieth i.e. Diamond Jubilee Anniversary. I am attached with this institution professionally and emotionally as well. Casting a glance over the years that have gone by, I cannot but thank my seniors for their devotion and contribution to make the Institution as we have it today. I honestly would like to thank all those visionaries who dreamt, the pioneers who expanded the vision with launching new projects, all those who worked so hard all through the past sixty years for the development of Survey Department and the future leaders and members who will continue to nurture and develop the Department into a vibrant future. When I look backwards, I very much cheerfully and respectfully recall all my senior and contemporary colleagues who excellently contributed for the foundation of Survey Department in building the basic infrastructure in the field of surveying, mapping and geo-spatial information. With this basic geo-spatial infrastructure and evolving new generation of geomatics professionals, I can confidently say that the Department will continue to maintain its excellence in its services to serve our nation as excellently as in those past days.

I extend my congratulations, felicitations and good wishes to Survey Department and all survey and geo-informatics professionals on this milestone of the history of the Department - Diamond Jubilee Celebration.

Krishna Raj B.C (2068-2069, 2072-2073)
Former Director General, Survey Department
Joint Secretary, Government of Nepal

MESSAGES FROM FORMER DIRECTOR GENERALS



Its my immense pleasure to express some words in the sixteenth issue of Nepalese Journal on Geoinformatics on the special occasion of 60th anniversary -Diamond Jubilee of Survey Department. Survey Department, being the National Mapping Organization of the country, has been serving in the nation building with the generation of wide spectrum of Geo-information Products. Those products undoubtedly play a prominent role in the planning, policy making and infrastructure development of the country. I would like to congratulate all the Geo-spatial Professionals on this diamond Jubilee of Survey Department and i believe department will formulate new plans and programs for generation of large scale databases and other user demand spatial data in the days to come.

Finally i wish for the grand success of the young and dynamic leadership of the department.

Nagendra Jha (2069-2071)
Former Director General, Survey Department

Happy Birthday to Survey Department and a big congratulation on 60 years of contribution in the field of surveying and mapping. It is indeed a matter of great joy and pride that the department has achieved several milestones in surveying and mapping within this time period. Every milestone in the history of any institution is an occasion for looking back and looking forward. Looking back with gratitude for all that has been achieved and looking forward to accomplishment of challenging tasks ahead with the use of advance tools and techniques in Geo-spatial technologies.

On this auspicious occasion, I wish the department continues to get better with time and I look forward to the future with zeal and commitment.

Madhusudan Adhikari (2071-2072)
Former Director General, Survey Department
Secretary, Government of Nepal

Roadmap for Re-establishment of Geospatial Relationship of the Control Points and Features in Nepal due to Gorkha Earthquake 2015

Rabin K. Sharma

KEYWORDS

Geospatial Relationship, Control Points, Topographical Features, Earthquake, Change Detection

ABSTRACT

Occurrence of earthquake in Nepal is obvious as it lies in earthquake prone zone. Amount of destruction caused by an earthquake will depend upon the magnitude of the earthquake and the strength of the infrastructures. On 25th April 2015, Nepalese people experienced a huge earthquake of magnitude 7.6 in Richter scale. The earthquake destroyed and damaged a noticeable amount of human lives and infrastructures due to which spatial relationship between points of the affected area were disturbed. The disturbance of the relationship was assessed by some of the case studies in the area. Therefore, it is necessary to re-establish the spatial relationship in the existing database for making use in reconstruction phase of the earthquake and for designing and implementation of development projects in future. The suitable methods for performing this activity are adopting modern technologies such as Global Positioning System (GPS), Remote Sensing method, and modern field survey method using Total Station Theodolite. Therefore, a roadmap needs to be designed to retain spatial relationship with respect to the adjusted coordinate of control points and update the database of the country.

1. Introduction

Since, Nepal lies in earthquake prone zone and ranked 11th in the list of earthquake prone countries of the world, consequently, from time to time, it is witnessing earthquakes of magnitude ranging from less than 4 to more than 8 Richter scale. Earthquake caused in Nepal is due to pushing the Tibetan plate of Eurasian plate upward by the Indian plate due to which every year, the mass of land moved northward by approximately 4 cm. Based on this truth, Nepalese people experienced a huge earthquake of local magnitude 7.6 in Richter scale on 25th April 2015, Saturday at 11.56 AM, whose hypocenter was about 15 km deep below the surface of the earth and its epicenter was in Barpak village of Gorkha district. The earthquake was recognized as the Gorkha earthquake 2015. The earthquake destroyed large number of infrastructures including national heritage monuments, settlements *et cetera* and there was a loss of large number of lives including human, animals and birds. Obviously, the tremor displaced the location of control points which disturbed the spatial relationship between the points with respect to its original positions. Therefore, a roadmap is designed for the re-establishment of spatial relationship of the points and features not only within the area affected by the earthquake but also that of entire Nepal. The reason is that the location of origin of the spatial data of entire Nepal which is at Nagarkot, was disturbed by the earthquake.

The roadmap navigates for assessment of damages and analyzes the changes in the location and determines a technique to re-establish the spatial relationship between the points and features. Changes in the location of the control points can be assessed by Global Positioning System (GPS) method and that of the features can be assessed and updated by new remote sensing technology using Drone and traditional field survey method using Total Station Theodolite. The results will guide in the right direction for reconstruction phase of the earthquake and for designing and implementation of development projects in future.

2. Damage caused by the Earthquake

The magnitude 7.6 in Richter scale of Gorkha Earthquake 2015 was strong enough for destruction of weak infrastructures of the affected areas. Accordingly, a large number of infrastructures like houses, buildings, monuments, temples, palaces, schools, official buildings, *et cetera* and other infrastructures including roads, irrigation canals, hydro power stations, electricity poles, *et cetera* were damaged and destroyed. Destruction of these infrastructures took life and injured large numbers of human and livestock. According to the theory of Omori, every bigger earthquake will be followed by the smaller tremors termed as aftershocks. So, after the major earthquake on 25th April 2015, a series of aftershocks were experienced among which two bigger aftershocks: the first one on 26th April and second on 12th May 2015 measuring 6.9 and 6.8 Richter scale respectively were experienced and further destroyed the structures and took lives of more human and livestock. In total, 8,835 people were killed and more than 22,000 were injured and 133 cultural heritages structures and 5,91,648 houses were completely destroyed as well as 608 heritages structures and 2,76,395 houses were partially damaged. In the context of livestock, around 56,000 of animals and 5,00,000 birds were killed due to the earthquake.

Photo 1: Clockwise from top left Destroyed building, Monument (Dharahara), School (Durbar High School) and Basantapur Durbar Square

3. Damage caused by other natural phenomena

After occurrence of the Earthquake, additional damages were made due to other natural phenomenon such as landslides, debris flow, avalanches, *et cetera*. Due to shaking of ground by the earthquake, the land especially in the mountainous region and Himalayan region became very unstable and loosen its grip, therefore, at number of places, there were landslides, debris flowing down the slopes containing soil and rocks and avalanches depend upon the nature of the ground. These natural phenomenons damaged and destroyed large number of settlement areas. The consequence of disasters was loss of lives including human and animals. For example, in Langtang valley, a huge avalanche came which swept away the total settlement of the area and around 350 people were missing. Similarly, immediately after the major earthquake on 25th April 2015, there was a huge avalanche at Sagarmatha base camp. The avalanche swept away mountain climbers who were on the way to atop the Sagarmatha. Later, it was declared that 10 Nepalese porters including some guides and 5 foreign mountain climbers were dead and 61 were injured by the avalanche.

Photo 2: Clockwise from top left Rock fall at Bhotang Village of Kavre, Landslide at Arniko highway and Avalanche at Sagarmatha base camp

4. Change Detection in Topography

Changes in topographical features at the areas affected by the earthquake have to be analyzed in two steps namely control networks used for the preparation of maps and the features that were shown in the existing topographical maps.

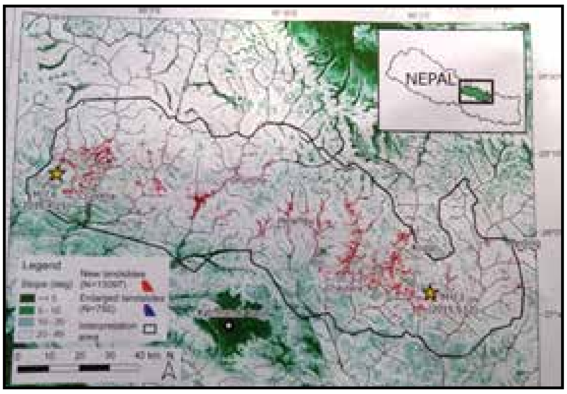
In case of detecting the changes in the control networks, it can be carried out either by determination of coordinate of the points by astronomical survey or by the system of ITRF 2008. The former method is a traditional method which is almost not in use now-a-days due to availability of artificial satellite based system such as Global Positioning System, GPS or Global Navigation Satellite System, GNSS.

Immediately after the occurrence of the earthquake, Survey Department took initiations to detect changes at the control points surrounding Kathmandu and its peripherals. According to the press release 2015 of Survey Department about the shift in the ground due to the earthquake, five control points located at Nagarkot of Bhaktapur/Kavre district, Phulchowki Danda and Bungamati Lakhe Danda of Lalitpur district, Swayambhu of Kathmandu district and Kumari Danda of Nuwakot district were chosen to take the measurements. GPS measurements were taken continuously for 24 hours in those points. Data processing of the measurements and the computation of new coordinate of these points were based on the data collected continuously for 24 hours at the points of 13 international cities namely Hong Kong, Lhasa, Banglore, Hyderabad, Kajakasthan, Oman, Mongolia, *et cetera*. Data processing of the coordinates before and after the earthquake was based on the system of Realization of Service in International Terrestrial Reference Frame (ITRF) 2008. As per the results, it showed that Kathmandu and its peripherals moved about 1.8 metres south-west and the earth surface were raised about 0.8 metre.

Since it was confirmed that there is changes in the coordinate of points at those five points, it is obvious that there could be changes in the coordinate of the points located at earthquake affected areas and consequently it is necessary to detect the amount of changes in the coordinate of these points as well.

Secondly, due to destruction and damages in the settlements, infrastructures at heritage sites, other infrastructures and the area of landslides caused by the main earthquake and aftershocks, it is obvious that the existing maps will not match the ground situation. Therefore, it is necessary to detect the amount of changes in the areas. One of the effective methods to detect the changes is by using remote sensing techniques. In case of small area, unmanned aerial vehicle (UAV) also called Drone is a very useful tool for analyzing the amount of changes. The method was used in Sankhu area of Kathmandu by ICIMOD immediately after the occurrence of the earthquake of 2015. Since the affected area was too big, it is recommend comparing the recent satellite image of the area with the archive image before the earthquake for finding out the amount of changes in the topographical features.

Recently, the Kaken Japan Research team for hazard mapping of earthquake-induced landslides initiated the three-year (2016-18) research project on the development of landslide hazard mapping technology. The project area covered 7.8 x 10^3 square kilometers of hills extending from Barpak, Gorkha to Chautara, Sindhupalchowk excluding the snow and glacier covered areas. The objective of the study was to analyse the landslides occurred due to the Gorkha Earthquake 2015 and the aftershocks and to contribute in reconstruction of severely damaged areas. The study was carried out by the members of J-Rapid Research Project of Japan Science and Technology Agency and the Japan Landslide Society for Satellite Data Utilization Project initiated by Ministry of Land, Infrastructure, Transport and Tourism (MLITT) of Japan. The study team prepared a landslide inventory as a first step for landslide assessment and mitigation of future landslide disaster in the affected areas.



Map 1: Landslides location of the Study Area

The findings of the study was presented by the team in a mini-workshop entitled "**the 2016 Japan-Nepal Mini-workshop on the 2015 Gorkha Earthquake-induced landslides"** which was jointly organized by the Kaken Japan Research team for hazard mapping of earthquake-induced landslides and Nepal Landslide Society at Kathmandu on 26th November 2016. The findings were focused on issues from a geological-geomorphological point of view. The team detected 13,087 newly formed landslides and 750 enlarged old landslides within the study area due to the main shock on 25th April and aftershocks. The study also showed that the areas could be susceptible future landslides by rain and earthquakes. The finding was based on the visual interpretation of optical satellite images provided by archive of Digital Globe Co. Ltd, Google Earth, Japan Aerospace Exploration Agency (JAXA) and National Aeronautics and Space Administration (NASA).

5. Re-establish Geospatial Relationship

From the discussion in the above paragraphs, it is clear that control points have been moved and there are lots of changes in topographical features. Therefore it is necessary to re-establish the geospatial relationship between the features in the database and if necessary to update the existing maps. The process for re-establishment of geospatial relationship could be performed in the following phases:

1) Re-establish the first order control network

It is necessary to re-establish the existing first order network because it is already detected that the origin of the network situated at Nagarkot was displaced due the earthquake. Therefore, coordinate of rest of the first order points of the network will definitely affected. Re-establishment of the first order network can be done by making GPS measurements at all the 68 first order points of the network and compute the fresh coordinates of the points based on data processing using system of Realization of Service in ITRF 2008. Based on the new data, analyze the situation and prepare a report. This will guide how to proceed further for the lower order control orders.

2) Re-establish the lower order control network

As the lower order control networks are based on the first order control network, the coordinate of the points in those networks will also be affected in the values. In order to overcome this issue, GPS measurements at all the second and third order points to be done and then re-computation and adjustment of the coordinates of the measured points has to be performed.

3) Change detection in topographic features and update the database

After re-establishment of the control network, topographical database need to be updated. In first instance, change detection of topographic features is to be identified and marked by comparing existing maps with the recent satellite image data with appropriate resolution. Then, correct the database of topographical base maps considering newly computed coordinates of the control points.

In case of database of the area outside the earthquake affected area, first of all, assess the effect caused by the change in the coordinate of the control points. If the effect is not visible due to the resolution of the database, the database can remain as it is but if the effect is noticeable then the database has to re-model with respect to the new coordinate of the control points.

4) Monitor the progress of reconstruction and update the database and maps

The country is in the phase of reconstruction of the damaged and destructed settlements and infrastructures. Some of the settlements were constructed at new sites and design and pattern of the features were also different from those in the past. Therefore, it is necessary to update the existing database and the topographical base maps.

As per the plan of National Reconstruction Authority, the reconstruction phase will be completed by five years period. But observing the progress so far made, it seems, it will take more time than it is expected. Therefore, it is recommended to update the database by the method of continuous process.

In order to do this, teams should be deputed to monitor the reconstruction at heritage sites and newly constructed settlement areas. As soon as the reconstruction of the site or area is completed, the database can be updated by collection of data applying appropriate technology which could be either ground survey method using Total Station Theodolite or remote sensing method by flying Drones. One of the examples of completion of reconstruction site was houses of the Giranchaur integrated settlement for quake survivors, built by the **Dhurmus Suntali Foundation**, in Melamchi of Sindhupalchok district as shown in the photo 3. The newly built settlement was inaugurated, on Friday, October 28, 2016 by the Honourable President Bidya Devi Bhandari and handed over to the locals.

Photo 3: Houses of the Giranchaur integrated settlement for quake survivors, built by the Dhurmus Suntali Foundation, in Melamchi of Sindhupalchok district

Based on the amount of changes in topographical features in a map, a decision is to be taken to either wait for the further changes before printing the map or to print immediately after the data is updated. In general, if there are changes of about forty percent of the features of a map, the revised data need to be printed immediately; otherwise, the map could be outdated and could not be used effectively.

6. Conclusion

Gorkha Earthquake 2015 not only damaged physical infrastructures and human and livestock but also affected the spatial relationship between the control points and topographical features. A few case studies for detection of changes are also referred in which GPS and Remote Sensing technology was adopted. In order to re-establish spatial relationship of the control points and the topographical features, modern technology using GPS and field survey method using Total Station Theodolite or Drone is recommended. The newly adjusted control points and updated spatial data are necessary for the reconstruction phase of National Reconstruction Authority and for designing and implementation of development projects in future. Therefore, the concerned authority should design a short term and long term plan for the re-establishment of spatial relationship of the control points and the features.

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Published Papers/Articles	:	Two books and more than seventy articles published in national and international proceedings and magazines
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Price of Maps

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

Price of co-ordinates of Control Points

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

Concept in Determining the Height of Mount Everest (Sagarmatha)

Niraj Manandhar

KEYWORDS

Height determination, sea level, gravimetric geoid, Mount Everest

ABSTRACT

In this paper we describe the concepts in determining the height of the Mt. Everest and elucidate the method of height measured relative to sea level. The current height determination procedure is limited by the accuracy of the calculation of height of the sea, (less than +/- 2m) or its mathematical approximation the geoid. Although Nepal has been recognizing 8848m as the official height of the Everest, many climbing team and scientific explorations from different countries in different time have been conducted and achieved different numerical values of height of the Everest. The challenging issue is defining the elusive sea level with or without nearby shoreline. Through some recognized media it has been made public that the Government of Nepal have plan to ascertain the height of Mt. Everest and if it is so this would be the first attempt by Nepal government to determine the height on its own. Survey Department under the Ministry of Land Reform and Management is the authoritative organization to translate Government's decision into action. Depending on the nature of the work; in order to accomplish the measurement, the complete task is divided into five parts such as Precise leveling survey, Determination gravimetric geoid, Trigonometrical leveling, Global Positioning System (GPS) Survey and Data processing. Survey Department, lacks in enough resources and infrastructures for completing this project in the complex environment of the most rugged High Himalayas therefore some other potential International Scientific organization can be expected to join hands in the process of height determination.

Background:

Mount Everest, situated along the border of Nepal and China, has been regarded as the highest point on the earth. Mt. Everest lies in the collision zone along the boundary of Eurasian and Indian plates, As the impact of Earthquakes, regular crustal movement and melting of the snow through global warming the variation in the height of Everest has been one prime concern in community of geosciences.

During the Great Trigonometric Surveys around 1840 and 1850s started measuring the height in jumble of northern Himalayan peaks. The calculation started in 1850 and completed in 1855 for all Himalayan peaks. Long before the announcement of its height attempts were initiated to find the local name of Peak XV given during observation. Since the mountain lies deep inside the Nepalese territory and half in Tibet its local name cannot be ascertained. In 9 August

1856 the Peak was named Mount Everest in the recognition of special contribution of Colonel Sir George Everest, Surveyor General of the then British India of Great Triangulation Survey (GTS). A year latter it was changed to Mount Everest. The height was announced 29002 ft. Nearly for 50 years this became the official height.

Height determination by SOI in 1954:

The new height 29028 +/- 10 feet was reported by G.L. Gulatee in 1954. During this time series of measurements were made by survey of India specially to determine the height of the Mount Everest. Trigometrical leveling was conducted by sighting the mountain form series of points of the triangulation network extended for the height measurement within 40 miles from the summit. This highly reduced the refraction errors. Deflections of verticals were also measured in series of points from the plain area to northernmost points. The points considered for the observation were linked to the extensive leveling network of India. This made possible to estimate the sea level height of the Mt. Everest but the uncertainty in sea level remained the largest contribution to the error in the Gulatee's height determination.

Although it was not extensively known the preparation of the height of the Mt. Everest from northern side (China) commenced in 1966. The Chinese triangulation network and leveling network was extended to the Rongbuk Glacier during this year and the measurement published the ice summit height 8849.75m with and uncertainnity +/- 2m. The result very much resembled with the height measured by Washburn in the year 2000.

Height determination by Chinese expedition in 1975:

In 1975 Chinese expedition was set out for redetermination of the height of the Mt. Everest. This time vertical triangulation was undertaken towards a summit at a distance ranging from 8.5 km to 21.2 km. These measurements can be considered as the closest ever taken measurements from the summit anticipating the smallest refraction correction in the vertical angle observation. For meteorological measurement balloons were lunched close to the optical sight line to minimize the refraction error.

Gravity measurements were carried out at points throughout the region including the point less than 1.9 km from the summit. The height was ascertained 29029 ft with and uncertainty of +/- 1 ft. (8848.13 m +/- 0.35m). The height was very effectively identical to the height calculated by Survey of India (SOI) in 1954 by G.L. Gulatee (29028 +/- 10 ft). However the noted difference were only the uncertainties which is much smaller. For the very first time this measurement was tied up with the rock height of Mt. Everest. In the report of this 1975 expedition it was reported that the depth of the snow is 0.92 m. The thickness of the snow was probed only by pole so it is possible to speculated that penetration stopped after reaching the hard ice.

Height determination by Italian/ Chinese expedition in 1992:

The joint exploration of Italian/Chinese took place in 1992. During this exploration comprehensive new measurement with adopting the new technology was undertaken in determining the height of the Mount Everest. Its mission was organized by Ardito Desio together with Italian geodesist Giorgio Poretti. This was the first time GPS receivers were operated on the Summit. It was also the first time that laser distance and theodolite measurement were used simultaneously to sight target placed on the top of the summit from north and south of the mountain. Three points in the China side and three points in the Nepal side concurrently targeted the reflector combined with GPS antenna placed on the top. Deflection of verticals were also measured in several points. By using vertical triangulation method the leveling lines were extended close to the base of the mountain in order to complement Chinese leveling carried from north (Datum based on Yellow Sea).

One of the important achievement in this 1992 Italian/Chinese exploration was to determine refined gravimetric geoid from the Chinese side to better estimate the sea level height.

The ellipsoidal height obtained was 8823.51 +/- 0.05m. The geoid adjustment used in 1992 derived the new height of 29031.0 ft +/- 6 ft given adopted geoid – 82.5 ft. ie elevation (8848.65 m) and geoid undulation of -25.15 m.

Height determination by National Geographic expedition in 1999:

The expedition was organized by Brad Washburn in 1999 in cooperation with National Geographic Society. The expedition decided simply to measure the height of the ice summit and also because of the difficulty in obtaining detailed gravimetric and leveling data of the region along with its laboriousness in computing the regional gravimetric geoid it was decided to use Earth Gravity Model (EGM96) a global geoid in the process of height determination. The height ascertained after GPS measurement and using the global geoid EGM96 was 29034.52 +/- 6 ft ie (8849.72 +/- 2m).

The ellipsoidal height determined was 8820.98 +/- 0.05m. The geoid undulation computed using EGM96 was – 28.74m +/- 2m.

Relevance of New Height Determination:

The comparison of the 1992 and 1999 measurements of the height of the Mount Everest the difference in the ellipsoidal height shows that we have a decrease in elevation by 2.5 m in 7 years difference. This indicates that ice summit have decreased. In 1999 revised geoid correction -26.2m was published from the Chinese side. The difference is 1.06 m. The negative sign indicates that geoid is below WGS84 ellipsoid. Gulatee pointed out that the height varied because of the thickness of the snow and ice on the top of the summit. And in the course of learning from scientific article on determining the height of Mount Everest the problematic quantity has become geoidal height beneath the mountain. Therefore precise geoid determination can give the new estimate of height of the Mount Everest. This is the further improvement in the geodetic history. The thickness of ice is next impediment in the accurate height measurement. The mapping of the rock summit using radar profiling can solve this problem. The Gorkha earthquake moved the Kathmandu valley 1.8m in south west direction and rise of the ellipsoidal elevation about 1m. which the observation elucidated just after the earthquake occurred in April 2015. It is one of the strong region why new measurement is necessary.

Procedure for the height determination:

Different technologies and methodologies are in practice to determine the altitude of any point above MSL depending upon the availability of the instruments, human resources and affordability of the organization. This measurement, being associated with the world's highest peak, is the concern of the world's researchers, scientists, geographical communities, and general people as well. Hence Survey Department will try to adopt the highly accurate methodology and precise instruments to determine the height of the Mt. Everest so far available and affordable. Following activities will be carried out during the project period.

Phase I: Precise Leveling

Phase II: Refinement of Geoid

1. Gravity Measurement
2. GPS Observation in the Bench Mark (Leveling Point)

Phase III: GPS Observation at the existing Network and the Base Points

Phase IV: Observation to the Summit

1. Expedition to the Summit
2. Trigonometric Leveling
3. GPS Observation at the Summit and the Base Points
4. Observation for Snow Depth

Phase V: Meteorological Data Collection

Phase VI: Data Processing and Release of the Report

Phase I: Precise Leveling

Geodetic Survey Branch has already established a leveling profile along the major roads throughout the country by geometrical leveling (spirit leveling). But the branch has not worked in the area where the road is not metallic or motorable. As the project area is mountainous and all the roads in this region are not motorable, GSB has not established the leveling profile in this project area. Thus the precise leveling work should be started from Katari of Udayapur District, which is about 250 km from the base of Mt. Everest, the Kalaptthar, up to which the precise leveling will be carried out. The MSL height of the bench marks of the leveling network of the country is derived from the Fundamental Benchmark at Nagarkot which is connected to the MSL at Indian Ocean.

Phase II: Refinement of Geoid

Survey Department has already established the geoid which fits best with the ground surface of the country with the help of Technical University of Denmark (DTU) and International Association of Geodesy (IAG) by airborne gravity method. Due to the lack of sufficient surface gravity data, the accuracy of the geoid is not satisfactory in the Himalayan region to determine the altitude of Peaks. Thus surface gravity observation needs to be carried out in the project area to refine the existing geoid of Nepal and GPS observation will be carried out at bench marks after every 4 km in the leveling profile to assess the quality and accuracy of the refined geoid. After the computation of highly accurate geoid GPS technology can be used to determine the orthometric height (MSL height) of any place.

Phase III: GPS Observation at the existing Network and the Base Points

Before the advent of GPS technology, triangulation and traverse methods were used to determine the horizontal position of any point. In Nepal, triangulation method was used to establish the higher order control points for the horizontal positioning. Geodetic Network of first and second order control points was established in the hilly region of Nepal by triangulation method. A number of first and second order trigonometric points are located in the project area. So to connect the new surveyed points with the existing geodetic network, GPS observations will be carried out at some of the triangulation points, newly established control points for the horizontal position of the peak of Mt. Everest and other points.

Phase IV: Observation to the Summit

As the main goal of this project is to determine the altitude of the Mt. Everest, a number of observations will be carried out at the summit of Mt. Everest. It is not an easy task to climb the Mt. Everest frequently and stay at the summit for a longer time, so all the necessary observations will be carried out at the same time. The followings tasks will be carried out for the observation at the summit.

1. Expedition to the Summit

By this time it cannot be guaranteed that the adequate number of Nepalese surveyors can reach the summit of Mt. Everest. Therefore a team of Sherpa, professional climbers, possibly accompanied by Nepalese surveyors, will be prepared for setting up the instrument at the summit. Before the expedition to the Mt. Everest each members of the team will be trained for setting out the instruments and carrying out the necessary observations.

2. Trigonometric Levelling

Geometric leveling cannot be carried out up to the peak of Mt. Everest so trigonometric leveling method will be resorted at the peak from the control points around the base of the Mountain. The control points are so selected that the peak of the Mt. Everest is visible from all of those points. The signal for the trigonometric leveling will be erected by the Mount Everest expedition team.

3. GPS Observation at the Summit and the Base Points

After joining the newly established base control points, from which the observations to the summit are made, with the existing geodetic network GPS observation at the summit, the base control points, and some other selected points is carried out. After the refinement of geoid of Nepal, GPS can be used to compute the altitude of any point above MSL. Specially designed GPS receiver and other accessories are used for this purpose because the GPS instruments that GSB is currently using may not work in the high mountain. Also the GPS receiver will be designed in such a way that it can work as a target signal for the trigonometric levelling. These instruments are operated by trained expedition team.

4. Observation for Snow Depth

This kind of project is very costly and it is difficult to conduct such project repeatedly. Sometime it may be the matter of depth of snow because the snow cover is not always the same. Thus, grabbing this opportunity, the depth of snow at the top of the Mt. Everest is calculated with the help of specially designed RADAR instrument so that it could be possible to find the position of rock at the top.

Phase V: Meteorological Data Collection

The trigonometric leveling is carried out from the points which are about 80 km from the peak of the Mt. Everest. Thus this line of sight needs to be corrected with the help of atmospheric data. Thus the data of temperature, pressure, humidity etc. are collected along the line of sight during the observation period.

Phase VI: Data Processing and Release of the Report

All the surveyed data in the field are processed in the Survey Department, Nepal jointly by the Nepalese Surveyors and the technical experts from the collaborating agencies. All the newly established control points are joined with the existing network of the country. Vertical controls are based on the fundamental bench mark at Nagarkot and the horizontal controls are also based on the fundamental point at Nagarkot. Nepalese surveyors are trained for advanced processing techniques in-house or abroad collaborating agencies.

Challenges of the Project:

This project is an ambitious task to accomplish. Followings are the challenges during the implementation of the project.

1. Training to the Mountaineers

All the project area contains high mountains including Mt. Everest. The first challenge for Nepalese surveyors is to climb the Mt. Everest. First attempt will be to prepare the interested Nepalese surveyors to climb the Mt. Everest. If not, all the necessary tasks done at the summit of Mt. Everest is accomplished by the expert mountain climbers. But again the problem is that they are not acquainted with the survey techniques. Thus to train the mountaineers for handling the survey equipments is also the challenge of this project.

2. Managing Specific Instruments

Another challenge of this project is the survey equipments. The instruments used by GSB may not be appropriate in high Himalayas. Also for the summit, it requires specially designed instruments which occupies less space, can be used as a multipurpose such as GPS receiver, target for the trigonometric levelling etc and can be handled in very low temperature and pressure. Managing such kind of equipments is not, at this moment, an easy task for GSB.

Conclusion:

Also, as almost all the project area is mountainous, it is not convenient to travel such area frequently. So the necessary observations should be accomplished as soon as possible. For this purpose adequate numbers of survey equipments are required and the existing number of instruments that GSB currently have may not be sufficient for this project. Further, most of the instruments are analogue (especially for levelling) which is time consuming and demand high costs. So, managing efficient instruments is also the challenge of this project.

Use of advanced instruments and processing of the field data with high accuracy requires trained and expert manpower. Thus the Nepalese survey team involved in this project needs some training for handling the new instruments and processing the surveyed data.

Another most important challenge of this project is the international recognition of the result obtained from this project. This project is of great interest to all the researchers, scientists, geographers and other communities, so the equipments used and the methodology adopted in this project should be worldwide accepted and accurate. Thus we should not forget these facts during the implementation of this project.

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Integrated Approach of Risk Sensitive Land Use Zoning: A Case Study of Banepa Municipality

Lekha Nath Dahal

KEYWORDS

Risk Land use zoning, Multi-criteria analysis, GIS, Integrated approach,

ABSTRACT

Land is a basic source of livelihood for most of the Nepalese. Land fragmentation, improper use of land, rapid urbanization and lack of formal plan has created serious problems mostly in urban areas including study area. So proper Land use planning is necessary for getting optimum benefit from land resource in sustainable way. Risk factor has to be considered in land use planning process. Since Expert driven (Top down) approach has not gained satisfactory achievement, Participatory (Bottom up) approach has emerged to ensure public participation in land use planning. Participatory approach has also some limitations.

So the study seeks to implement integration of both expert driven and participatory approach to identify low risk land use zones in study area. Study targeted to identify risk areas from participatory approach before land use zoning. The case study was carried out in Banepa Municipality. The research was completed by following integrated approach using both primary and secondary data. Both desk study and case study method has been applied. Questionnaire, focus group discussion, interview techniques has been used in the study for collecting primary information where as high resolution satellite imagery, municipal GIS database, Census data etc. were used as secondary data. GIS application was used for Multi-criteria Analysis (MCA). To determine corresponding weight for each factor for land use zoning AHP (Analytical Hierarchy process) has been implemented.

Different risk zones in the study area are identified using participatory approach. Final risk free land use zoning map of the study area is prepared. Study concludes that integrated approach is useful for effective land use zoning and risk should also be considered in this process. Different kinds of risk like landslide, flooding, industrial hazard etc. are dominant in the study area. Legal, organizational and technical improvement is required for effective implementation of land use zoning .

1.Introduction

Land is basic resource of livelihood for more than 75 % of Nepalese. Most of the parcels are fragmented due to population growth and other causes. The issues of slums, land less, tenants etc. are also increasing. Nepal has a severe threat of facing problem of food insecurity and hunger in future. Similarly, unplanned settlement, detrimental habitat, rapid Population growth, lack of urban infrastructure, natural disaster, and environmental degradation are other serious challenges to be faced in near future. Mostly population growth takes places in urban areas dramatically (Schmandt, 1961).

According to Basyal and Khanal (2001),urbanization in most cities of Nepal is taking place due to migration of people from rural to urban areas in search of employment, for commercial activities and in seek of education and other opportunities. Land use planning offer many opportunities and options to reduce human, economic, and physical losses due to natural disasters (UN-HABITAT ,2015).

Land use zoning, i.e. the delimitation of homogenous zones in regard to their characteristics (topography, soil, vegetation, land cover, forest classification, ecological system etc.) or functions (current land use, land use potential, agricultural potential, conservation values, ecosystem services etc.), should be part of any land use analysis. The categories for zoning should be derived from the key problems, major challenges and/or main potentials of the planning area or if already identified from the planning objectives (Pickardt, 2011).Land use zones are micro level of planning which has to be prepared mandatorily by each Municipality or VDC through community participation (KVDA, 2015).

Dhakal (2012) has concluded that the public participation in decision making, implementation, monitoring and evaluation, and benefit sharing of urban planning is well taken by the community itself. Conventional (top-down) planning approaches have had very little achievement due to a lack of dialogue and coordination among implementing bodies and local stakeholders Hence, participation has been identified as key factor for a successful land use planning. The old expert driven approach resulting in one way communication still exists here and there. Risk mapping, for instance, can be done in a participatory way together with the local population during a normal land use planning workshop (Pickardt, 2011).

Rapid Urbanization is a major problem for most of the cities in Nepal. According to Building bylaws of Banepa Municipality, Banepa is one of the rapid growing city with increasing population and urbanization. Lack of formal planning increases the adoption of informal ways of planning, which may or may not be effective. So it is necessary to develop land use plan for optimum benefit in sustainable way. Since city is suffering from different hazards like land slide, flooding ,industrial hazard etc, we have to consider those risk in proposed land use plan. Many countries have failed to address natural disaster like flood in land use planning though it provides the missing basis for taking precautions against catastrophes (Sudmeier-rieux & Jaboyedoff ,2015).

Expert driven approach of land use planning has not gain satisfactory achievement in land use planning. Public participation in every step of land use planning should also be ensured (Pickardt, 2011).

The main objective of the study is to identify risk sensitive land use zones in Banepa Municipality from integrated approach of expert driven and participatory.

2. Study Area

Banepa Municipality, a small valley lies in the north-west part of Kavre District, Bagmati zone of Nepal. It lies 26 km east from the capital city Kathmandu. Its geographical limits are latitude 27^0 37' 1" to 27^0 39' 2" north and longitude 85º 30' 55" to 85º 32' 59" east. The elevation varies from about 1400 meter to 1800 meter from mean sea level. The political boundaries of this Municipality are: Rabiopi VDC in the north, Panauti Municipality in the south, Dhulikhel Municipality in the east and Ugratara and

Ugrachandi VDCs in the west. Study area is lacking of formal land use zoning .

3. Methodology

The research starts from Data preparation phase. After that present land use was analyzed and updated using high resolution Geo I image. Risk was analyzed using participatory approach. Both spatial and Socio-economic data were analyzed using Multi-criteria and Subjective approach. Finally different land use zones were declared in final risk sensitive land use zone map. Following two approaches has been applied for this study .

3.1 Multi-criteria Analysis

Land use zoning is carried out by considering various criteria collected from literature review and key informants interview. Those criteria are translated in GIS software and analysis is done. This is a scientific process and individual judgments cannot be made while applying the process. The suitability of certain use is judged by the software based on the provided criteria.

3.2 Subjective Analysis

Subjective analysis on the basis of requirement and expert's opinion is carried out. As an example, although, if a small piece of land is found suitable for agricultural use, however, it is surrounded by residential area, then it is located in the residential area.The conceptual framework of overall research methodology is presented in the following figure 1.

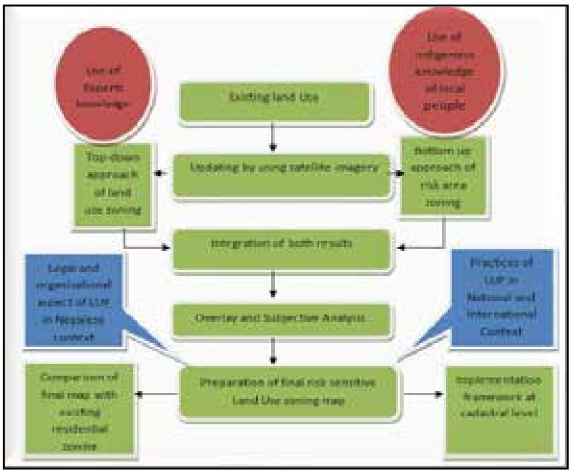


Figure 1: Conceptual framework

4. Result and Discussion

Results from the analysis of the collected data and discussion are presented below.

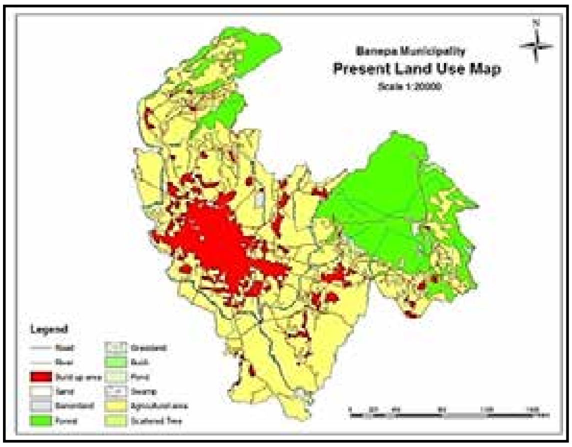
4.1 Population of Banepa Municipality

Banepa Municipality has 12597 populations according to 2048 Census. This increased up to 24764 in 2068 B.S. Population growth rate is 4.83.(Population of 2068 -Populationof2048)/ Populationof 2068*100/20=4.83).

The residential area is 6862509Square meters and forecasted area required for 10 years Period is 1061179 square meters. So extra area required for 10 years for residential purpose is 344166 square meters.

4.2 Present land use of Banepa Municipality

Banepa Municipality has 11 land use types (however, all categories are not as adopted by NLUP) and their corresponding area is given in the Figure 2.



The area of different types of Present land use of study area are shown in the following table 1.

Table 1 : Present land use distribution

Land use Type	Present land use (Ha)
Buildup area	755031
Cultivation	3906118
Forest	1836761
Grass	42414
Bush	68673
Scattered Tree	183652

Swamp	1637
Sand	2477
Barren land	72756
River	27804
Pond	3199
Total	6862509

4.3 Risk zones in Study area

Risk zones in the study area were identified from participatory approach.GPS field survey was also conducted for data collection as well as validation of the result. Some types of risk found in the study area are:

- Flooding
- Forest fire
- Industrial Hazard
- Land Slide

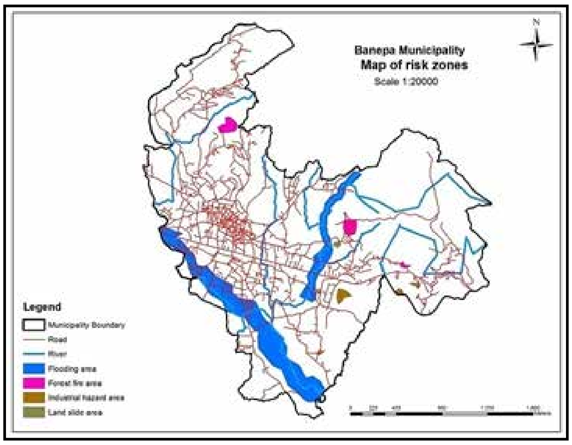


Figure 3: Risk map of Banepa Municipality

This study area is in moderate risk from earthquake perspective .So we haven't considered that risk in the study area.

4.4 Parameters and mapping of different land use zones

The land use zoning should be carried out on the basis of multi criteria analysis using present land use, land resource data sets and socio economic data sets. However, the present land use is also given due consideration in the issue of Cultural, forest, residential, commercial, Industrial as well as public use. According to the Land Use Policy 2072 BS, there must be following eleven land use zones. This research has also considered all specified zones in land use zoning process as far as possible by analyzing data and public requirements. Some of the criteria used for land use zoning of different categories are as follows:

A. Residential Zone

Residential zone means the land used by people for shelter or housing and the word also includes animal shed, food container, garage, stable, well, tap, orchard, backyard, courtyard or land with any other use whether joined with the house or separate. This word also denotes a collective housing or apartment built by a business company or institution, and also to a specific land declared by the government for housing purposes. The existing residential area is kept intact.Some of the criteria to identify appropriate land for these new settlements are:

i. The area should be in the neighborhood of the existing settlement

ii. Availability of Road and infrastructures if possible

iii. Not in the flood plain of any river

iv. Geologically stable

v. Not in the vicinity of dense forests and Industrial areas as much as possible

vi. The land should be of marginal utilization, i.e. the land should be less capable for agricultural crop production

According to LUP experts, factors like Risk, Accessibility, land capability etc. are responsible for residential zoning. Accessibility should be considered highly according to 17 respondents. Similarly other factors should also be considered. Table 2 describes about factors and their corresponding weights according to LUP experts.

Table 2: Factors for residential zoning

Parameters	No .of Respondents
Risk	13
Accessibility	17
Land Capability	12
Utility services	13
Social Sentiments	5
Geology	10

Topography	7
Existing Settlement	4
Land System	7

Following figure describes about factors and their corresponding weights for residential zoning according to Survey Measurement Act 1963.

By following all sources of parameters given, Some of the parameters considered as a factor for residential zoning are as follows:

- Slope- slope up to 30 degree is better
- Aspect-East west slope is better
- Present land use-Built-up area, barren land are better, Forest, water body are restricted
- Land Capability-Warm, temperate, humid and moisture regime is suitable.
- Land System-Less than 30 degree mountain sloppy area are suitable
- Accessibility- Near to road is preferable
- Nearness to river-Far from road is preferable

Making comparison matrix (reciprocal matrix)

Based on the value obtained from pair wise comparison, comparison matrix was developed. Since factors are taken as parameters for pair wise comparison, the matrix size is 7×7. To fill the lower triangular matrix, the reciprocal values of the upper diagonal were used. If a_{ij} is the element of row i column j of the matrix, then the lower diagonal is filled using this formula: $a_{ji} = 1 / a_{ij}$

Eigen value (λ)

After determining the relative weights, the consistency of output was checked... This is iterative process. Principal Eigen Value is obtained from the summation of products between each elements of Eigen vector and the sum of column of reciprocal matrix. The Eigen value is in second iteration is 8.08.

Consistency Index (CI) and Consistency Ratio (CR)

Prof. Saaty proved that for consistent reciprocal matrix, the largest Eigen value is equal to the size of comparison matrix, or $\lambda_{max} = n$. Then he gave a measure of consistency, called Consistency Index as deviation or degree of consistency using the following formula.

$$CI = (\lambda max - n)/(n-1)$$

Principal Eigen Vector calculated in our result was found to be 8.08. Since the value of λmax is 8.39 and the size of comparison matrix is 7, thus the consistency index (CI) is

$$CI = (\lambda max - n)/(n-1) = (8.08-7)/(7-1) = 0.18$$

Now, our objective is to find Consistency Ratio (CR) which is ratio of Consistency Index (CI) to Random Consistency Index (RI).

$$CR = CI / RI, CR=0.18/1.32, CR=0.136$$

Therefore, consistency Ratio= 13.6 %

So after testing the final consistency ratio of AHP parameters, using Weightage of each parameter, the weighted overlay operation in model builder was carried out.After all process weight of each parameter has been calculated as shown in the following table 3.

Table 3: Weightage of each parameter

Parameters	HP Values		Principal Eigen Vector (%)
1	Slope	0.07	7
2	Aspect	0.02	2
3	Road	0.33	33
4	Nearness to river	0.05	5
5	Land cover	0.15	15
6	land capability	0.24	24
7	Land System	0.14	14
		Total	100

Using those principal Eigen vector as a percentage value of weight of each parameter, weighted overlay was prepared and run.Then final residential zoning rating map is prepared after running model. It describes about suitable and unsuitable areas for different land use zoning which is shown in Figure 4.

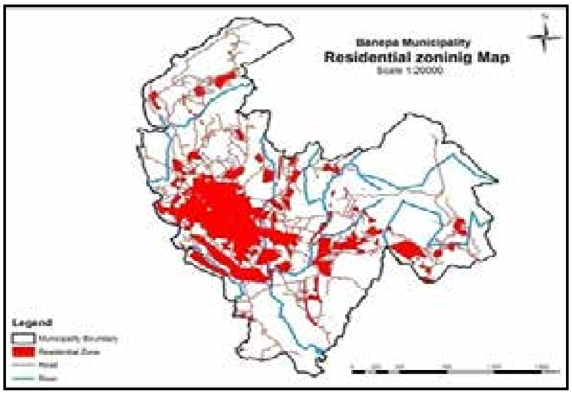


Figure 4: Residential zoning map

Similar approach has been applied to find suitable areas for different zones.Some of them are:

B. Agricultural Zone

The agricultural zone means the area where there is a presence of agro products (food grains, cash crops, horticulture, etc.), animal husbandry, fisheries, agro and forest products or orchards in a private land. .

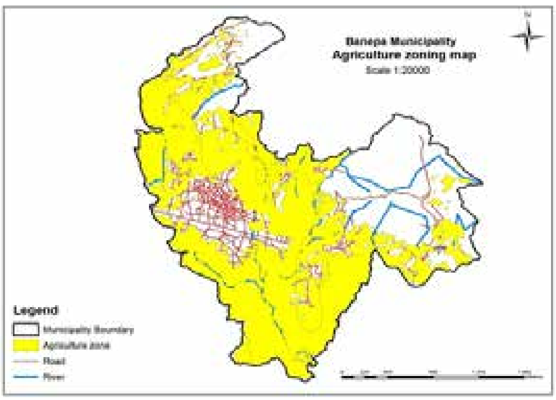


Figure 5: Agriculture zoning map

C. Commercial Zone

Commercial zone means the land occupied by or allocated for shops, hotels, exhibition stalls, petrol pumps, warehouses, health and information facilities, commodities trade centre, an organization providing any literary, scientific or technical service or advice, fair venues, discos, clubs, etc. Different parameters like Existing settlement; Accessibility, geology topography etc. are responsible for commercial zoning according to the LUP experts. Area suitable for the commercial purpose are shown on the map in red color.

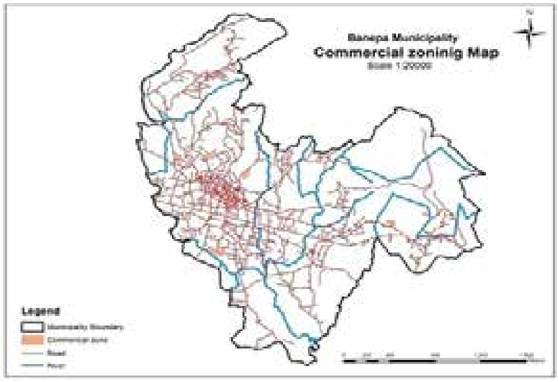


Figure 6: Commercial zoning map

D. Industrial Zone

Industrial zone means the land occupied by or allocated for any workshop, goods manufacturing industry, the associated buildings and sheds. This word also denotes an industrial corridor, industrial village, cluster, special export zone and special economic zone declared by the government for industrial promotion in a definite geographical region. Different parameters like Existing settlement; Accessibility, geology topography etc. are responsible for commercial zoning according to the LUP experts.Areas suitable for industrial purpose are shown on the map in black color.

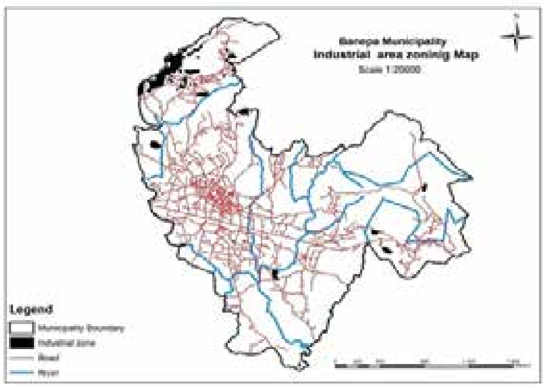


Figure 7: Industrial zoning Map

E. Public use Zone

Public utilities and open zone means land occupied by schools, colleges, vocational educational centers, academic institutions including the universities, security agencies, health centers, health posts, private or community hospitals, telecom, drinking water, government agencies involved in providing electricityetc. Areas suitable for the Public use purpose are shown on the map in purple color.

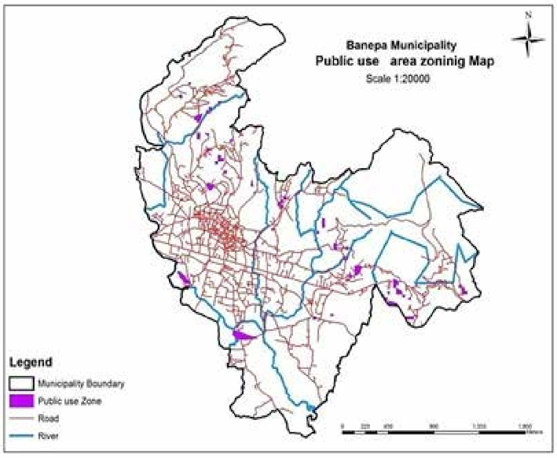


Figure 8: Public use zoning map

F. Forest Zone

Forest zone means an areas being covered with public, community, leasehold forests in part or entirety, national parks, wildlife reserves, conservation areas, bushes, shrubs, plains, all types of jungles and places designated by the government as a forest regardless of whether there are trees or not.

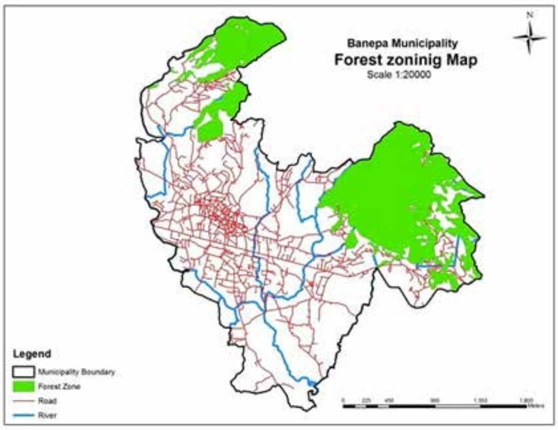


Figure 9: Forest zone map

K. Other Zone prescribed as required

Other Zones prescribed as required mean the areas that do not fall under any of the above land use zones but which need to be mentioned as an exclusive land use zone..

4.5 Final Risk Sensitive land use zoning map

Final risk sensitive land use zoning map with 10 different land use classes was prepared after identification of risk area. Four types of risk were identified in the studyarea Tourist zone was added to the previous map approach.

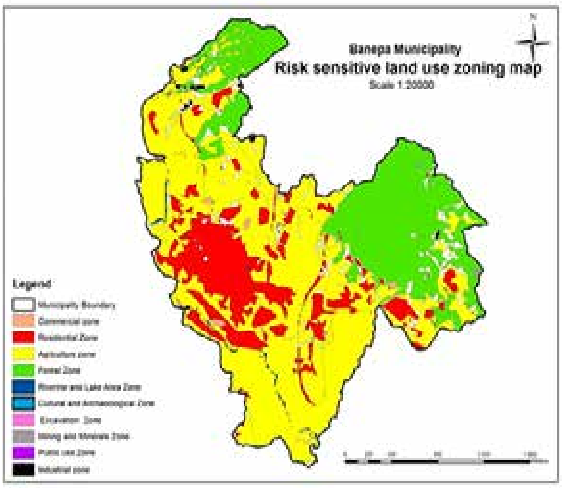


Figure 10: Risk sensitive land use zoning map

4.5 Verification (accuracy assessment) of Land Use Zoning Maps

The final proposed risk sensitive land use zoning map is verified by field visit and observation. All proposed land use zones are visited and also interaction with local people was held. The real situation and map was compared and analyzed whether proposed zones are implementable or not in the study area. There was a work shop organized in Banepa Municipality with Municipality representative to approve and verify final map. According to the suggestions from that discussion, some minor changes were done in the risk areas as well as proposed zones. Municipality and local people were agreed upon proposed zoning map and willing to accept implementation of the proposed zones at cadastral level. The 80 different random points are generated on the zoning map and are assessed on the ground with public participation to analyze feasibility of the proposed land use class in the real field. Following results are found and overall accuracy was calculated in the error matrix.

Result from Expert Driven approach:

Land use zoning from expert driven approach was analyzed and overall accuracy was calculated as shown in Table 4.

Table 4: Result from Expert Driven approach

	Ground data				
Expert driven data					
	Resi-dential	Agriculture	Forest	Road	
Residential	20	5	0	0	20
Agriculture	5	30	0	5	30
Forest	0	0	15	0	15
Road	0	0	0	0	0
Total	25	35	15	5	80

Overall Accuracy: 81.25

Result from Participatory approach:

Land use zoning from participatory approach was analyzed and overall accuracy was calculated as shown in Table 5.

Table 5: Result from Participatory approach:

	Ground Data				
Participatory data					
	Residen-tial	Agricul-ture	Forest	Road	
Residential	15	5	0	0	15
Agriculture	10	25	0	0	25
Forest	0	5	20	0	20
Road	0	0	0	0	0
Total	25	35	20	0	80

Overall Accuracy: 68.75

Result from Integrated approach:

Land use zoning from integrated approach was analyzed and overall accuracy was calculated as shown in Table 6.

Table 6: Result from Integrated approach

	Ground Data				
Integrated data					
	Resi-dential	Agricul-ture	Forest	Road	
Residential	20	5	0	0	20
Agriculture	0	30	0	0	30
Forest	5	0	20	0	15
Road	0	0	0	0	0
Total	25	35	20	0	80

Overall Accuracy: 87.5

For overall accuracy assessment, 80 random points are generated through software and those points are assessed on the ground. The land use of those points are analyzed on land use zones from participatory approach, Expert Driven approach and Mixed approach. The overall accuracy or the result was found to be 81.25% for Top Down approach where as 68.75% for Participatory approach and 87.5% for integrated approach. From this analysis we can suggest for implementation of integrated approach for land use zoning rather than top down and bottom up approach.

4.6 Implementation Strategy of land Use Zoning

For effective implementation of proposed land use zoning, LUP professionals and experts have suggested different facts to be improved. To implement land use zoning at cadastral level, Strong political commitment is necessary. Public should be involved in land use zoning and implementation process .So government should ensure public participation. Similarly public should get compensation for their loss during the land use zoning implementation process. Land use policy is not sufficient for implementation of the proposed land use zoning. Acts, laws, guidelines and procedures should be prepared for effective implementation. All legal documents should be clear so that people can understand the process. But laws and policies and their strong implementation are necessary. Regular monitoring mechanism of implementation process is suggested. Our organizational structure is not favorable for land use zoning implementation.

5 .Conclusion

Land use zoning is necessary for getting optimum benefit from land in a sustainable way. Risk factor should also be considered in land use zoning process. The Banepa Municipality has dominant risk factors like Flooding, forest fire, industrial hazard and land slide. Those risk zones are not suitable for any kinds of land use activities.

Banepa Municipality has prepared land use zoning map and approved it from Municipal Council but most of the residents of Banepa Municipality don't know about that zoning process. So considering different factors as suggested by land use planning experts, Survey and Measurement Act 1963 and Building Bylaws of Banepa Municipality, which are necessary for land use zoning, risk sensitive land use zoning map is proposed. The existing land use zones are compared with proposed risk sensitive land use zoning map and found that land use zones are not consistent in both map. Since Present land use zoning map is not prepared from participatory process and hasn't considered risk factor, people are not willing to accept this and are agreed to follow new land use zoning map.

6 . Recommendations

Due to lack of proper land use zoning practices, we are not getting optimum benefit from land resources. Although NLUP has started land use zoning at District level, it is not implemented. So it is highly recommend following both expert driven and participatory approach in an integrated way for finding suitable zones for different land uses. Risk factors should also be studies and considered in this process. Since present land use zoning map of the study area is not scientific and hasn't follow participatory approach, it is recommended to follow proposed risk sensitive land use zoning map.

Existing data for land use zoning is not accurate enough to superimpose it at cadastral level. So data of high accuracy is required. For effective implementation of proposed zones, public awareness program should be launched as soon as possible and our current laws and policies should be reviewed. Since local bodies like Municipality and VDC are responsible for implementation, it is better to empower those agencies to make them able to handle this process effectively.

Further research is necessary to follow scientific approach for risk mapping and look after land use planning at local level. High accurate data are recommended for the study and impact assessment of land use planning from National land use project can also be assessed. Another research is required for assessing practical aspect of implementation of land use plan prepared by National Land Use Project.

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Utilizing Geo-information for Mountain Community Adaptation

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KEYWORDS

Adaptation, Geo-information, Mountain Community Adaptive System (MCAS).

ABSTRACT

Mountain communities are vulnerable to diseases, malnutrition, and insecurity of land, which may lead to losing shelter and livelihood. This paper reveals that the current way of living of the mountain communities is unsustainable and vulnerable, and there is a lack in improving their adaptive ability for climate change adaptation. In order to understand how to improve the adaptive ability of the mountain community, this research makes a critical analysis of three case studies in Nepal, Indonesia and Peru. The results indicate the importance of geo-information as services or products at each scale ranging from global, regional, national, state/province, community to individual. The aim is to emphasize on access to geo-information that helps reduce the community vulnerability by providing a more effective adaptation program. Here we propose a framework for a Mountain Community Adaptive System (MCAS) which establishes the relationships between the vulnerability, livelihood and climate change adaptation.

1. Introduction

Climate extremes and changes in temperature or rainfall disrupt water supply, infrastructure and settlements. People often re-settle in a safe place where land plays a vital role to safeguard their shelter and livelihood in a sustainable way. Currently there has been very little attention to vulnerability of mountain people and their roles in the process of adaptation to action have been largely neglected(Gentle and Maraseni 2012; Bajracharya, Furley, and Newton 2006) We argue from both theory and case studies that participation of mountain communities in Community-Based Adaptation (CBA) strategy and plan requires effective management of geo-information for vulnerability reduction, livelihood improvement and land tenure security.

FAO (2002) defines land tenure as *'Who can use What resources for How Long and under What Condition?'*. Who, what resources, where, how long and what conditions are information that exist at different scales from global, regional, national, state/provincial, local/community to individual. There is a need of reliable and timely access to structural climate change data as well as livelihood information and activities, and regions of interest for environmental conservation and economic development. Here emphasis is on the participation of the mountain community and the individual in the implementation of adaptation (FAO 2012) by giving information about their environment including the effects of climate change, what and where the available resources are, how to access the assets and increase their livelihood choices, under what conditions they can experience economic benefits and what the potential adaptation actions are in their regions.

This paper explores access to geo-information that helps reduce mountain communities vulnerability. First, the methodology has been explained in section 1. Second, the components of vulnerability in general, community livelihood vulnerability in practical and geo-information to support communities have been discussed. Specifically, we propose a model for adaptation factors at community level and the potential role that geo-information plays. Third, climate change adaptation strategies and plans at community level are described, and the needs are identified at community level with the implications for the mountain communities. Fourth, three case studies derived from secondary sources (Maharjan & Joshi, 2013; Macchi et al., 2011; Kerr et al., 2006; Torres, 2012), representing mountain community climate change perception in Nepal, mountain community conditional land tenure system in Indonesia and mountain community value chain in Peru. Then, a Mountain Community Adaptive System (MCAS) is developed based on a conceptual framework at different scales. The potential ability of MCAS in geo-information services delivery to improve the adaptive capacity of the mountain community are finally presented.

2. Materials and methods

The research method used first is literature review of the components of the vulnerability based on IPCC(2014) and Watts and Bohle 's (1993) vulnerability model. Based on that, community livelihood vulnerability is explained. Adaptation factors and the role that geo-information plays in a CBA are derived from integrating the components of vulnerability and is represented in table 1. Next, climate change adaptation strategies and plans, and relevancy to mountains communities are analyzed.

Three case studies have been selected from secondary sources (Maharjan & Joshi, 2013; Macchi et al., 2011; Kerr et al., 2006; Torres, 2012), representing mountain communities' livelihood and vulnerabilities to climate change, land tenure security and whether there is any adaptation plan. We assessed each case study to identify the stakeholders, the experienced impact for each stakeholders such as the impact of climate change on the communities and their environment and the experienced impact in the adaptation process, the roles each stakeholder played, the stakeholders' responses to and their limitations in the process of adaptation to climate change. This assessment is presented in table 2.

The methodology followed for each case study is based on adaptation factors which are identified in Table 1. As such, an inductive research approach was taken, as the vulnerability aspects have been identified. In doing so, we attempted to understand the needs of mountain communities in climate change adaptation. Next, a Mountain Community Adaptive System (MCAS), its functionalities and its framework are proposed. A MCAS is a geo-information tool which will be able to supply information in terms of services at different spatial scales (Table 3) that address the needs of communities in adaptation to climate change.

3. Community vulnerability

The term *'Community'* is defined as a group of people with backgrounds that have the same characteristics. A community is involved in common actions in a geographic space and ties up together socially (MacQueen et al. 2001). Literature shows that climatic events and environmental changes cause losing lives and livelihood ofmountain community. This section reviews the components of vulnerability including adaptive capacity, sensitivity and exposure, community livelihood vulnerability and its components and then the role that geo-information plays for the communities.

3.1 Components of vulnerability

According toIPCC (2014), vulnerability is '*lack of capacity to cope and adapt'* and includes three components: adaptive capacity, sensitivity and exposure.

Adaptive capacityas the ability of stakeholders is '*a function of wealth, technology, education, information, skills, infrastructure, access to resources, and stability and management capabilities'* (McCarty et al. 2001). Capacity depends on '*capitals*' (Hinkel 2011) consisting of the following aspects:

- *Social capital,* which relates to the stability of relationships among communities and their management capabilities to deal with climate change.

- *Human capitals* related toaccess to education, availability of information and skills for a community.

- *Natural and financial capitals* are about accessibility to resources and finance/ wealth respectfully.

- *Physical capitals* on the availabilities of infrastructure and technology.

Since climate events take place on land either through natural or anthropogenic activities, the authors argue that these issues should be directed towards the better use of land. Combining land issues and capitals as a function of adaptive capacity would bring benefits to a community to adapt to climate change. If a community is aware of information on land and capitals, it is likely to increase community adaptive capacity.

Sensitivity is the way a community has access to available resources that are directly or indirectly influenced by climate change. Resource for a community is the level of access to and use of information about their environment to achieve the aim of vulnerability reduction. For instance, floods and droughts have an impact on communities sensitive to agriculture. They have lower agricultural production and that means less accessibility to resources or natural capitals. Therefore, they need to invest in crop diversity or change to other sources of food for their survival. They have fewer financial capitals since they spent their money previously on agricultural products. Moreover, they have fewer human capitals as they do not have enough skills on how to grow new crops or how to find the best way of accessing to resources. It is important to reduce community sensitivity by enhancing their human capitals. In this way they are well-prepared to tackle the impacts of climate change.

Exposure is the stress or difficulty a community faces to cope with climate variability and disasters. Exposure as the level of a community interaction with climate events is location-based. For instance, one community is endangered by drought while another community in a different location is at the risk of falling rocks. A community's knowledge on the type of climate events that happen in their region is necessary. A community's exposure to the effects of climate change increases if they do not have reliable information on climate variability and climatic events. However, their actions to reduce the effects of climate change depend on physical capitals including infrastructure such as type of roads, buildings and the level of access to and use of technology like agro-forestry or smart-agriculture.

Watts and Bohle (1993) define two sides (figure 1) for vulnerability which the relationship between them is usually established through the political economy approach in terms of social inequalities, crisis and conflict resolution, capacity to take actions and manage emergency situations of climate events. Thus, the external side of vulnerability or exposure is influenced by:

- Human-Ecology perspective: community capacities to manage environment.

- Entitlement theory: inability of people in a community to access or manage assets.

The internal side of vulnerability or coping side is influenced by:

- Action theory approach that allows space for people to act.

- Models of access to assets for mitigating vulnerability.

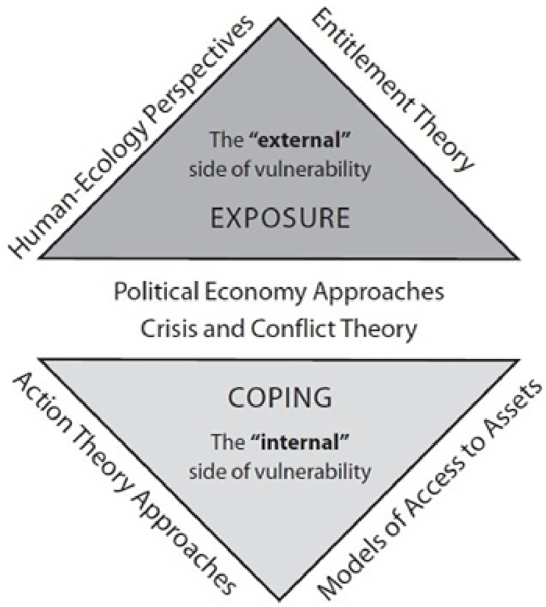


Figure 1- The two sides of vulnerability according to the Bohle model (Watts and Bohle 1993)

Thus the model (figure 1) suggests vulnerability largely depends on people's assets management and control mechanism (Villagrán de León 2006). UN/ECE (1996) defines vulnerability as results from the impacts of climate change on community and land as a basis of human activities, natural resources and source of life and wealth. We argue that vulnerable communities require knowledge on the best way of using and protecting their lands from climate variability and climate events. Currently they mostly depend on their local knowledge rarely assisted by local experts on their livelihood.

3.2 Community livelihood vulnerability

A community always has interaction with available resources including access to land in their environment as a means of securing their livelihood (Ingold 2000). A livelihood is determined by '*the activities, the assets, and the access that jointly determine the living gained by an individual or household'*(Ellis 1999). A social-ecological system like a community is vulnerable when it experiences shocks and stresses (Adger 2006).

Hahn et al. (2009) developed the Livelihood Vulnerability Index (LVI) for assessing the impacts of climate change on the communities. It consists of:

- Socio-demographic profile, livelihood strategies (type of work) and social networks (lending or borrowing loans, getting support from the government, non-government agencies and family members).
- Availabilities of health centers, food (availability of food type, crop diversity production) and water (water sources and their accessibilities).
- Natural disasters and climate variability.

In addition to the above components Shah et al. (2013) added *'housing and land tenure'* elements, addressing the sensitivity as explained in section 2.1. These were directly related to the type of material used to construct houses and the right holders of the houses that are living there. It further emphasizes on participation of local and indigenous people in planning and management of climate change. The study concluded that a community is more vulnerable if it does not have access to secured housing and land tenure.

3.3 Geo-information for communities

Geo-information consists of any information related to a specific location. It facilitates communities with access to resources needed on climate change adaptation from stakeholders of different scales of global, regional, national, provincial, community and individual, contributing toward community sustainable development. The factors and the role that geo-information play in a community adaptation are derived from integrating components of vulnerability. Based on the above we developed a model which is depicted in table 1 on adaptation factors and geo-information needs at community level. Based on that, community and livelihood vulnerability consist of external and internal aspects.

Table 1 – Adaptation factors and geo-information at community level

Vulnerability aspects	Adaptation factors	Geo-information types
Internal	Access to resources (Sensitivity)	Socio-economic data, health facilities, educational facilities, crop diversity, forest, water resources
	Capitals (Adaptive capacity)	Land right , land use, land value
	Access to assets	Loan, credit, social services, governmental aids
	Exposure to external shocks and stresses	Hazard map, risk and crisis maps
	Access to Geo-information	Meta-data on geo-information
	Space for community to act	Local policies and plans
	Capacity to manage in emergency situations	Administrative jurisdiction, topography, road/ transportation
External	Governance	Interaction forums between state, Non-Governmental Organization (NGO) and private market sector
	Institution	Legal acts
	Integrated policies and plans	National policies, strategies and plans
	Spatio-temporal changes	Climate variability (snow, temperature, rainfall)

Internal aspects refer to the factors that make a community vulnerable to climate events and variability. Access to resources, assets and their use for a community livelihood are mostly affected by shocks like droughts, floods and climate variability events due to vulnerability components as mentioned in section 2.1. Generally, a community does not have the capacity to manage in an emergency situation because:

- The type of threat is not known.
- They are not ready for the threat.
- They do not have plan for a climate change threat.

Therefore, a community needs to have information on environment like topography and transportation to enhance its capacity and to get the maximum benefits in climate change adaptation. Moreover, community access to geo-information creates a space to act, to enhance their capitals and adjust their plans according to their needs, to improve their livelihood and to reduce their vulnerability. Integration of capitals increases interaction among them. For instance, human capitals such as education and skills facilitate management of natural capitals like natural resources to strengthen financial capitals such as the economy of an individual or a community.

External aspects refer to the external community factors that cause threats to a community. Spatio-temporal changes have negative effects on community livelihood. Whereas a community is expecting a rainy year for crops to grow, they are faced with a dry year. They do not know how to adjust themselves to the new situation. Rapid changes of natural events and exposure to external shocks and stresses like forest fires, land and mud slides are external threats. For a community that uses land for their livelihood, changes in the natural system and ecosystems become unpredictable. Geo-information facilitates producing natural disasters and hazard maps of the area by combining spatially referenced data. It supports a community and higher administrative levels by providing information on the climate change hazard zones and the natural disasters that they are faced with.

The external aspects highlight other important factors such as institutions, policies, strategies and plans. Institutions like political and economic institutions need to establish a legal framework for a community as regards access to assets and their needs to improve their livelihood. Policies, strategies and plans in terms of national and local climate policies accelerate the objectives of adaptation to climate change and community participation. Governance concept increases interactions among climate change stakeholders i.e. state, private sector and Civil Society Organizations (CSOs), including communities in the areas.

4. Climate change adaptation strategies and plans at community level

Adaptation is about stakeholder actions from a local to a national level (Klein et al. 2014) to reduce the impacts of climate change. IPCC (2007) indicates that different adaptation strategies and plans are made considering various adaptation dimensions consisting of spatial scale, sector, type of action, actor, climatic zones and development. Adaptation strategy has a spatial dimension (Biesbroek, Swart, and van der Knaap 2009) in different sectors like land, water resources, agriculture, infrastructure and settlement, human health, transport and energy.

Climate change effects such as landslides, severe droughts and floods lead to displacement and forced migration of people from their original places at community level. The competition for fertile land and natural resources increased by climate change impacts over time. It directly influences vulnerable and marginalized groups. In many instances vulnerable individuals and communities are trying to adapt themselves by learning to practise (Banjade, Schanz, and Leeuwis 2006) with the available resources. Lack of information hinders communities in accessing potential resources available around them. They do not have information on adaptation strategy and plan, policy and finance.

4.1 Policy, strategy and plan at community level

Availability of information and participation increase the effectiveness of CBA activities and communications with districts and national levels. Implementation of local adaptation plans at community level mostly depends upon strategies and plans of national governments with regional and global inputs about climate extremes data and information in terms of scale. The knowledge needed for activities on their lands and livelihood means that communities need a supply of information by geo-information to act on and to adapt to climate change. It is necessary for national and state/provincial levels to inform vulnerable individuals and communities about global, regional and national climate change strategic adaptation plans. For instance, Nepal developed National Adaptation Plan of Action (NAPA) based on national needs to support mountain people in adaptation to change. The Local Adaptation Plans for Action (LAPA) framework has been prepared as a bottom-up approach to implement NAPA and facilitate adaptation services for mountain communities. LAPA emphasises on participation of local bodies and vulnerable people to provide information on their needs and prioritize adaptation activities for decision makers (GoN 2011).

4.2 Relevancy to mountain communities

The United Nations General Assembly (2013) recognizes that mountain regions are highly vulnerable to the negative impacts of climate change including deforestation, a changing pattern of agriculture, land use change and land degradation. Chapter 13 of agenda 21 of the United Nations Conference on Environment & Development (UNCED) highlighted managing fragile ecosystems and strongly recommends involvement of relevant stakeholders including local authorities, civil society, local people and the private sector in mountain development activities.

Communities play a key role in the adaptation to climate change. When there is a policy, strategy and action plan, they combat impacts of climate change and also improve their lives and livelihood, leading to economic development. There is a need to inform the community about the potential resources and events that are taking place regarding climate change to create a better adaptation action.

5. Case studies

This section presents three case studies from Nepal, Indonesia and Peru. These case studies have been chosen from mountainous countries which are climate change (Byrne et al. 2014) and/or land hotspots.

5.1 Community vulnerability due to climate change variability in Nepal

Two cases from Nepal are presented to study the effects of climate change variability. The first case is about the Chepang community of indigenous people in rural Mid-hills of Nepal for community perceptions about climate change and its impacts, while the second case study, located in eastern and western Nepal, demonstrates impacts due to climate variability.

Chepang community: The Chepang community is categorized as a highly marginalized indigenous people of Nepal living in hilly villages of the Chitwan, Makwanpur, Dhading and Gurkha districts. This case study discusses if the households of Chepang community perceived any changes in climate, the impacts on crop production and livelihood assets, and if adaptation strategies are adopted. Since agriculture is the main activity for this community, many forests are cleared for cultivation. But due to the nature of the topography and the unsuitability of lands for agriculture, the community mainly depends on livestock, labor working, getting loans and paying them back by their livestock and collecting wood from the forests.

This case shows that the majority of people in the Chepang community experience dramatic changes in the rainfall patterns, late monsoon, longer and hotter summers and frequent hailstorms. The experiences on increased summer temperature and less amount of rainfall are in line with the climate data of the Department of Hydrology and Meteorology (DHM) in Kathmandu. It further reports about problems on drying crops, human health, less livestock productivity and the death of small livestock as the result of climate change. The case does not indicate if the Chepang community implemented any adaptation strategy and plan, as they did not have any information about the possible strategies and plans for climate changes (Maharjan and Joshi 2013).

Bajhang and Terhathum communities: This case is about responses of the communities to climate change in the rural villages of west and east Nepal, namely Bajhang and Terhathum, where the effects of climate change have largely damaged agricultural productions, and brought the communities poverty and insufficient food. The communities are mostly involved in agricultural labour on low salaries. The communities are often faced with warm summers and cold winters, changes in rainfall patterns and monsoon, food spoiling and a growing number of mosquitoes and pests.

The study reveals that the communities respond to the changes by (a) deforestation to gain more land for cultivation and agriculture; (b) crop diversity; (c) selling assets and taking loans to cope with food insecurity; (d) building canals to divert water from soil erosion and control floods and (e) migration to other cities and countries for paid work. A number of Community-Based Organizations (CBOs) are involved in providing loans with interest to the communities and to have the forest areas protected by local people. Governmental institutions are responsible for building infrastructure, support agro-forestry and provide fruit trees for the farmers.

The Western Uplands Poverty Alleviation Programme (WUPAP) and Environment, Culture, Agriculture, Research, and Development Society, Nepal (ECARDS) collaborate with the International Fund for Agricultural Development (IFAD) and the Nepal National Government. They interact among communities, government and non-governmental institutions to train farmers and distribute the seeds (Macchi et al. 2011). Now, communities know what type of seeds are needed; how, when and where to plant the seeds; therefore they are not faced with a shortage of agricultural products. Food security strengthens the livelihood of the communities.

5.2 Community conditional land tenure system in Indonesia

Sumberjaya is a sub-district of Lampung province in Sumatra, Indonesia. The study area includes private land, protected forest (governmental land) and a national park where rice and coffee farming are two major agricultural activities on private land. The case study describes the forced eviction of farmers, local people and communities based on the government perception that coffee farming on slopes causes soil erosion and is harmful for the operation of the hydropower dam (Catacutan 2011). Forced eviction has created violence and conflicts over lands and has led to forests being burnt by the evicted people. Consequently, the government's efforts of planting trees in forests did not produce a sustainable forest management (Kerr, Pender, and Suyanto 2006).

The studies by the World Agro-forestry Centre (ICRAF) showed that coffee farms in those areas were the main sources of income for the communities and they also prevented soil erosion of the natural forest (Catacutan 2011). Later on, the government transferred the forest land to the evicted communities with conditional land tenure (Kerr, Pender, and Suyanto 2006). Then ICRAF and IFAD funded the Rewards for Use of and shared investment in Pro-poor Environmental Servicesprogramme (RUPES) to bring multiple stakeholders together for forest protection and watershed management at both pilot and implementation levels.

The first program is the Community Forestry Program implemented by the Local Forestry Department under supervision of the National Government's Community Forestry Program. It provides coffee farmers and local communities with a five-year conditional land tenure to avoid eviction. In return coffee farmers committed themselves to the protection of forests by agro-forestry and coffee plants for coffee production. There is an opportunity of 25 years extension of land use right if the local people achieve a sustainable forest management (Porras and Neves 2006). The second program is the River Care Program, which removes sediments from hydropower reservoir in a sub-catchment through Payment for Environmental Services (PES) for community to practise soil and water conservation. This is an ongoing agreement on the condition of the removal of sediments by the community. Lastly, there is the Soil Conservation Program, a reward scheme for soil conservation, which stimulates the farmers to control erosion and reduce sediments from their farms by '*terracing, sediment pit and strip weeding techniques'*, for which farmers receive cash payments based on their progress (Catacutan 2011).

5.3 Community Value Chain in Peru

This case is about community mountain adaptation in Peru where communities implement a program on adaptation to climate change as an opportunity to expand their economy. Cajamarca is located in the Andean highlands of northern Peru and is one of the poorest and highly-populated areas. Productivity level of coffee and cocoa are low due to poor soil fertilization and lack of knowledge amongst the farmers. Deforestation and land degradation are caused by farmers since they need more agricultural lands to cultivate corn and cotton as the sources of their income. As a result, the risk of natural disasters and loss of biodiversity has increased. Subsequently the lives and livelihood of farmers are exposed to the dangers of climatic events.

This project was initiated through collaboration of the Food and Agriculture Organization (FAO) and the Institute for Hydrology, Meteorology and Environmental Studies in Colombia (IDEAM) with the objective to implement sustainable agricultural practices in mountains. NGOs introduce natural forest environment into the local production system by agro-forestry. They design farm management plans by using farmers' information on local biodiversity and the production methods of different native forest species and motivate farmers to use fertilizer for higher quality products. NGOs also establish local committees, where farmers share their knowledge and sell their products to national level and international social enterprises that search for high-quality cocoa and coffee productions in mountainous areas(Torres and Frías 2012).

6. Discussion

Table 2 presents findings of the case studies based on five components: (a) stakeholders; (b) experienced impacts; (c) role of stakeholders, (d) responses and (e) limitations. The adaptation factors that are given in section 2.3 are discussed for each case study.

Community vulnerability in Nepal: Access to resources and assets such as land, crops, forest products and income generation are difficult for the Chepang community as the main stakeholder of climate change effects. Chepang's responses are deforestation that bring flood, erosion and no forest products to use or to sell. Therefore, the community's adaptive capacity decreases because they are more exposed and sensitive to climate change events. Since they do not have a concrete role in climate change adaptation, they do not have the space to act and to adapt themselves to the effects of climate change. The Chepang community does not have the knowledge about managing their environment due to lack of information about on-going changes in climate and limited access to land and income. Since external adaptation factors did not play any role, they became more vulnerable to climate change.

As stakeholders the Bajhang and Terhathum communities, CBOs, government and non-governmental institutions and international organizations experience different climate change impacts. Therefore, their responses vary from one scale to another. While the communities' responses like selling assets and migration increase their exposure, their sensitivity affect crop diversity, erosion control and floods. The communities try to improve their adaptive capacity by doing and learning. However, their limitations in access to agricultural land, shortage of income and unsecured land tenure stop them from having an effective adaptation programme. The CBOs provide training for farmers and communities on how to conserve their environment and how to increase their income. Thus communities have more space to act, and the communities' adaptive capacity increase because they have information about their environment through the training program. This case study also reveals that though government and non-governmental institutions collaborate with international organizations, CBOs do not interact with higher levels and this limits giving information to the communities on accessing resources. There is a need of a strong network in which different stakeholders participate, particularly communities at all scales.

Community conditional land tenure system in Indonesia: Different stakeholders had been identified at three scales of communities, NGOs and government. The communities' lives and livelihood are endangered because they do not have land tenure security, access to resources, assets and capacity to manage in conflicts due to forced eviction. Consequently, the communities' sensitivity and exposure are high. However, NGOs mediate among stakeholders to bring capitals to the communities by implementing community forest protection and watershed management program. This case also shows that having access to information is one of the best ways for communities to increase their adaptive capacity themselves. Forced evicted communities did not have information on how to preserve their environment by means of agro-forestry. They did not know that the forest is a resource that generates income through forest products and a market-based mechanism like PES.

Since NGOs bring different adaptation programs that are implemented by communities, each adaptation program covers one of the adaptation factors that identified in table 1, section 2.3. Firstly, conditional land tenure brings capitals to the communities as they have right to use the land as a shelter and a source of food. Secondly, agro-forestry gives the communities access to resources, for example diverse forest products such as coffee and crop diversity. Lastly, soil conservation program support communities financially which is access to assets because communities are getting paid cash money. The Government uses the conditional land tenure as a policy to manage the environment in the communities, which means that the government has more information about the communities' requirements to prioritize the policy. Consequently, it gives the communities more space to act, as the government, through its legal framework, hands over the implementation of adaptation to the communities. It improves the link between stakeholders, which facilitates the design and implementation of adaptation programs. This case includes all adaptation factors that are necessary to overcome internal vulnerability aspects as well as some of adaptation factors regarding external vulnerability aspects, based on the proposed model in table 1.

Community value chain in Peru: Three scales are involved in the climate change adaptation plan. The communities do not have access to resources and capitals such as agricultural lands, farm products and land management technical skills which would make them more sensitive and exposed to the effects of climate change. There is no place for the communities to get information about the consequences of their activities on the environment and climate change events. Each community tries to provide for its basic needs, which are shelter and income.

The national strategy for climate change of Peru supports the community adaptation to climate change to act through agro-forestry and access to local, national and international marketing. First the NGOs give information about the role of agro-forestry and its benefits to the communities, then the NGOs create a network among farmers to manage their environment better and transfer agro-forestry skills to other communities. Farmers have more information, skill management and access to resources, which gives them space to act. Consequently, the market expands to international level because the communities produce high-quality cocoa and coffee. Networking gives the communities more knowledge on climate change as it links them with the national level where they explain their needs and their vulnerability due to climate change.

The above three case studies show a hierarchical level of stakeholders ranging from international, regional, national, state/provisional, community and individual levels where each scale has different level of plan, policy, authority, knowledge and ability to act respectively. These case studies highlight the importance of access to information at each scale. It reduces the community vulnerability and transforms adaptation program to an economy platform. Therefore, it is necessary to consider the adaptation factors in table 1, section 2.3 in designing an adaptation programme.

Case studies show that communities are mostly vulnerable to climate change. They also suggest that vulnerability aspects and adaptation factors (indicated in table 1) largely depend on the development and implementation of local adaptation plans so that communities have more space to act according to their needs. The strong need for the supply of information through geo-information for climate change adaptation at community level can be concluded from the above case studies. Timely available reliable geo-information creates a platform to link different scales for the development and design of an adaptation policy and plan based on the stakeholders' requirements. This, in turn, improves the community knowledge and information on managing the environment and raises the awareness of the communities about the impacts of climate change. Nevertheless, case studies indicate ongoing debates at different scales particularly international, regional and national levels to establish constant contacts among them. While regional levels collaborate with national levels to strengthen the communities' adaptive capacity by developing different strategies related to climate change and its impact, national level are involved with designing climate policy and adaptation plans such as NAPA and LAPA to reduce the effects of climate change on the communities. The information on climate data including temperature and precipitation, changing rainfall patterns and monsoon, duration of floods, droughts and landslides, crop types and land use among other spatial data are important for the communities, so they can prepare themselves for possible changes.

This paper emphasizes a need of supplying information by geo-information and climate change service delivery through a system by involving different scales, particularly individuals and the community. Such a system provides an ability for decision makers and the chance to monitor climate change interaction, leading to design a better adaptation strategy and policy. The Mountain Community Adaptive System (MCAS) will be introduced in the next section which allows the communities access to information and services including geo-information to reduce vulnerability of the communities.

Table 2 – Findings of the case studies

Cases		Stakeholder	Experienced impact	Role of stakeholder	Response	Limitation
Community vulnerability due to climate change variability in Nepal	**Chepang community**	Community	Changes in the rainfall patterns, late monsoon, longer and hotter summers, frequent hailstorms, drying crops, health problems	No concrete role in climate change adaptation	Deforestation, labor working, get loans and pay them back by their livestock and forest products	Limited knowledge and information in climate change, limited access to agricultural land, shortage of income
	Bajhang and Terhathum communities	Community	Agricultural production failure, poverty, food insecurity, crop pests and mosquitoes	Practicing by learning in climate change adaptation	Deforestation, crops diversity, selling assets, taking loans, control erosion and floods, migration	Limited information on climate change and access to agricultural land, shortage of income, insecure land tenure
		Community-Based Organizations	Difficulty in interaction	Interacting with communities	Facilitate farmers to take loans, protection of forest areas by local people	Weak institution
		Government and non-governmental institution	Difficulty to identify community need in adaptation plan	Collaboration with international and national organizations	Building infrastructure, agro-forestry, provide fruit trees for the farmers	Weak institution, adaptation of policy and plans
		International organization	Top-down approach	Strengthening the livelihood systems of local people	Seed distribution, training of farmers	Weak interaction
Community conditional land tenure system in Indonesia		Farmers, local people and communities	Forced eviction	Implementation of adaptation program	Forest protection, agro-forestry, coffee production, soil conservation, watershed management	Land tenure insecurity, lack of information on how to increase adaptive capacity
		NGOs	Monitoring	Bring multiple stakeholders together	Mediation	Weak institution
		Government	Violence, conflicts over lands and forest fires	Forming a national level network to incorporate different stakeholders	Providing five year conditional land tenure with the possibility to extend to 25 years	Weak institution, adaptation of policy and plans
Community Value Chain in Peru		Communities	Low productivity of coffee and cocoa, natural disasters	Implement adaptation program	Deforestation	Lack of information on tropical rainforest ecosystem and agricultural techniques
		Local NGO, social enterprise	Market	Strengthening of social organization, products improvement, commercialization,	Capacity building by agro-forestry	Pilot project
		Government	National/international market	Project design	Capacity building by giving access to land and international marketing	Pilot project

7. Mountain Community Adaptive System (MCAS)

The aim of a Mountain Community Adaptive System (MCAS) is to strengthen the communities and/or the individual to climate change adaptation. It provides reliable information to communities so that their actions are timely and correctly taken. A MCAS needs an information system that consists of different components that work together for the predefined purposes or services. It has characteristics including system components, interrelationships, boundary, purpose, environment, system interfaces, inputs, outputs and constraints (Norman 1996).

The main functions of the proposed MCAS are given below:

- It provides access to all available data of different scales at global, regional, national, state/provincial and community levels.
- It maintains these data and processes them to make suitable geo-information for climate change adaptation at community level.
- It disseminates geo-information as a service to the community and/or the individual for their timely actions via web services on smart mobiles.

Table 1 shows adaptation factors and geo-information for climate change adaptation in view of a community's vulnerability and livelihood. These services or products are derived from the data of different scales by MCAS. A MCAS allows members of the community to participate and make decisions in the appropriate adaptation actions with the aim of reducing the community's vulnerability and improving the community's resilience to climate change. Consequently, MCAS improves the adaptive capacity of the mountain communities.

7.1 Geo-information services for climate change adaptation

Sections 2.1 and 2.2 highlighted the role of land and land tenure security including geo-information as services for the community and/or the individual. The proposed MCAS as a service-oriented system interlinks land administration services on land rights, restrictions and responsibilities at individual level. Such interlink strategies provide opportunities for better services via available land administration services. Geo-information services at different scales are presented in table 3. Based on table 3 each scale is able to provide or use different geo-information services. A service that is provided by a scale can be used at the same scale or at higher and lower scales. For instance, in the case of the community value chain in Peru district and national levels expand marketing while communities increase their adaptive capacity and income by agro-forestry. Here, communities are both a service provider and user at community level whereas the national level is just a service user.

Table 3 - Geo-information services at different spatial scales

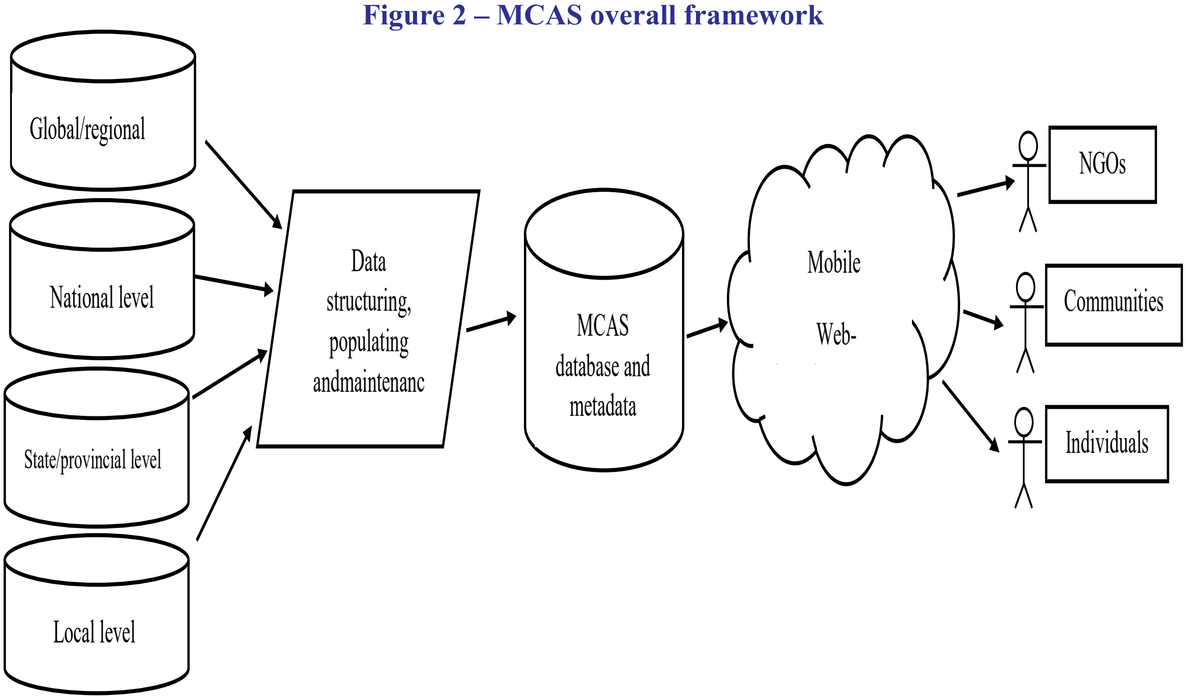
Geo-information services (maintenance and dissemination)	Spatial scale				
	Global	Regional	National	District	Community
Climate information (temperature, rainfall and snow,)	✓	✓	✓	✓	✓
Climatic zone (Tropical wet/wet-dry, monsoon, steppe, desert, dryland, floodplain, mountain, marine, tundra, arctic/subarctic)	✓	✓			
Information on type and frequency of natural disasters	✓	✓	✓	✓	✓
Locational information of districts, and local village offices, community offices, NGOs involved			✓	✓	✓
Information about the impacts of climate change on humans, livestock and their environment			✓	✓	✓

Geo-information services (maintenance and dissemination)	Spatial scale				
	Global	Regional	National	District	Community
Information on land rights,, cadastral data, land use and land value			✓	✓	✓
Information on transportation			✓	✓	✓
Information on water resources			✓	✓	✓
Energy (Water, electricity, windmill, solar panels, gas and oil)			✓	✓	✓
Ecosystem zone, forest zone, protected areas			✓	✓	✓
Infrastructure (buildings and settlements)			✓	✓	✓
Topography, administrative jurisdiction, geographic area boundaries, elevation model			✓	✓	✓
Information about forest products			✓	✓	✓
Marketing		✓	✓	✓	✓
Integrated climate and land policy			✓	✓	✓
Legal framework			✓	✓	✓
Farm and non-farm training			✓	✓	✓
Health centers and educational facilities	✓	✓	✓	✓	✓
Natural disaster and hazard map			✓	✓	✓
Adaptation plans and actions			✓	✓	✓

7.2 Framework for a MCAS

MCAS's framework consists of users, spatial data, data providers and web-based services to clients at community level. The objective is to connect land-based community service providers together. See figure 2 for overall framework.

Figure 2 – MCAS overall framework



Users at different levels, also at the local level, including NGOs, community groups and individuals can have access to the MCAS's services because it is based on a mobile/web-based system. As shown in figure 2, spatial data sets from global/regional, national, state/provincial and local level organizations are structured and brought to the MCAS database to populate and maintain it. Spatial data sets and data sources at different scales will be defined after further research on the MCAS requirements.

8. Conclusion

Climate change and its effects can be found worldwide, particularly in mountainous areas because of their fragile nature. While mountain communities are struggling to have their basic needs, which are shelter and income, they are trying to cope with their climate variability. Climate change policy together with NAPA and LAPA are parts of UNFCCC's and IPCC's concerns about climate change and related issues. IPCC as a knowledge sharing panel produces reports at international level to understand the causes and effects of climate change in the best way at regional and national levels. This is a top-down approach and is not sufficient for lower scales. It is fact that community and individuals are mostly endangered by climate change effects because even though climate change is a global phenomenon, the concrete events are happening at community level. Moreover, climate change events are different region by region and they change over time and space. In the three case studies mentioned, we identified that adaptation strategies and plans are not functioning well when there is not a sharing platform to raise awareness of provincial, community and individual levels constantly. However, the community and the individual are participating actively in the climate change adaptation programme. CBA requires more information and land services. The flow of information enhances the individual's and/or community's knowledge on the current adaptation programmes and plans. A MCAS as a service-oriented system was introduced to raise awareness of community and individual by providing geo-information services to improve their adaptive capacity. It consists of interrelated components or subsystems with various kinds of well-organized geospatial data (of land and climate) and integrated services that give national, provincial, community and individual levels the potential for an efficient and effective community adaptation. MCAS raises the awareness of a community about community vulnerability and the possible way to protect livelihood from climate change.

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Participation in the International Events by the Officials of Survey Department

- **Mr. Krishna Raj B.C**
  Joint Secretary, MoLRM (then Director General Suvey Department)
  The Sixth Session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM)
  1-5 August 2016
  New York, USA

- **Mr. Krishna Raj B.C.**
  Joint Secretary, MoLRM (then Director General Suvey Department)
  India-Nepal Joint Commission, the top bilateral body at the Foreign Minister-level,
  26 - 27 October, 2016
  New Delhi, India.

- **Mr. Krishna Raj B.C.**
  Joint Secretary, MoLRM (then Director General Suvey Department)
  Group on Earth Observations Thirteenth Plenary Session–GEO-XIII
  9- 10 November 2016
  St Petersburg ,Russia

- **Mr. Ganesh Prasad Bhatta**
  Director General (then DDG)
  Courtesy Meeting with the Minister for Agrarian and Spatial Planning
  June 27 - July 1, 2016
  Indonesia

- **Mr. Suresh Man Shrestha**
  Deputy Director General
  International Workshop on Geospatial Data Management and Quality Control
  12-16 December, 2016.
  Tianjin, China

- **Mr. Anil Marasini**
  Chief Survey Officer
  Group on Earth Observations Thirteenth Plenary Session–GEO-XIII
  9- 10 November 2016
  St Petersburg ,Russia

- **Ms. Roshani Sharma and Er. Sushmita Timilsina**
  Survey Officers, Survey Department
  Seminar on Promoting the Applications and Data Sharing of China's satellite ZY-03 in Central and South Asia
  4th January-7th January 2017
  Beijing, China.

- **Er. Laxmi Thapa**
  Survey Officer
  12-19 July, 2016
  XXIII ISPRS Congress 2016
  Prague, Czech Republic

- **Er. Shrijana Sainju and Er. ElizaShrestha**
  Survey Officers
  Geoinformatics Summer School
  19-30 June,2016
  Wuhan, China

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/-

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.

Late Chakra Bahadur Shahi,
Surveyor,
Survey Office Dang
2073/05/10.

Late Rajendra Kumar Shrestha
Surveyor,
Geodetic Survey Division
2073/05/14

SIGNAL COVERAGE MAPPING OF LOCAL RADIOS

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Janak Raj Joshi, Ganesh Prasad Dhakal**

KEYWORDS

Coverage mapping, Transmission station, Radio Mobile, Signal strength

ABSTRACT

FM radio transmission is greatly affected by geography. Nepal faces particular problems in relation to variations in signal reach because of its varying topography. Radio signal coverage mapping indicates service areas of radio communication transmitting stations. The objectives of this study are to map the signal coverage of local radios (Kavre district) and to assess parameters affecting FM signal strength. The primary data were GPS co-ordinates of FM transmission stations and bearing of antenna. The secondary data regarding frequency of station, transmitter model, transmitter power, antenna model, and height of antenna from ground level were collected from respective FM stations. For elevation data freely available SRTMv3 was used. Combined Cartesian coverage maps for each FM stations were prepared using Radio Mobile software that showed varying signal strength of station in dBμV/m. The accuracy of the maps through field validation was observed to be 85%. Assessment of parameters affecting FM signal strength concluded that increase in antenna elevation, gain of antenna and power of transmitter increases the signal coverage.

1 INTRODUCTION

Coverage maps are designed to indicate service areas of transmitting stations within which the user can expect to obtain good reception using standard equipment under normal operating conditions. Typically these may be produced for radio or television station, for mobile telephones networks and for satellite networks. Radio signal coverage map shows the field signal intensity of broadcast radio signals by the FM transmission components taking into account topography, frequency, antenna and its height above ground.

FM radio transmission is greatly affected by geography. Nepal faces particular problems in relation to variations in signal reach because of its varying topography. FM radio stations being the most prevalent form of mass communication in Nepal, it is necessary to ensure the reach of radio signals to every household. Considering this, radio signal coverage mapping was carried out in Nepal in 2006-2007 AD for the first time by Equal Access Nepal. On the basis of data provided by Ministry of Information and Communications (updated till 2073/10/20 B.S), there are 700 FM stations in Nepal.

2 OBJECTIVE

The objectives of this study are to map the signal coverage of local radios and to assess parameters affecting FM signal strength.

The growing FM stations everyday have increased the demand of signal coverage maps as they are extremely useful for them. These maps can assist the radio broadcasters to analyze their current signal reach and also in planning for new radio station, providing assistance in document submission process to government or related media organization.

3 STUDY AREA

This project deals with the signal coverage mapping of local radios of Kavrepalanchok district. It includes mapping of six stations namely:

1. Grace FM 107.6 MHz
2. Madhyapurva FM 104 MHz
3. Namobuddha FM 106.7 MHz
4. Prime FM 104.5 MHz
5. Radio ABC 89.8 MHz
6. Radio Shepherd 88.4 MHz

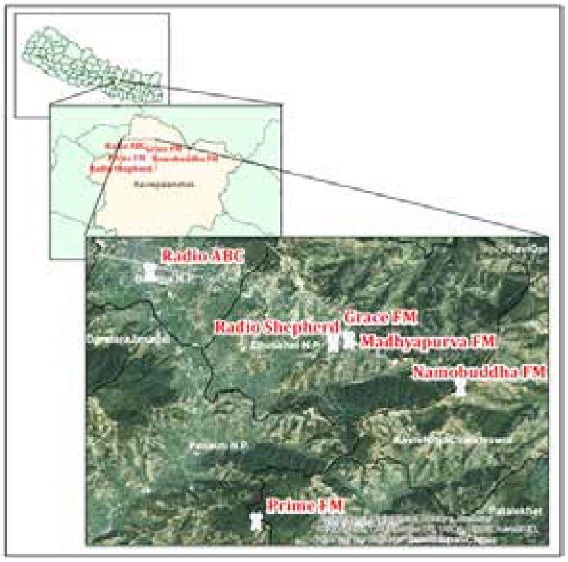


Figure 1: Study area

4 METHODOLOGY

4.1 Data Collection

The primary data for the study includes GPS coordinates of transmitting tower and bearing of antenna. A technical datasheet was prepared to collect the secondary data from each FM station. It includes radio station details (station name, frequency), radio transmitter details (transmitter power, model), and antenna details (antenna height, model). Along with these, antenna gain was obtained from **manufacturer's specification list.** For elevation data, SRTMv3 (*version 3*) of accuracy 90m was downloaded from USGS website.

4.2 Mapping

Radio Mobile computer program, a free software written and maintained by Roger Coudé, is used for this study to map the coverage of FM stations. It is a radio propagation simulation program which operates over the frequency range of 20MHz to 20GHz. It uses Longley-Rice Propagation Model and follows the radio signal mapping recommendations made by International Telecommunications Union – Radio Communications (ITU-R). The Longley-Rice model, which is based on electromagnetic theory and on statistical analyses of both terrain features and radio measurements, predicts the median attenuation of a radio signal as a function of distance and the variability of the signal in time and in space (Longley and Rice, 1968). All radio coverage is based on probability theory. Radio coverage is affected by weather and atmospheric conditions on a continual basis (Henderson B. J., 2011). Study of atmospheric effect on these signal coverage is beyond the scope of this project.

For mapping signal coverage, primary and secondary data were given as input in the software. Two units namely FM station whose coverage is to be prepared and Mobile, the receiver were defined. The path to the SRTM data was defined to extract the elevation map for the area of interest taking the location of transmitting tower as the centre. The colored elevation map extracted was changed to grayscale so that the coverage plot when overlaid can show the colors defining signal levels clearly. After this, pixel resolution for the output map was defined to align with the resolution of elevation data used. Combined Cartesian coverage plots were generated one at a time for all stations that uses an X-Y rectangular method of calculating coverage. Apart from the plots, a kml layer showing the coverage is also generated which can be visualized in Google Earth. The prepared coverage plots were mapped in a GIS environment by georeferencing and transforming to WGS 1984 Universal Transverse Mercator Zone 45N.

4.3 Validation of Coverage Maps

Value	Interpretation
4	Perfectly clear, no station-specific noise
3	Noticeable noise a minority of the time
2	Consistent noise, but still understandable
1	Hard to understand
0	No Signal

Table 1: Evaluation table for validation at field

In order to check the accuracy of the coverage maps of FM stations, field validation was carried out with respect to map information. Multiple ring buffers at distance of 2 km were created each using location of transmitting tower as a centre point. At every circle, some accessible places were selected and visited to evaluate signal quality by using a mobile phone. The coordinates of selected places were also obtained using GPS and then plotted in the coverage map. The evaluation of radio signal was done by analyzing its quality as shown in table 1.

4.4 Assessment of Parameters Affecting FM Signal Strength

An assessment of the parameters that affect the strength or power of the radio signals was performed. For FM stations the signal strength is determined by height of antenna location, antenna gain and power of transmitter.

5 RESULT AND DISCUSSION

5.1 Radio Signal Coverage Map of Radio Stations

Combined Cartesian coverage maps for each FM stations are produced from the software. The coverage is shown using multiple colours referred to as "rainbow" where varying colours represent various signal levels in dBμV/m. The coverage area displayed in red colour indicates highest signal strength (near the transmitting tower) and that displayed in blue color indicates least signal strength. The arrow in the maps shows antenna direction of transmitting tower. Coverage maps for each FM stations are shown in figure 5.

5.2 Result of Validation

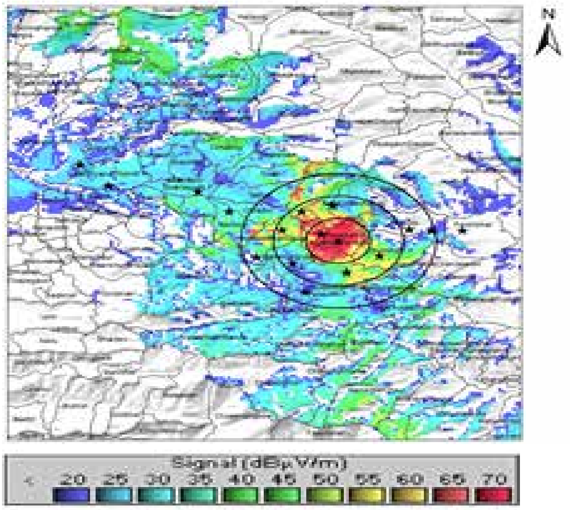


Figure 2: GPS location of selected points overlaid on coverage map for field validation.

The field validation of the coverage maps was carried out for two FM stations namely Grace FM and Radio ABC. The interpretation made in field based on evaluation table for each point was visually compared with the signal strength shown in maps. Based on our samples, the overall accuracy of coverage map was observed to be 85%.

5.3 Assessment Result

5.3.1 Height of Antenna Location

Among 7 FM stations, Radio ABC has the least height, so in spite of having the highest transmitter power i.e., 500 watt, the coverage of this FM is the least.

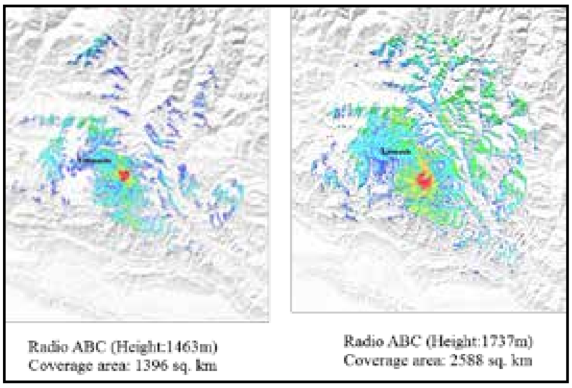


Figure 3: Comparison of antenna elevation

As shown in the figure 3, with the increase in height of transmitter station, the signal coverage also increases.

5.3.2 Antenna Gain

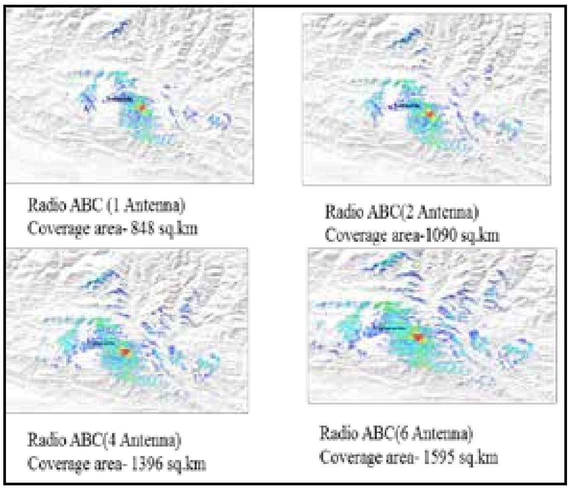
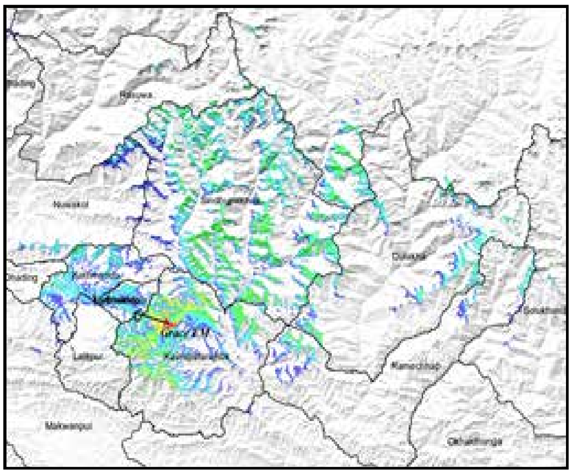
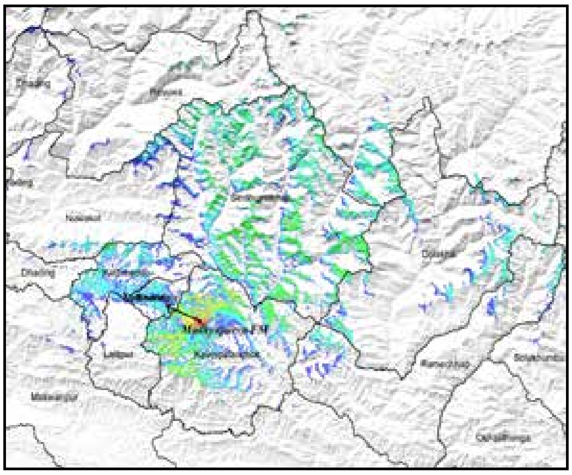


Figure 4: Comparison of antenna gain

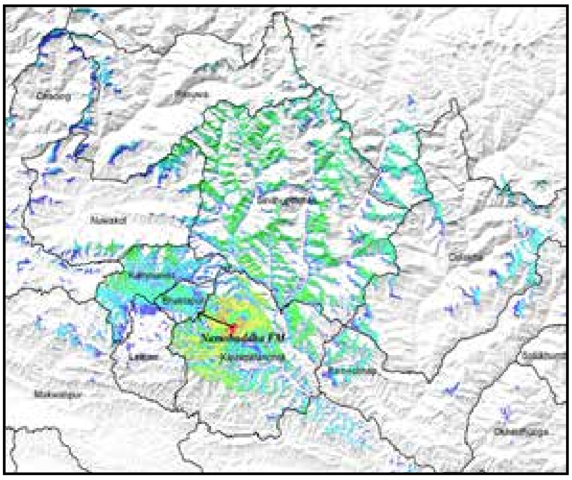
Grace FM



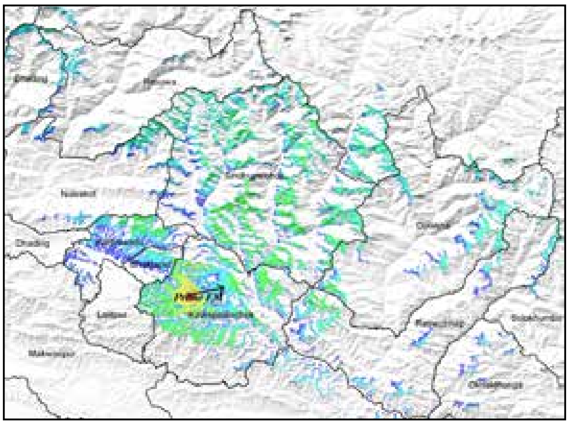
Madhyapurva FM



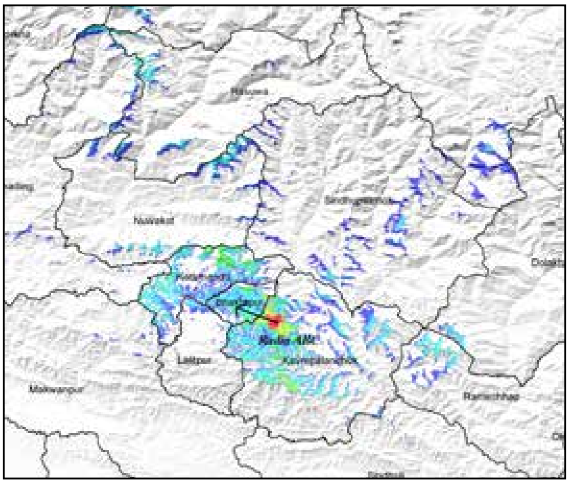
Namobuddha FM



Prime FM



Radio ABC



Radio Shepherd

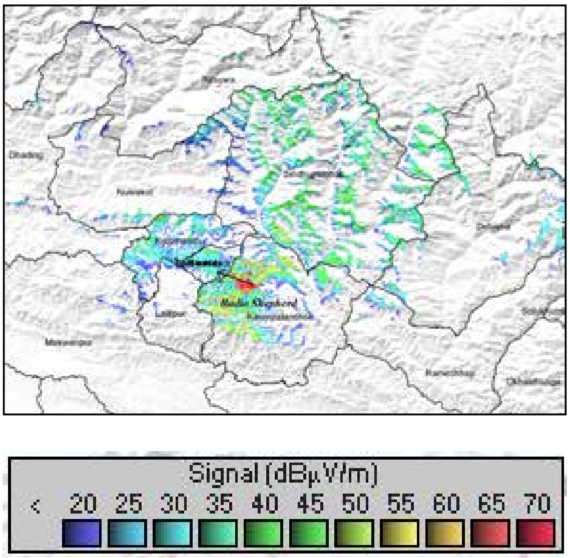


Figure 5: Coverage maps

Figure 4 shows that signal coverage area increases with the increase in antenna gain (considering other parameters constant). Increase in antenna gain increases signal transmission distance. However, as the antenna gain is increased, the signals get focused to one particular direction and therefore multiple antennas are required to set up to spread the signals in all directions.

Based on the output maps, Radio Shepherd, having transmitter power 50 watt, has coverage similar to other radio stations with 100 watt. This is because it has 6 antennas which results in more gain, unlike other stations which have 4 antennas. This also shows gain of transmission antenna is one of the major factors in determining the transmission capacity of the radio station_

5.3.3 Power of transmitter

The power of the transmitter is generally used to explain the broadcasting capacity of the radio station. The higher the power, higher is the signal strength. As shown in figure 6, keeping other parameters constant, coverage area increases with the increase in transmitter power.

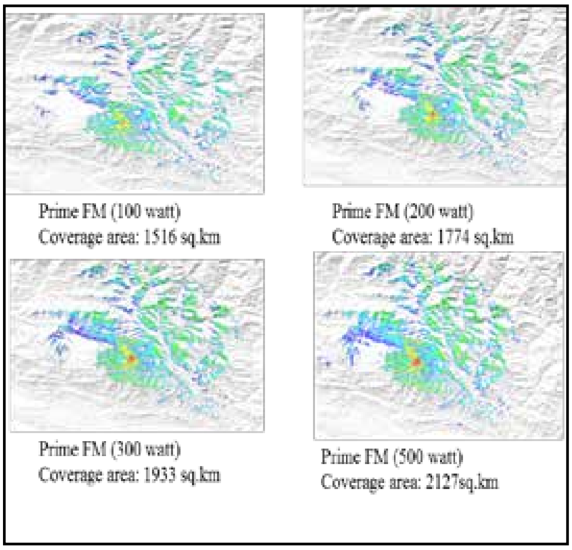


Figure 6: Comparison of transmitter power

6 Conclusion

The radio signal coverage mapping was done successfully with Radio Mobile software with the accuracy of 85%obtained through field verification. This shows that the software ‘Radio Mobile’ is applicable in our context. From above mentioned assessment, increasing the height of transmitter is found to be an effective way of increasing the coverage area of a particular FM station. So, it is better to set up transmission antenna at the highest point available in the locality. If possible, the antenna should be constructed at the top of a nearby hill or a high building. Also, increasing the power of transmitter in coordination with number of antenna can be another means to have maximum coverage. Such coverage maps help the radio broadcasters to take decisions regarding their need to increase signal reach and ensure sustainability.

7 Acknowledgement

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Survey of Location Sensing Techniques

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KEYWORDS

Location-based services ; Location Sensing; GPS; IP based Positioning; RSS; VLP

ABSTRACT

Location-based services (LBS) have wide applicability in areas like navigation, tracking, emergency services, gaming, persuasive applications etc. The core element of any LBS is its positioning technology. This paper reviews taxonomy of location sensing techniques. Then several location sensing techniques like Global positioning system, Visible light positioning, Cell-Id, Received signal strength, Image recognition and IP based geolocation is surveyed, summarized and classified. Finally, this paper identifies the similarity and differences in location sensing techniques, current research trends and also area for future study.

Introduction

The ability of mobile devices to be aware of it s location has opened door to multitude of applications. Most popular computer and mobile applications including Facebook, Twitter, Google map, Pokemon Go and Tinder are using location based service. However, location sensing techniques used in those applications are not same and vary based on methods, accuracy, environment of the usage etc.

Location sensing or position techniques are undoubtedly core element of any location based service. Location sensing can be considered as hybrid technology comprising of both the positioning, system which computes its own position and the tracking system which monitor tracked object without involving tracked object in computation [4]. Wide varieties of location sensing techniques are available and are continuously evolving. For the systematic study of these sensing technology different attempts has been mad e [3][14].

This survey paper aims to provide an overview of the most important sensing technique. This paper also aims to review different taxonomy attempts and compare them. The author hopes that this paper will highlight the existing knowledge in location sensing and also identify the limitations and research gap. The paper wil help researchers to select an appropriate sensing technique for their application or develop suitable sensing technique.

This paper is different from existing taxonomy and summary paper [12, 13, 14] because it intends to review some sensing techniques which were not classified before. Moreover, this paper also aims to assess existing approaches for taxonomy and identify their limitations.

In the rest of the paper, first existing classification approaches made for Location sensing are reviewed. Then we summarize some important papers related to location sensing techniques and also classify them. Finally, we conclude the paper with significant findings of the survey.

Taxonomy of location sensing Techniques

Various studies have been conducted to systematically classify location sensing methods. Location sensing techniques are classified based on how the location data are expressed, into Absolute, Relative, Anonymous or Symbolic data [3]. Absolute data is the absolute coordinate of adevice in terms of longitude and latitude. Relative data refers to a location relative to other device but does not have absolute coordinates. Motion sensors also identify presence of object however it does not ascertain the identity of the object. Such data are anonymous data. In this data you know something is present at any specific location but you don't know the id of that object. Further anonymous data can also be obtained in privacy preserving Location based services. Symbolic data does not have a geographic location in itself. However, it can be converted into geolocation in the subsequent step. IP address is an example of symbolic data.

Another paper which was published after a year categorized positioning technique into self-positioning and remote positioning based on whether the object to be positioned knows its location or not [14].

In self-positioning approach, receiver receives signal (electromagnetic wave) transmitted by terrestrial or satellite antenna and calculates its own positions. So the receiver is the object to be positioned and knows its own position. The examples of such approach as mentioned in the above paper are GPS and Assisted GPS (A-GPS), Indoor Global Positioning System (Indoor GPS) and Mobile Terminal Positioning over Satellite UMTS (S-UMTS). A-GPS uses data from mobile network to assist faster location. Indoor GPS uses pseudo satellites to generate GPS like signals in indoor environment. S-UMTS is also form of GPS which uses only two satellites so there is no need of dedicated satellites.

In the remote positioning approach the object to be positioned either reflects signals transmitted by the set of receivers or emits the signals which are then received by the set of receivers. The signal measurements are then used to compute the location of the object. So the object to be positioned does not know its location. Its examples as described in the paper are Cell Identification (Cell-ID), Direction or Angle of Arrival (AOA) and Time delay positioning.

Location Sensing Techniques

This section briefly summarizes some important location sensing techniques. Finally, table presented at the end of this section classifies the location sensing technique reviewed during the survey.

Global Positioning System (GPS)

GPS is the most commonly used outdoor sensing technology [13].It is a satellite-based navigational technology which uses radio signal broadcasted by a group of satellites which are orbiting around the earth. These signals are received by receiver and distance of satellite to the receiver is computed based on the transit time of signal. The distance from at least three satellites is used to compute the position of receiver based on the principle of trilateration.

GPS give precise position and are cost efficient because of the availability of inexpensive receivers and GPS antenna are already installed and there is no cost for the user. Therefore it is most appropriate technology for outdoor sensing.

However, near dense trees and tall buildings signals are obstructed and do not give good fix. Nevertheless due to the availability of a large number of satellites than required this problem can be resolved. Another issue with GPS based positioning is it consumes a large amount of battery.

The energy consumption can be reduced up to 90% by optimizing algorithm in such a way that only positioning method with least energy consumption get activated [1].

Visible Light Positioning (VLP)

Though GPS is precise, cost efficient and flexible positioning technique, it is unsuitable for indoor positioning and the places where signals are blocked by trees or buildings.

The proliferation of white LEDs provides an alternative for indoor location sensing system. Visible light transmitted by the LED can be used to determine the position of an object within a room [7].

The visible light positioning sensor uses the received signal to determine distance and or direction to the number of LED transmitter. These measurements are used to compute the position of the receiver either using triangulation or trilateration [8]. Though it is not possible now to envisage all the use of LED based positioning, It will surely have a multitude of applications in future for indoor positioning.

Luxapose is an example of VLP which uses unmodified camera present in a commercial smartphone as receiver and slightly modified LEDs to allow rapid blinking as signal. Smartphone receives transmissions using its camera and determine its location and orientation using an angle-of-arrival localization algorithm. It not only computes the position but also provide the orientation of the receiver [6].

Vision Based Positioning

One of the uses of Image matching technique is location sensing. Vision based positioning using Augmented reality [5] recognizes location from image taken in indoor environment by comparing it with previously made database and location model of indoor environment. The average recognition rate in this system was found to be 89%.

IP Address based Positioning

IP address of a computer is widely being used to compute location of the user. Based on the location we are getting tailored advertisement, search results, web content and security warnings in different websites.

Each IP address is mapped to a location and ip of the user is compared to that database. There are several databases that provide IP geolocation but their reliability can be questioned [10]. There are not many studies that access the reliability and accuracy of IP geolocation. This study published on 2011 claims to be first study which uses ground truth to access the reliability of IP geolocation. Based on this study there is bias in mapping location of few popular cities. Thus IP geolocation can be claimed to be accurate to the country level only but not city level.

Received Signal Strength (RSS) based Positioning

Radio-frequency identification uses the electromagnetic field to detect tag present in the vicinity. This technology has been used for tracking goods in warehouses, tracking livestock and in industries to track progress in assembly lines.

SpotOn [3] is a pioneer work where an active tag is used for location sensing through analysis of the strength of radio signal . The principle of SpotOn is that multiple base stations provide signal strength data to an active tag whose approximate distance is known. The server then aggregates all the measurement and compute precise location based on the principle of triangulation. This system prov ided accuracy of about 3 meters. The accuracy might not be sufficient for positioning within a room. Still, it provides theoretical basis for future research.

Later signal strength based positioning research focused on fingerprinting technique which performed better than triangulation based computation. In fingerprinting technique first training database is built then this database is used for positioning. RSS positioning was basically developed for the indoor system but fingerprinting also perform ed well in the outdoor environment [11]. In the above study Wifi signal and fingerprinting was used to find the location in the outdoor environment. The study was conducted in CBD area of Sydney and result in an accuracy of 35 meters on an average.

Location Sensing Technique	Environment	Technology	Data Expression	Position Fixing	Position Awareness
Fingerprinting	Indoor/ Outdoor	Wi-Fi	Relative/Absolute	Fingerprinting	Self-Positioning
Spoton	Indoor	RFID(Radio Frequency)/wifi	Relative/Absolute	Trilateration	Remote Positioning
Luxapose	Indoor	Visible Light	Relative	Triangulation	Self-Positioning
IP Based	N/A	Database driven	Absolute/ Symbolic	Database Mapping	N/A
GPS	Outdoor	Radio Wave	Absolute	Trilateration	Self-Positioning
Cell ID	N/A	Radio Wave	Relative/Absolute	Proximity Sensing	Remote Positioning
Vision based position	Indoor	Object recognition	Symbolic	Image matching	Remote Positioning

Table 1 Classification of Location Sensing Methods

Cellular Network based Positioning

The cellular tower has a zone of radio frequency around it which is known as a cell. When a cell phone enters to that zone cellular tower recognize it. Thus the approximate position of the device can be known based on the cell tower that device is using. The accuracy of this method is low ranging from 200 meters to kilometers [2]. Nevertheless, the accuracy can be increased by increasing number of cells

Conclusion

In this paper, we surveyed major location sensing techniques. Different approaches of taxonomy of the location sensing techniques were also reviewed in this paper. Furthermore, we also classified the surveyed location sensing techniques into different categories.

From this study we identified GPS is most popular outdoor positioning technique. We also identified the research in indoor sensing is rapidly increasing in recent years. Regarding outdoor positioning, developing energy efficient algorithm is new research trend. This survey also suggests that the VLP has huge potential in indoor navigation. Though IP based Geolocation is becoming popular, study claims that the current location mapping database can be used with certainty only at country level [10].

It can also be inferred that existing positioning techniques compute location from either solving triangle (using range measurement or angle measurement) or some kind of database mapping.

Based on the survey we also identified few research gaps in location sensing technique that should be addressed in future. The accuracy requirement for different location based system is different and the application might not work in desired way when accuracy requirement is not meet. So location based application should be aware of the accuracy also. Existing study is lacking to address this issue.

Also there is limited research about IP based Geolocation and its accuracy. Furthermore we observed that most of the studies that we considered do not address temporal dimension of geospatial data. So study is needed to define temporal extent, temporal accuracy and time sequence of spatial data.

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CALENDAR OF INTERNATIONAL EVENTS

10th International Symposium On Mobile Mapping Technology and Summer School on mobile Mapping
Date: 06-08 May, 2017
Country: Cairo, EGYPT
Website: http://mmt2017.aast.edu/index.php

The 37th International Symposium on Remote Sensing of Environment
Data: 08-12 May 2017
Country: Tshwane, SOUTH AFRICA
Website: http://isrse37.org/

Pre-conference Workshop of the 20th AGILE International Conference on Geographic Information Science 2017
Data: 09 May 2017
Country: Wageningen, THE NETHERLANDS
Website: http://geosem.ntua.gr/

GEOMATICS & RESTORATION: Conservation of Cultural Heritage in the Digital Era (Conference and Workshop)
Data: 19-24 May 2017
Country: Florence, ITALY
Website: http://geores2017.geomaticaeconservazione.it/

FIG Working Week 2017
Data: 29 May - 02 Jun 2017
Country: Helsinki, FINLAND
Website: http://www.fig.net/fig2017 `

ISPRS Hannover Workshop
Data: 06-09 Jun 2017
Country: Hannover, GERMANY
Website: https://www.ipi.uni-hannover.de/hrigi17.html

GeoInformatics Summer School 2017
Data: 29 May- 9 June, 2017
Country: Wuhan, China
Website: http://www.lmars.whu.edu.cn/geosummerschool/

8th International UBI Summer School 2017
Data: 12-17 Jun 2017
Country: Oulu, FINLAND
Website: http://ubicomp.oulu.fi/ubiss/

Remote Advances in Space Technologies, RAST 2017
Data: 19-22 Jun 2017
Country: Istanbul, TURKEY
http://www.rast.org.tr/

International Workshop on the Analysis of Multitemporal Remote Sensing Images
Data: 27-29 Jun 2017
Country: Bruges, BELGIUM
Website: https://multitemp2017.vito.be/

2017 International Symposium on Planetary Remote Sensing and Mapping
Date: 13-16 August 2017
Country: Hong Kong
Website: http://event.lsgi.polyu.edu.hk/prsm2017/call.html

The ISPRS Geospatial Week 2017
Data: 18-22 Sept, 2017
Country: Wuhan China
Website: http://gsw2017.3snews.net/

38th Aisan Conference of Remote Sensing 2017 (ACRS 2017)
Data: 23-27 Oct, 2017
Country: New Delhi, India
Website: http://www.acrs2017.org/index.html

Applicability of Stream Order Data for Morphometric Analysis and Sub-watershed Prioritization

Shobha Shrestha, PhD

KEYWORDS

Morphometric Analysis, Watershed planning and management, Sub-watershed prioritization, GIS, Kailash Khola, Stream order, Spatial data

ABSTRACT

Sub-Watershed management and planning is integration of both technical and social aspects. Physical assessment of sub-watershed includes among many other bio-physical parameters, the morphometric analysis. The current study examines the applicability of existing stream order digital data for morphometric analysis and sub-watershed prioritization of Kailash Khola watershed. The study is based on secondary data and desk study and uses GIS data produced by Survey Department of Nepal and GIS tool for the analysis. Three linear and three aerial/ shape parameters are taken for the morphometric analysis and simple ranking method based ob calculated value is applied for sub-watershed prioritization. Technological tools like GIS and Remote Sensing has aided for spatial analysis using morphometric method. The study show that variation is found in vulnerability of sub-watershed in terms of linear and aerial morphometric parameters. The finding show that western part of the watershed is relatively vulnerable in terms of potential soil erosion and flooding. The study concludes that the importance of readily available stream order digital data and GIS tool and technology in identifying and analyzing priority sub-watershed is reasonable. However, it is realized that spatial data at more finer spatial scale will improve the analysis and provide better analysis result and exemplify local problems in the area of topographical variation. The study suggest that, introduction of stream order data set finer scale or will allow analysis to be performed at much greater so that more localized effect of drainage morphometry in varying topographical landscape of the country could be assessed.

Introduction

Different analytical approach to watershed management is in practice such as watershed management as a process of planning and implementation, as a planned system of management measures and implementation or as a set activities for specific management tasks (FAO,1986). A standard process of watershed management begins with the problem identification such as land and water resources degradation leading to resource management task. In this setting, assessment of drainage, geomorphology, physiography, soil and land use - land cover is one of the important step of watershed planning and management. The potential role of spatial information in improving natural resources depletion and land degradation problem is realized for long (Sugarbaker, 2000). In recent years, with the advent of application-ready geospatial data and tools like Remote sensing and GIS, spatial assessment of resources has become simple and universal for watershed planning and management. Morphometric analysis using various linear, aerial and relief parameters is one of the important tool utilized for assessment of watersheds for soil conservation and water resource management at micro level. The morphometric analysis of watershed gives quantitative description of the hydrological system which is significant to understand the structural, lithological, geomorphological aspects of the watershed (Strahler,1964). Previously, morphometric parameters were measured manually but nowadays GIS provide flexible environment and powerful tools for integrating, manipulating and analyzing such spatial information. It aids on the challenges of understanding the hydrological behavior, environmental management and public policies (Martins and Gadiga, 2015). Several studies have been carried out using GIS and morphometric analysis to understand the watershed dynamics and their usefulness in watershed prioritization and management in terms of soil erosion, flood hazard risk and landslide studies, groundwater potential assessment and natural resource management(Biswas et. al., 2014). However, base line spatial data is prerequisite for carrying out morphometric analysis in GIS environment. River network, watershed boundary or contour/ elevation/DEM data for watershed boundary delineation are basic requirement. In this context, the present study is an attempt to explore the efficacy of digital spatial data layer from Survey Department of Nepal in order to assess watershed condition based on morphometric analysis.

Study Area

Kailash Khola watershed is selected as a study area. It lies in the Achham district of far western development region of Nepal and occupies 224 Km2 area. The Kailash river flows from east to west indicating slope gradient of the region. Sub-tropical climate is found in the lower western part of the watershed whereas upper eastern part has temperate climate. Average annual rainfall of the area is 130mm. The elevation ranges from 657m to 3163m with average elevation of 1665m. Most part of the watershed has steep slope and more than 80% of the area lies above 30 percent slope. Agriculture is dominant land cover occupying 49.7% of the total area followed by forest with 47%. Settlement concentration is higher regarding the settlement distribution within the whole district.

Data Base and Methodology

The present work is based on use of existing application ready spatial data for morphometric analysis of Kailash Khola watershed. To assess the morphometric conditions, secondary GIS data sources such as contour and spot height data from 25000 scale and river network data of 100,000 scale digital topographic maps were compiled. Watershed and sub-watershed boundaries were delineated using these base data in GIS platform to carry out watershed and sub-watershed level morphometric analysis. Morphometric analysis starts with the stream ordering and sub-watershed delineation. In Kailash Khola watershed, stream order up to level five is identified and total of 12 sub-watersheds are delineated. After stream ordering and sub-watershed boundary generation, various morphometric parameters were calculated using standard method for the analysis. The basic, linear and aerial morphometric parameters such as area, perimeter, basin length, bifurcation ratio, drainage density, stream frequency, form factor, circulatory ratio, and compactness coefficient were computed based on the methods suggested by Horton (1945), Miller (1953), Schumn (1956) and Strahler (1964). Definitions of these morphometric parameters are as following:

Stream order is defined as a measure of a position of a stream in the hierarchy of tributaries (Strahler, 1964). Stream order of the river data is based on the hierarchical ranking of Strahler. Basin length refers to the aerial distance between the watershed inlet and outlet point (Schumm, 1956). Bifurcation Ratio refers to the number of streams in a low order to the number of streams in the next high order (Horton, 1945). Drainage density is the ratio of the total length of the streams of all orders of basin to the area of the basin (Horton, 1945). Stream Frequency is the total number of stream segments of all orders per unit area (Horton, 1945). Form factor is the ratio of basin area to the square of basin length. For perfectly circular basin the value of form factor would always be 0.7854 (Schumm, 1956). Circulatory ratio is the ratio of basin area to the area of circle having the same perimeter as the basin (Miller, 1953). Compactness Coefficient is the ratio of perimeter of watershed to circumference of circular area, which equals the area of the watershed (Horton, 1945).

Each parameter is ranked as per the calculated values. Linear parameters value such as of bifurcation ratio, drainage density and stream frequency have positive relationship with erodibility hence, higher rank is assigned for higher value for linear parameter. In contrast, aerial or shape parameters have inverse relationship with the erodibility and lower the value, more will be the erodibility. Therefore, higher values are assigned lower rank in case of aerial parameter. The compound value is calculated summing all individual parameter rank and the sub-watershed with lowest compound value has been given highest priority.

Result and Discussion

Morphometric Analysis

Morphometry is the measurement and mathematical analysis of the configuration of the earth's surface, shape and dimensions of its landforms (Clarke, 1966). It is the measurement of the surface form of a drainage basin, and of the arrangement and organization of the associated river network. It is carried out through measurement of linear, aerial/shape and relief aspects of basin and slope contributions. It provides information about the basin characteristics in terms of slope, topography, soil conditions, runoff characteristics and surface water potential etc. The Morphometric characteristics of different sub-watersheds indicate their relative characteristics with respect to hydrologic response of the watershed.

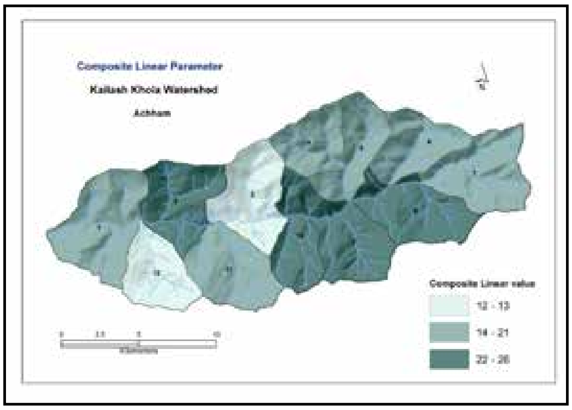
Linear parameters:

Linear parameter includes, drainage density, bifurcation ratio and stream frequency. In general, lower drainage density is found to be associated with regions having highly permeable subsoil material and high value of drainage density is noted for the regions of weak or impermeable subsurface materials (Nag, 1998; Pidwirny, 2006). The drainage density (Dd) of Kailash Khola is 1.45 and sub-watershed number 4 has the lowest calculated Dd value (1.28) indicating low runoff and high permeability whereas sub-watershed number 2 has the highest Dd value (1.67) suggesting high runoff and low recharge. However, relative relief and slope steepness largely controls the drainage density. Stream frequency on the other hand reflects the texture of a stream network and reflects the bedrock properties such as fracture density and infiltration. Though sub-watershed number 1 is the largest in size, sub-watershed number 6 has the highest stream frequency suggesting impermeable sub-surface material and low infiltration. Similarly, the lower bifurcation ratio values are the characteristics of structurally less disturbed watersheds without any distortion in drainage pattern (Strahler,1964). Sub-watershed number 9 has the highest bifurcation ratio among other 12 sub-watersheds of Kailash Khola indicating high runoff, low recharge and mature topography whereas sub-watershed number 3 has the lowest value indicating structurally less disturbed sub-watershed but higher risk of flooding. However, compound linear parameter value shows that sub-watershed number 8 is most vulnerable and sub-watershed number 12 is the least vulnerable in terms of erodibility. Details of calculated values of linear parameters are provided in the table 1 and composite linear value is plotted in figure 1.

Table 1: Linear Morphometric Paramters

Sub-watershed	Area Km^2	Perimeter Km	Stream Count	Basin Length	Bifurcation Ratio	Drainage density	Stream Frequency	Linear Parameter
1	25.95	22.32	68	8.40	1.07	1.42	2.62	20
2	19.41	19.45	67	7.12	1.03	1.67	3.45	22
3	20.51	20.44	61	7.35	0.82	1.44	2.97	13
4	13.88	15.15	31	5.89	1.26	1.28	2.23	18
5	14.96	20.23	53	6.14	1.92	1.47	3.54	21
6	15.76	17.85	69	6.33	1.02	1.66	4.38	18
7	22.03	20.89	61	7.65	1.01	1.48	2.77	18
8	21.02	22.34	58	7.45	1.27	1.49	2.76	26
9	18.43	17.57	39	6.91	2.66	1.31	2.12	25
10	16.53	20.45	34	6.50	1.01	1.45	2.06	24
11	20.58	18.23	43	7.36	0.71	1.38	2.09	17
12	15.86	16.98	34	6.35	0.69	1.30	2.14	12
Total	224.94	231.90	621	28.63	1.29	1.45	2.76	

Figure 1:Composite Linear Parameter



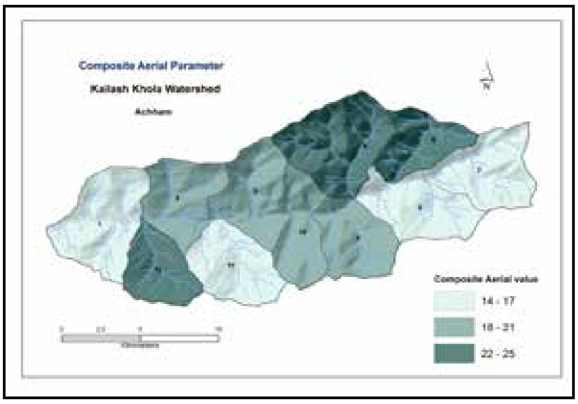
Aerial parameter:

Aerial or Shape parameter includes form factor (Rf), Compactness coefficient (Cc) and Circulatory ratio (Rc). Form factor is inversely related to the shape of the watershed. Smaller the value of form factor, more elongated and irregular will be the shape and watersheds with high-form factors experience larger peak flows of shorter duration and hence difficult to manage the floods. Among 12 sub-watersheds of Kailash Khola, there is not much variation and most of them reflects elongated shape. Sub-watershed number 1 has the lowest value indicating more elongated and irregular shape and low peak flow of longer duration. Whereas sub-watershed number 4 and 5 tend to be relatively circular suggesting high peak discharge and caution for flood management. Compactness coefficient value is associated with erosion assessment. Higher coefficient values denote more elongate watershed and slow discharge with potential of less erosion, while lower values indicate less elongation and faster peak discharge with potential of high erosion. Sub-watershed number 5 of Kailash Khola has the highest value indicating less erosion potential in the area whereas sub-watershed number 11 has high erosion potential. Similarly, circularity ratio indicates the potential of erosion and flood hazard. Higher the value, faster is the runoff and more is the possibility of erosion and flooding. The calculated Circulatory Ratio value is lowest for sub-watershed number 5 (0.46) indicating more elongated and irregular shape and low peak flow of longer duration with less potential of erosion and flood, whereas the highest value is of sub-watershed 11(0.78) suggesting relatively circular shape, high runoff and faster peak discharge with potential of erosion and flooding. Detail aerial parameter values are listed in table 2 and composite aerial parameter value is plotted in figure 2.

Table 2: Aerial Morphometric Parameters

Sub-Watershed	Form Factor	Compactness Coefficient	Circulatory Ratio	Composite Linear Value	Composite Aerial Value	Compound Value
1	0.37	1.24	0.65	20	14	34
2	0.38	1.24	0.65	22	19	41
3	0.38	1.27	0.62	13	18	31
4	0.4	1.15	0.76	18	25	43
5	0.4	1.48	0.46	21	24	45
6	0.39	1.27	0.62	18	23	41
7	0.38	1.26	0.63	18	15	33
8	0.38	1.37	0.53	26	16	42
9	0.39	1.15	0.75	25	20	45
10	0.39	1.42	0.5	24	21	45
11	0.38	1.13	0.78	17	17	34
12	0.39	1.2	0.69	12	22	34

Figure 2: Composite Aerial Parameter



Morphometric prioritization of sub-watershed of Kailash Khola is carried out combining three linear and three aerial/shape parameters. Linear parameters have a direct relationship with erodibility and the aerial/shape parameters have an inverse relation with linear parameters. Composite value of linear and aerial parameters are ranked and compound factor value is calculated and all sub-watersheds are grouped into three priority classes namely, Low, Moderate, and High (Figure 3). Lowest calculated compound factor value is for sub-watershed number 3 (31) followed by sub-watershed number 7 (33) and sub-watersheds 1, 11 and 12 (34) with High priority. Highest value is calculated for sub-watersheds 5, 9 and 10 (45) with Low priority. Result of prioritization of sub-watershed shows that sub-watershed 3 and 7, followed by 1, 11 and 12 are more susceptible to soil erosion as per morphometric analysis. Therefore, immediate attention towards soil conservation measures is required in these sub-watersheds to preserve the land from future erosion and natural hazards. Among 12 sub-watersheds of Kailash Khola, relatively vulnerable sub-watersheds in terms of erosion and flooding are located in the western part and towards lower elevation whereas there is one vulnerable sub-watershed in the east. Middle part of the Kailash Khola watershed is relatively less vulnerable. Watershed management and planning at sub-watershed level should be focused at earliest towards western part of the watershed.

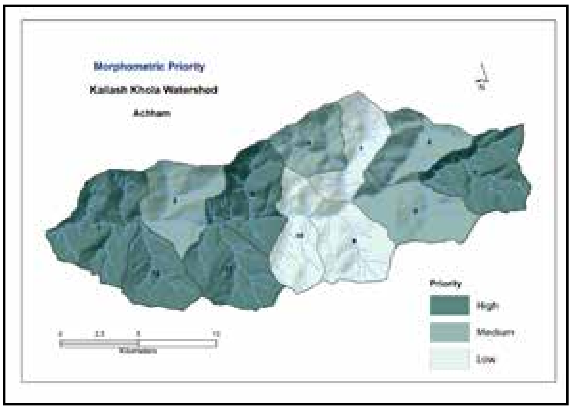


Figure 3:Morphometric Priority

Importance of stream order data

The current exercise demonstrate that taking some basic parameters, a problem area identification at first hand morphometric analysis could be carried out and based on the morphometric analysis. Identification of potential problem areas provides the basis for a targeted field assessment and using the data and maps created targeted field assessment could be conducted to verify and further describe erosion problem areas and key features. Finding sources of drainages and erosion areas is a critical step in developing comprehensive and effective solutions to erosion issues. Topography is the driving force behind surface water movement through watersheds, so the detailed river and elevation databases allow general users, managers, planners as well as hydrologists to predict the location and state of water related problems. The development of GIS capabilities and databases have greatly facilitated watershed research and planning efforts. GIS has enabled government agencies and private organizations to extend the delivery of their data from hardcopy maps to digital spatial data layer in various formats and scale. A good example of such is the digital topographical data of Survey Department of Nepal. Availability of such baseline digital data has impact beyond research as spatial analysis using these data influences planning, implementation and management of development projects for better interventions. However, it is realized that spatial data at more finer spatial scale will improve the analysis and provide better analysis result and exemplify local problems in the area of topographical variation. As depicted in figure 4, increasing aggregation consequently causes loss of information, complexities and incompleteness of information for decision making (Abson et al., 2012). As the stream order changes with the spatial detailing, all the morphometric parameters values will be changes and the prioritization of sub-watershed will ultimately change.

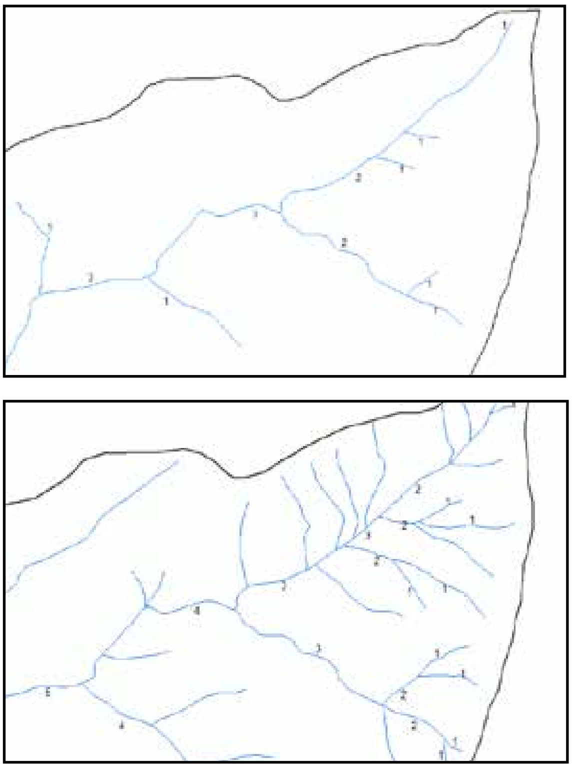


Figure 4:Effect of Scale on Spatial details

Stream order(Scale 1:100,000)

Conclusion

Number of studies reveal that the choice of data source and scale can impact analysis as they provide different results for the same geographical area. Number of morphometric analysis and prioritization of watershed and sub-watersheds have been carried out using existing DEMs such as ASTER, SRTM etc and creating streams, and watershed boundary. But using existing river data with stream order information such as one produced by Survey Department, aids morphometric analysis as well as prioritization. it also overcomes the problem of data unavailability at lower scale such as soil and geology for morphometric analysis and other land degradation assessment. This approach is simple to adapt and useful as it combines the best available information with the knowledge of users. Simple GIS techniques together with readily available stream order data and its interpretation offer a scope for determining the priority areas for watershed management and planning. It supports identification of sub-watersheds with relatively serious degradation problem for conservation activities according to level of need and degradation status. However, it is realized that spatial data at more finer spatial scale will improve the analysis and provide better analysis result and exemplify local problems in the area of topographical variation. The study suggest that, introduction of stream order data set finer scale or will allow analysis to be performed at much greater so that more localized effect of drainage morphometry in varying topographical landscape of the country could be assessed.

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Price of Aerial Photograph and Map Transparency

Product	Price per sheet
a) Contact Print (25cmx25cm) b) Dia-Positive Print (25cmx25cm) c) Enlargements (2x) d) Enlargements (3x) e) Enlargements (4x)	Rs 300.00 Rs 1000.00 Rs 1000.00 Rs 2000.00 Rs 3000.00
Map Transparency	
a) 25cm * 25cm b) 50cm * 50cm c) 75cm * 75cm d) 100cm * 100cm	Rs 310.00 Rs 550.00 Rs 800.00 Rs 1250.00
Diazo/Blue Prints Photo copy	Rs 80.00 Rs50.00
Photo lab facilities	US$ 200/day

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Price of Digital Topographic Data Layers

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Administrative	100.00
Transportation	200.00
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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.

Impervious Surface Detection in Semi-Urban Environment Using Lidar Data and High Resolution Aerial Photographs

Govinda Baral

KEYWORDS

Land use, land cover, impervious surface, semi-urban, object oriented classification, Australia

ABSTRACT

Land use information plays a vital role in effective management of natural resources in any country. It helps manage water, soil, nutrients and plants, animals and provides relationships between land use dynamics, economics and social conditions both in urban and rural areas. The land use and land cover mapping is always a dynamic issue in every country because of the dynamic nature of the land use. Knowledge of land use change patterns has important implications in sustainable development and sustainable environmental management. Impervious surfaces are generally defined as any anthropogenic materials that water cannot infiltrate. Increase in impervious land in urban area is causing high accumulation of storm water during the wet season and causing widespread flooding. This research develops an improved method for impervious land use detection using object–oriented classification system. Although pixel-based approaches have certain strong merits and remain in widespread use, operating at the spatial scale of the pixel can have major drawbacks. Foremost among these is that a pixel's spatial extent may not match the extent of the land cover feature of interest. That is pixel's spatial extent may not match the extent of the land cover feature of interest-the problem of mixed pixels may lead to misclassification. Also, when object of interest is considerably larger than the pixel size such as VHR images, urban area comparisons show that the object oriented approach is superior to pixel based approach in terms of accuracy. Object Oriented classification technique is used to separate urban and non-urban features. Negative values of NDVI helped to classify impervious area. Non elevated impervious surfaces are well addressed by NDVI threshold. LiDAR data is used to separate elevated impervious area. By and large, the research shows that impervious land in urban area can be detected using the developed technique with satisfactory accuracy

1. Introduction

1.1 Background

Land uses changes impact on the natural resources and environment of Australia and result in issues such as soil salinity, acidification, rates of erosion, carbon losses and nutrient and water quality decline pose serious threats to land productivity. The provision of land use information is essential for the implementation of effective assessment and management solutions for these problems(Rowland et al. 2002). Impervious surfaces are generally defined as any anthropogenic materials that water cannot infiltrate(Lu et al. 2011). This research work focuses on the land use and land cover, it intends to study different methods of land use classification/ determination and develop an improved method for assessing land use change in semi-urban environments.

Pixel based image classification is a commonly used approach to study land cover/land use. A number of studies of comparison between the pixel based and object oriented methods have been carried out ((Bhaskaran et al. 2010; Cu et al. 2009; Matinfar et al. 2007; Oruc et al. 2004; Weih & Riggan 2008; Zhou et al. 2009). These comparisons show that the object oriented approach is superior to pixel based approach in terms of accuracy.

1.2 Significance of the Research

This research developed a method to map impervious land use in urban-rural fringe area using High Resolution aerial photograph and LiDAR based on Object-oriented classification method and see the change. Urban growth, changing from green vegetation to man-made infrastructure has different impacts on environment(He et al. 2011). This change especially in urban-rural fringe should be monitored on a regular basis. This study proposes a method to detect land use and its change in semi-urban area.

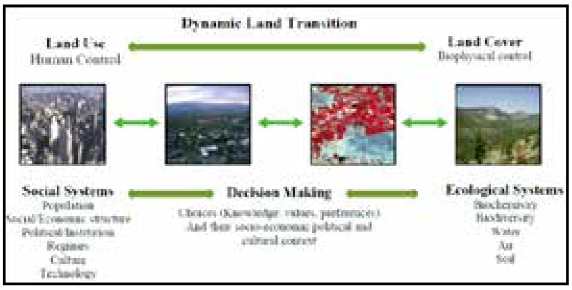

Figure 1-1. Land use-land cover relations(Adapted from Global Plan Report(GLP 2005))

The city of Toowoomba, in the Darling Downs, was hit by flash flooding after more than 160 millimetres (6.3 in) of rain fell in 36 hours to 10 January 2011; this event caused four deaths in a matter of hours. Cars were washed away. Toowoomba sits on the watershed of the Great Dividing Range, some 700 metres (2,300 ft) above sea level.

Figure 1-2. Toowoomba Flood event (Source: Google Search)

The urban impervious area can be estimated to be increased in Toowoomba because of which storms water was quickly accumulated and unexpected inland flood occurred. This research becomes more relevant in this scenario.

Given below are three images of northern part of Toowoomba of three different stages of time 2006(a), 2009(b) 2010(c) which shows the urbanization trend in growing city.

a b

c

Figure 1-3. Rapid urbanizing area. (Source: Fig. a and b: Google Earth)

2. Use of Object oriented classification

2.1 Object Oriented Classification

Object Oriented Classification, OO, is basically multi resolution segmentation, a patented technique for image object extraction. The segmentation can be used to construct a hierarchical network of image objects. The hierarchical structure represents the information of the image data at different resolutions simultaneously. Fine objects are sub-objects of coarser structures (Baatz et al. 2005). OBIA has been applied for many applications like mapping urban features (Bhaskaran et al. 2010), coal fire study (Yan et al. 2006), sea grass spatial structure mapping (Janas et al. 2009), flood risk and flood damage assessment (Vandersande et al. 2003).

2.2 Comparison between OBIA and Pixel based Classification

In Per Pixel Classification a pixel is assigned to a class based on its feature vector, by comparing it to predefined clusters in the feature space which requires definition of the clusters and methods for comparison. Object Oriented Classification is generally multi resolution segmentation and it can be used to construct a hierarchical network of image objects. Fine objects are sub-objects of coarser structures. Pixel's spatial extent may not match the extent of the land cover feature of interest-the problem of mixed pixels may lead to misclassification
(Blaschke 2010).

Lu et. al. (2011) developed a method based on combination of per-pixel based impervious surface mapping with filtering and unsupervised classification and sub-pixel based method with linear spectral mixture analysis (LSMA). According to Lu et. al. although this method can effectively map impervious surface distribution with Landsat and QuickBird images it has possibility of improving the accuracy using Object based classes.

Table 1: Comparison of Pixel based and Object oriented classification

Per Pixel Classification	Object Oriented Classification
• Pixel is assigned to a class based on its feature vector, by comparing it to predefined clusters in the feature space • comparing each pixel to predefined clusters, which requires definition of the culsturs and methods for comparison	• multi resolution segmentation • can be used to construct a hierarchical network of image obejcts • fine objects are sub-objects of coarser structures

Although pixel-based approaches have certain strong merits and remain in widespread use, operating at the spatial scale of the pixel can have major drawbacks. Chief among these is that a pixel's spatial extent may not match the extent of the land cover feature of interest. For instance, the problem of mixed pixels is well known, whereby a pixel represents more than a single type of land cover (Fisher 1997), often leading to misclassification. This can be compounded by the effect of the sensor point spread function on the area sampled per pixel. Another common problem, though, and one that is less often considered, is where the object of interest is considerably larger than the pixel size(Carleer et al. 2005). There are many research dedicated to compare pixel based approach and object oriented approach of land cover/ land use classification (Cu et al. 2009;

Matinfar et al. 2007; Watmough et al. 2011; Weih & Riggan 2008; Yan et al. 2006).

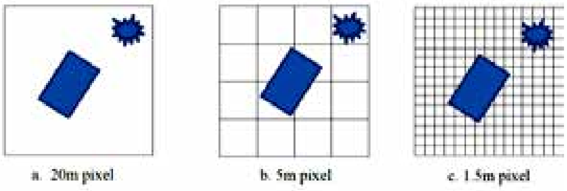

Figure 2-1: Relationship between objects under consideration and spatial resolution(Blaschke 2010)

The figure 2-1 above shows relationship between objects under consideration and spatial resolution: (a) Low resolution: pixels significantly larger than objects, sub-pixel techniques needed. (b) Medium resolution: pixel and objects sizes are of the same order, pixel by- pixel techniques are appropriate. (c) High resolution: pixels are significantly smaller than object; regionalisation of pixels into groups of pixels and finally objects is needed.

3. Method

3.1 Dataset used

High resolution aerial photographs and LiDAR point cloud datasets of Toowoomba, Australia were used for this research. The aerial photograph comprises of 4 bands – band 1,2 and 3 are in visible range and band 4 is infra-red. LiDAR data has an average ground spacing of 0.9 meter.

Figure 2-2: High resolution aerial photograph of project area

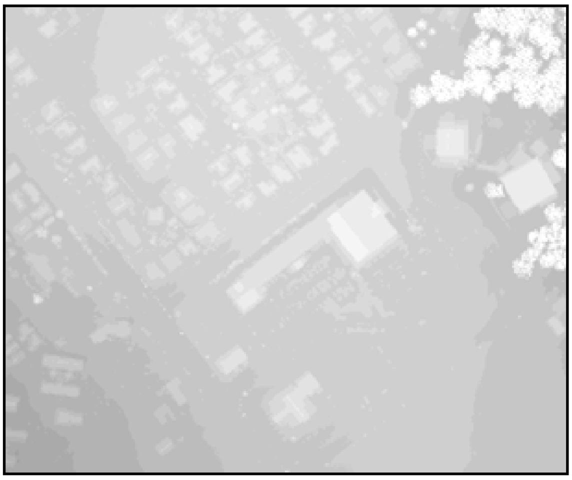

Figure 2-3: Digital Surface Model created from LiDAR point cloud.

Land use classes (ALUM Classification Version 6) developed by ACLUMP are the standard land use classes adopted in Australia. It has a three tired structure – Primary, Secondary and Tertiary. There are six primary classes- Conservation and natural environments, Production from relatively natural environments, Production from dryland agriculture and plantations, Production from irrigated agriculture and plantations, Intensive uses, and Water. Every primary class has different secondary and tertiary landuse classes. Following processes are adopted in the research to classify land use and detect impervious surfaces.

3.2 Date preparation

High resolution Aerial photographs and LiDAR data and other ancillary data are collected from Toowoomba Regional Council, Queensland. Their compatibility is checked. The data structure, suitability of the dataset to use in the research is confirmed.

3.3 Image processing

All the aerial photographs were corrected for radiometry and geometry. Digital Image Processing is largely concerned with four basic operations: image restoration, image enhancement, image classification, image transformation. Image restoration is concerned with the correction and calibration of images in order to achieve as faithful a representation of the earth surface as possible—a fundamental consideration for all applications. Image enhancement is predominantly concerned with the modification of images to optimize their appearance to the visual system. Visual analysis is a key element, even in digital image processing, and the effects of these techniques can be dramatic. Image classification refers to the computer-assisted interpretation of images—an operation that is vital to GIS. Finally, image transformation refers to the derivation of new imagery as a result of some mathematical treatment of the raw image bands.

3.4 LiDAR data processing

LiDAR points cloud is processed to create elevation model. Dilation filer is applied to model the manmade features in a regular and sharp shape. Digital Surface model is created using the first and last returns of the LiDAR data. This gives the impervious building structures and vegetation.

3.5 Image segmentation

The object oriented classification technique constitutes the two processes of object formation (Segmentation) and then labelling the objects thus formed (Classification). Before starting the classification process, segmentation process were done. Image segmentation is the process of completely partitioning an image into non-overlapping segments in the image space (Detwiler et al. 1985)via (Chen et al. 2009)). The resultant segmented objects represent the real world counterparts and are proper in shape. The segmentation algorithm used in eCognition software system is a region-growing method, the main idea of which is to collect the pixels whose attribute values represent a region. A seed pixel is first found as the springboard for region-merging. Neighbouring pixels with attribute values the same as or similar to that of the seed pixel are then consolidated into the region where the seeding pixel lies. The new pixels act as new seeds until no pixel fitting pixels remained. Essential parameters, such as band parting in operation, scale parameter, color criterion, and shape criterion (smoothness and compactness), are set to get ideal segmented results. Among these parameters the scale parameter is the most important factor in determining the size of the objects which decide the maximum allowed heterogeneity for the target image objects(Chen et al. 2009).

eCognition Professional software uses a multi-resolution segmentation approach which is basically a bottom-up approach region-merging technique starting with one-pixel object. In numerous iterative steps, smaller image objects are merged in to bigger ones. The outcome of the segmentation algorithm is controlled by scale and a heterogeneity criterion. The choice of segmentation parameters (scale, colour, smoothness, and compactness) are determined using a systematic trial and error approach and will be validated through visual inspection of quality of the image objects.

3.6 Selection of Algorithm and Image classification

Actual classification will be performed based on the data set and the rules created using a suitable classification algorithm. The actual classification was performed by using the Nearest Neighbour (NN) algorithm as the classifier allows quick and straightforward classification results. Potentially, it can use a variety of variables related to spectral, textural, shape and/or contextual properties of image objects.

3.7 Rule setting for land use classification

Based on the aerial photograph, LiDAR data and other data, different rules were created to assign land use classes to segmented objects. Elevation information, spectral reflection values, existing land use information, land cover information etc. was used to create rules. The classification result achieved through neighbour algorithm was refined by implementation of these rules. The rules were implemented by assigning a membership function. Membership function assigned will be equal to 1(“yes”) if the previously classified image object satisfies the rule condition. Otherwise, the class will receive a membership function value of zero ("No"). All the image objects not satisfying this rule will be assigned the second best class. The figure below explains the method implemented in the research. Normalized Difference Water Index, NDWI, and Normalized Differential Vegetation Index, NDVI were derived from high resolution aerial photograph which also contains infra-red band. The difference of first and last returns of LiDAR points, nDSM (DSM-DTM) will give building, tree, grassland and vacant land. Threshold values (a, b, c) were set for NDWI, NDVI and object height to delineate water (or shadow), vegetation and building structures. Cadastral (Tenure) information, existing land use, elevation information and the land cover objects generated during the classification process were used to implement different rules to find out urban and impervious land use classes. Vegetation and water classes were also extracted during the process although these are not the land use classes intended to classify. The reason of extraction of these classes is to map the changes from vegetation to urban impervious surfaces.

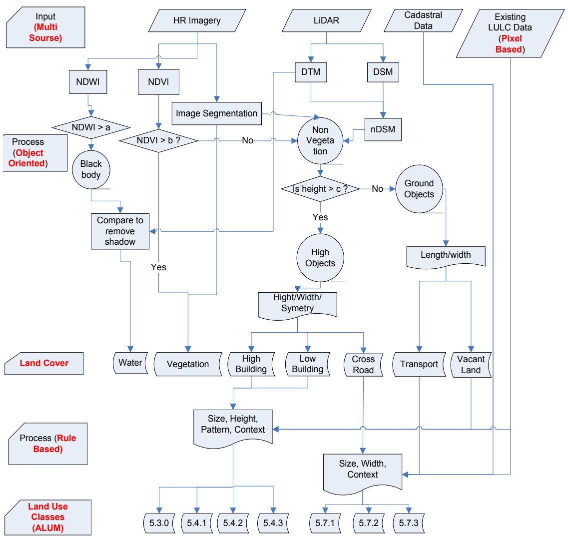

Figure 3-6: Workflow and example rules in OO classification

(5.3.0, 5.4.1, 5.4.2, 5.4.3, 5.7.1, 5.7.2, 5.7.3 are Land use classes in ALUM Classification scheme version 6.0(ACLUMP 2010a)) which come under impervious surfaces)

3.8 Land use class verification

After running the actual classification the primary result of classification are verified on the field and existing land use data to confirm the suitability of the algorithm selected and the rules created.

3.9 Adjustment in the rules and Classification of Images

Based on the result of preliminary land use classification and comparing with the existing land use maps and field verification, necessary adjustment was done in the rules to finalize the classification method.

4. Presentation of Result

Different impervious objects have different spectral characteristics. For example, building roofs with bright or white colour have high reflectance in visible, near-infrared (NIR) and shortwave infrared (SWIR) wavelengths; conversely, roads or building roofs with dark colours can absorb most of the solar energy, resulting in very low surface reflectance in the visible, NIR and SWIR bands. Therefore, bright impervious surfaces appear white, while dark impervious surfaces appear dark grey to black on the IKONOS colour composite image(Lu et al. 2011). The similar theory applies for all of the images in visible optical spectrum. The object oriented classification is presented in the figure below (Figure 4-1). The NDVI could not differentiate blue-painted roofs as impervious class. Elevation information was used to classify blue-painted roofs as impervious class. The part of image below represents different features. It includes concrete parking lot in a shopping mall, roads, driveways etc. Few tree canopies were also classified as impervious class, this is because of shadow of big trees over small ones. Elevation information from LiDAR DSM was used to differentiate between shadow and dark objects.

Figure 4-1: Impervious land use classes shown over aerial photograph (RGB).

The result was found satisfactory. Even small driveways of residential houses were classified as impervious surfaces. Due to unavailability of detailed land use classification map, it could not be compared with the existing land use map. The impervious land-use classes were then further classified according to the land use classes derived by Australian Land Use and Management (ALUM) classification scheme version 6. The classified land use classes were 5.3.0(Manufacturing and industrial), 5.4.x (Urban Residential, Rural Residential, Rural Living), 5.7.x (Transport and communication). The impervious land use classes detected by this method were validated by field visit and local knowledge.

Further research should be in developing methodology to classify all types of land use classes using object oriented classification method.

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State and Public Land Management: Issues of Encroachment and Protection Technique

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KEYWORDS

State and public land, Encroachment, Protection technique

ABSTRACT

The aspect of the management of state and public land directly supports to alleviating poverty, food sovereignty, protection of human rights and peace and security. So, management of state and public land directly or indirectly touches security of common property rights, pro poor and indigenous access to land and revenue generation for the state. State and public land are normally badly managed throughout the world because of its low national priority agenda and insufficient policy process, institutional arrangement and information aspects.

This paper assumes that, overall framework about policy, management and operational levels with external factors and review process of state land will enable for screening major concerns of reforming the regulatory framework, regularization of public land, complementary governance support, management rules for public property, improvement of institutional arrangements, data and information, users services, capacity building and user satisfaction. SWOT analysis has been performed to identify major factors of encroachment and strategies formulation for cases of protection technique.

Badly managed state land and low priority agenda is not only decreasing its efficiency but increasing encroachment options too. Mainly the unclear definition of state and public land tenure, lack of proper land governance, having gap and overlaps in institutional arrangement and lack of information are causes of inefficient management of state land, which lead not only misuse and bad allocation of land but highly motivate to lead towards severe encroachments.

1 Introduction

There are 1.6 billion poor people living in forested lands worldwide, nearly 80 percent of which is considered public and state land (Franco, 2008). Considering protection of state and public land is important issue of every national land administration because it is directly related with socio-economic development perspective and environmental sustainability of a country. It is important aspect as management of state and public land directly supports to alleviating poverty, food sovereignty, protection of human rights and peace and security. The management of state and public land directly or indirectly touches security of common property rights, pro poor and indigenous access to land and revenue generation for the state(FAO, 2013).

Generally, State land covers all land which is in control of state i.e. government owned land and public lands. State and public land tenure almost refers common property system. The existence of common property systems in many parts of the world imitates the importance of social relations as composite scopes of land tenure (Zhao, 2013). The equitable access on land for all social group is crucial for social agreement, which can be fulfilled by management of state and public land. State and public land management is a critical factor for ensuring good governance in the land administration of a country. So, this study mainly aims to identify issues of encroachment and development of protection technique

There is normally ambiguity in influential roles and responsibilities, a lack of accountability or procedure in the systems of distribution, appropriation, disposal or use of state and public land, and a lack of information on state resources (Zimmermann, 2008). Many different authorities and administrations have the legal responsibility to maintain records of state and public land and to protect it. There is more emphasis on the maintenance of records rather than the physical maintenance and management of state and public lands. The encroachment of state and public land is more affected by country's policy, process and institutional arrangement being existence of duplication, gap in responsibility. State and public land property are often mismanaged, and nearly all countries underutilize these resources in case of its use. Public land management is quite often inconsistent and argumentative because it is ruled by a top-down process that encourages favors to special benefits and stimulates divergence to obtain such favoritisms.

The conceptual framework for the study is set out in terms of policy aspect, institutional arrangement aspect and land information aspect for state and public land management. Identification of different aspect, indicators and best practices related to state and public land management are important part of study to recognize key factors of state and public land encroachment. After discussion and assessment about indicators and best practices, the conceptual framework performs SWOT analysis to formulate strategy. Conceptual framework for protection technique of state and public land management is shown as given Figure 1.

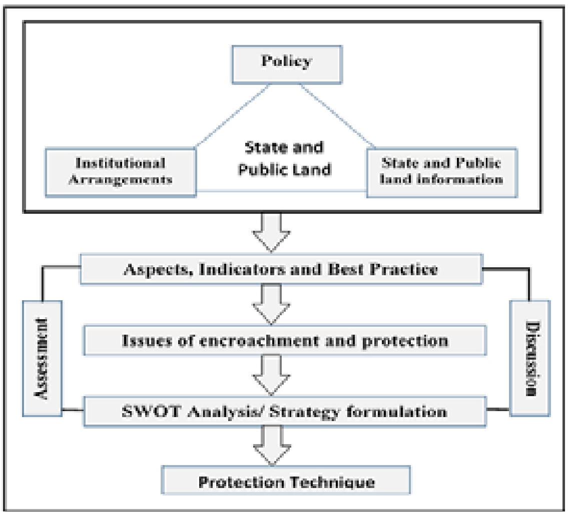


Figure 1: Conceptual framework

2 State and Public land management: An experience

State land management is the management of all state and public land (F. Thiel, 2009). Public land is base of development of any country to its social, economic and environmental perspective. Public land is highly important for public benefit. If it is properly managed and preserved, it can be an important resource for populaces and permits for sustainable development based on a rational stability of social needs, economic activity and ecofriendly management (Grover, 2008).It is directly related to income generation and access to land for poor people of nation. Public Land Management is the better technique for optimum utilization of natural resources of country.

Willi Zimmermann describes that the value of public land management by some of the statistics introduced as 37% surface area of the planet was owned by 147 states in which ultimate landownership was vested in the state and 21% of the planet was owned by 26 monarchs who held ultimate landownership. A further 30% of all land was common property, mostly in the form of property rights on state land (Grover, 2008).

2.1 The community and public land

Scholars, Gordon, Demsetz, and Hardin exploded a general concern that when property rights related to a valuable resource did not exist, the resources would be over collected (Ingram & Hong, 2009). The concept 'Tragedy of Commons' is more relevant with state and public land management. There appears some truth in the conventional belief that everybody's property is nobody's property. The property and wealth easily available for all is valued by none because he who is impulsive enough to wait for its proper time of us will only find that it has been taken by another(Gordon, 1954). In agrarian cultures, the social owner of common land is consistently a community. It is a fact that, generally, the larger a river, the less localized the claim upon it. As a rule, forest, pasture, marshland, and rangeland falling within the area of a particular group, village, or village group, are considered the assets of that community (Alden, 2011).

3 Assessment Framework

The way forwarded to evaluate the performance with well-defined objectives, clear strategy, outcomes and evaluation component can be adjusted with the diverse organization level such as policy level, management level and its external factors and review process described by (Steudler, 2004). As (Zimmermann, 2008) advocated about the following policies for improving the management of public lands i.e. Reforming the regulatory framework, the regularization of public land, land management rules for public property, fair and just compulsory acquisition, complementary governance support and the improvement of institutional arrangements are selected as possible aspect of public land management considering its policy, management and operational level of evaluation.

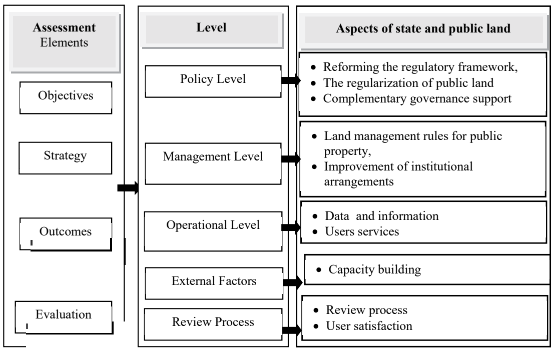


Figure 2: Overall evaluation framework adapted by concept of (Steudler, 2004) and (Zimmermann, 2008).

Data and information, Users services, Capacity building, Review process and User satisfaction aspect are chosen from "*Summary of evaluation framework for land administration systems*"(Steudler, 2004). For assessment of paper objective, Figure 2 shows the overall evaluation framework for public land management with combined conceptualization of scholar (Steudler, 2004) and (Zimmermann, 2008).

3.1 Possible aspects, elements, indicators and good practice criteria

This part tries to list possible aspects, elements, indicators and good practice criteria with reference of pre described framework as per Figure 2, which shows systematically different five levels and possible aspects within. There are lists of selected elements assuming that it will support to meet study objectives. Indicators and good practice are defined with review of literatures and country context of Canada, New Zealand and Korea assuming that these countries are better in public land management. Further, these selected elements and indicators are used for data collection methods.

Table 1: Identification of possible aspects, elements, indicators and best practice

Level	Possible Aspects	Elements	Indicators	Good Practice
Policy Level	Reforming the regulatory framework	Definition of state and public land	Use, Ownership defined	Clear Definition
		Land right	Rights offered	Secured right
	Regularization of public land	Formalization of informal right	Certificate of formalization	Certainty of rights (temporal/use)
	Complementary governance support	Legitimacy	Legitimate procedures	Consistent and coherent
		Fairness	Fair allocation of state/public land and rights	Un-biased allocation of land and rights
		Participatory	Participation of stakeholders in all kind of decision making	Each of the decision are taken from the active participation of relevant stakeholders
		Accessibility	Accessibility options and privileges to general users	Open, transparent, and simple system for accessing the data
		Transparency	Access to information	There is a good mechanism of accessing the data
			Awareness	General users are aware of the availability of information
			Publicity	Data, charts display Example: Signboard

Level	Possible Aspects	Elements	Indicators	Good Practice
Management Level	Land management rules for public property	Maintenance of Cadaster	Cadastral Coverage of state and public land	Complete and comprehensive cadastral system
		Registration	Registration of spatial unit and right	Complete registration of right, use and ownership
	Improvement of institutional arrangements	Accountability	Responsible staff and methods	Highly responsible staff and users in public land management
		Role and function	Role and functions defined	Roles and functions are clearly defined and there is no overlap in roles and functions
Operational Level	Data and Information	Completeness of records	Record keeping	Each individual parcel are recorded with necessary information
		Spatial data infrastructure	Availability of data, data sharing policy, Metadata	An efficient data modelling technique enabling an interoperable sharing of data
	Users services	Reliability	Number disputes	Numbers boundary disputes are low
		Accuracy of information	accurate information about public land	Information available for general public
External Factors	Capacity building	Land inventory	Number of inventory records about state and public land allocation, use and vacancy.	Periodical audit and fiscal control of state and public land
Review Process	User satisfaction	Reviewing process	Use and allocation of such land	When a regular review takes place and when customers are satisfied
		Users satisfaction	The satisfaction of the system user	

A well designed assessment framework for the state and public land management that incorporates all the evaluation areas, related aspects and corresponding indicators with its best practices is vital for the comprehensive assessment process. Hence this part tries to present a complete framework for evaluation. The evaluation of any activities is important because it serves to achieve objective and provides lesson for future guidance. Formally these frameworks are used in data collection and data analysis methods to meet study objectives.

4 Materials and Methods

The case study area was selected in Ward no 11 of Banepa Municipality, Kavrepalanchok district in Nepal. It was suitable for the study because there are ongoing different types of use, management and activities of public land in one hand and different encroachment issues are noticed in other hand. It is also suitable because the location contains geographical variation and spread commercial land to rural forest area within. Banepa is situated in a valley at about 4800 feet, above the sea level. Banepa, the historical town, about 26 km east from Kathmandu situated in Bagmati, Central Nepal and geographically located in 27° 38' 0" North, 85° 31' 0" East, which is shown in Figure 3.

Figure 3: Map of study area

The primary data collection and secondary data collection is important for every study which are based on spatial and household survey for this study. The selection of the key informant was fulfilled by cluster sampling technique. In case of data collection and its validity, the way of scientific approaches were applied. Ethical consideration was taken in high priority. The data processing and analysis of the qualitative data processing is done using Visio-2007, SPSS and also by the MS-Excel 2013 and for spatial analysis there is used Arc Map 9x.

5 Results and analysis

This part includes state land information on tabular format, map of state land encroachments of case study area. There is 126126 m^2 public land in study area in which only 56111 m^2 is found as barren or open public land.

S.N.	Public Land Type	Area/m^2
1	Barren(Open public Land)	56111
2	Road	34192
3	Stream	22786
4	Pond	2172
5	Building	2670
7	Nursery	8194
	Total	**126126**

Table 2: State and public land distribution

There is also sloppy forest in north side of study location covering area of 1041566 m^2. But in the legislation of Nepal, it is classified as state land and no public can directly use and enjoy it. Forest are restricted and protected resource in Nepal and committed to maintaining more than 40% area of national land area.

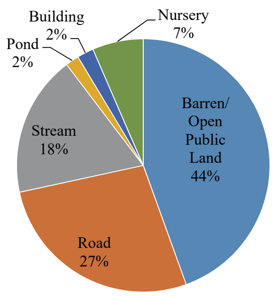


Figure 4: State and public land distribution

In total public land about 44% land exists as barren or open public land, 27% consists as road, 18% as stream, 2% as pond and government buildings and 7% used as restricted in purpose of Nursery, which is shown in Figure 4. There is easy access of highway and roads in about more part of public land in study area. They are also suitable for sheltering and performing different social recreational activities. But most of public land including forest area is out of access of road, inaccessible of services and slope ground nature.

The areas suitable for open space public land are allocated in so called different development and local activities. The maximum part of public land suitable for open spaces, parks and recreational area is already covered or used for other purposes i.e. for vegetable market and covered hall which replaced the community playground, same as for Red cross buildings and building for Journalist etc. which is shown in Table 3.

FID	Description	Area(m^2)
0	Vegetable Market and Covered Hall	7320
1	Red cross Building and Office of Journalist	6905
2	Animal Development Area (Pashu Bikash Ratmate)	1445
3	Bhakteshor School	1112
4	Road	672
5	Ward Office	165
6	Road	1162
7	Kavre Multiple Campus	3615
8	Road	1598
	Total Area	**23994**

Table 3: List of total used state and public land

There may be distinct positive impact of such allocation of the good characterized state and public lands in study area. But most of respondents do not agree that ongoing allocation of public land use is sustainable. In study area, about 23994 m^2 of public land is allocated for different social purposes where 32118 m^2 public land which is located in inaccessible and slope nature is remained, which is shown in Table 4. That data table shows that there is inconsistency and no plan in distribution and allocation of public land. The result can be analyzed as there may be lack of open space and public land access for purpose of parks, children entertainment spots, recreational area and spots for sheltering when disaster occurs.

FID	Description	Area(m^2)
0	Chandeshori Stream (Khola)	58
1	Kuikel Village (Gau)	7393
2	Kuikel Village (Gau)	711
3	Kuikel Village (Gau)	565
4	Chandeshori forest east	8864
5	Khatri Village (Gau)	1667

FID	Description	Area(m²)
6	Ratmate- Punyamati Riverside	700
7	Vegetable Market and Covered Hall	1266
8	Red cross Building and Office of Journalist	5166
9	Kavre Multiple Campus	2979
10	Chandeshori forest east	2748
	Total Area	**32118**

Table 4: List of total remained / vacant state and public land

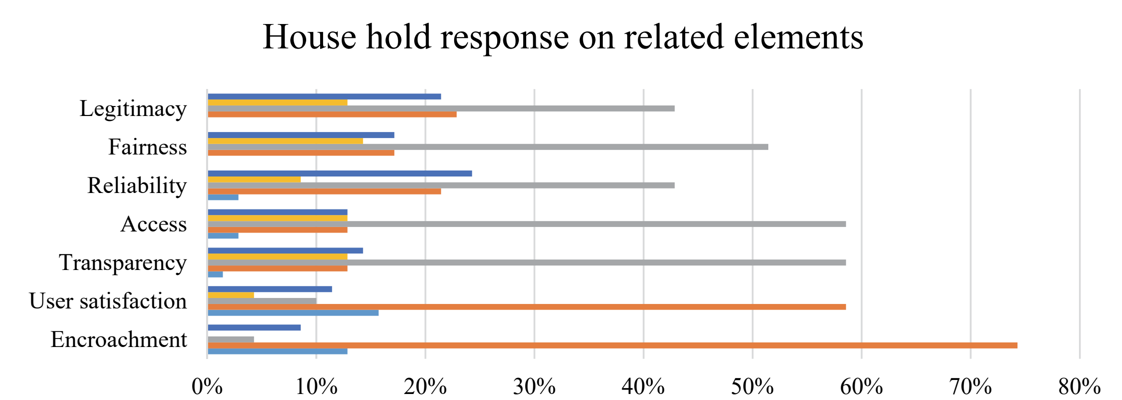
There is information about total used state land as 43% and total vacant land as 57% in ratio of state land without jungle area.

No.	Area/m2	Description
1	360	Khatri village-Gau
2	1865	Khatri village-Gau
3	1374	Khatri village-Gau
4	2934	Eye Hospital
5	520	Eye Hospital
6	5672	Kuikel village-Gau
7	903	Kuikel village-Gau
8	2625	Kuikel village-Gau
9	939	Bhakteshor Pond
10	216	Cold store Pond
Total	17409	

Table 5: State and public land encroachment

As the result of study, there are maximum encroachment evidences in open border i.e. forest boundaries, open public lands and ponds. Forests that are bounded by natural stream are safe from public encroachment. But the public land with having private parcels are more in risk of encroachment which we clearly see in map as Figure 6 and result as Table 5. So, we can easily evaluate the importance of physical boundary for state and public land protection. Table 5 tries to show the encroachment description with respect to area concerning related map in case study area.

Based on about 70 house hold survey and interview data, there exists lack of sustainable vision of local government, communities and stakeholders in better management of state and public land which is shown in Figure 5. In study of encroachment and different management, governance aspects of state and public land management, responses indicates



	Encroachment	User satisfaction	Transparency	Access	Reliability	Fairness	Legitimacy
No idea	9%	11%	14%	13%	24%	17%	21%
Highly disagree	0%	4%	13%	13%	9%	14%	13%
Disagree	4%	10%	59%	59%	43%	51%	43%
Agree	74%	59%	13%	13%	21%	17%	23%
Highly Agree	13%	16%	1%	3%	3%	0%	0%

Figure 5: House hold response

about continuous encroachment of public land. They disagree on good transparency, access and reliability on public land information. They feels there is need of improvement in fairness and legitimacy as governance aspect.

Different types of state and public lands in case study area, mainly the Parti i.e. Barren land, Road, Stream, Pond, Government building, Jungle- Forest area, Nursery and Temple are shown on map in Figure 6. The overall content and context of state and public land are shown with the categories and area of state land in units.

This paper tries to identify the encroachment of state and public land after comparative analysis with study of cadastral maps, images and field verification. Major noticed public land encroachment or more than 100 m^2 are identified in map which is shown in Figure 6 and parcels are tabulated in Table 5. This indicates that the Jungle or forest area is severely encroached in study location. Another, Ponds are secondly more encroached public land in study area.

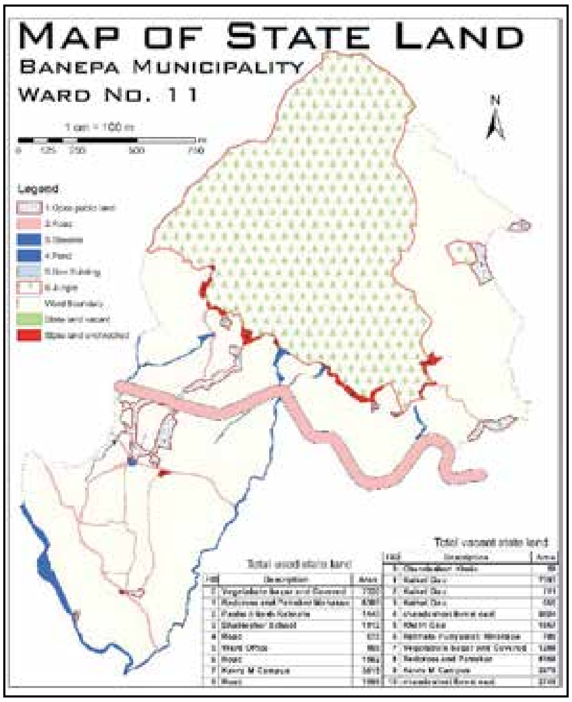


Figure 6: Map of State and public land encroachment

6 Discussion

On the basis of literature review, case study and data analysis, for overall state and public land management, boundary of environment is set out with its policy, institutional arrangement and land information constraints. SWOT analysis is commonly known for the analysis of situation to developing the strategic planning process, which is applied to study and identify factors of public land encroachments.

Internal Factor	**Strength** • Legal provisions of Acts and rules for management and protection. • Existence of National Land Use Policy- NLUP and Working Policy for Government land Registration and Lease- WPGRL. • Addressed level wise institutional management and protection issues. • State land registers and maps.	**Weakness** • Unclear tenure definition and use right mechanisms of state and public land. • Poor public land governance in terms of legitimacy, fairness, participation aspects. • Gap and overlaps in institutional role, function, accountability and responsibility. • Lack of data reliability, completeness, accuracy, transparency and user access of state land information. • Lack of periodical review of state and public land property. • Lack of boundary demarcation of state land property.
External Factor	**Opportunity** • Formalization of informal and encroached settlements. • Provision of land access to poor and discriminated social groups. • Support concession, lease and contract. • Land inventory and audit. • Proper registration and maintenance of cadaster. • Proper use of SDI and ICT.	**Threats** • Increasing rate in state land encroachment and informal settlement. • Misuse and unsustainable allocation of state and public land. • Increasing loss of open spaces. • Lack of land for infrastructure development towards concept of smart city. • Stakeholders and user satisfaction.

Table 6: SWOT matrix

Major factors influencing encroachment and state and public land management system is shown in Table 6. It shows main strength of the system in internal factors as its legal provisions, existence of National Land Use Policy- NLUP and Working Policy for Government land Registration and Lease- WPGRL, addressed level wise institutional protection issues and availability of map and registers of land. Unclear tenure system, poor land governance, institutional gaps and overlaps, poor land information and lack of periodical review are main weak factors of state and public land management .in study area.

In case of external factor, formalization of informal settlements, concession, lease and contract, land inventory and audit, registration and maintenance of cadaster and use of SDI are emerging factor to develop efficient state and public land management and protection. But, there is still threat of increasing land encroachment, misuse and unsustainable allocation due to poor state and public land management.

The factors of state and public land encroachment and poor management are fused in SWOT matrix to formulate strategy as shown in Table 6, where Strength-Opportunity, Strength-Threat, Weakness- Opportunity and Weakness-Threat strategies are generated in major aspects of policy, institutional arrangement and information level.

There is taken Strength factors of state and public land to overcome its Weakness and minimize Threats when formulating strategy. Opportunistic factors are considered to address system and environmental Weakness and recover them, which will support to avoid and lessen factors related to Threat.

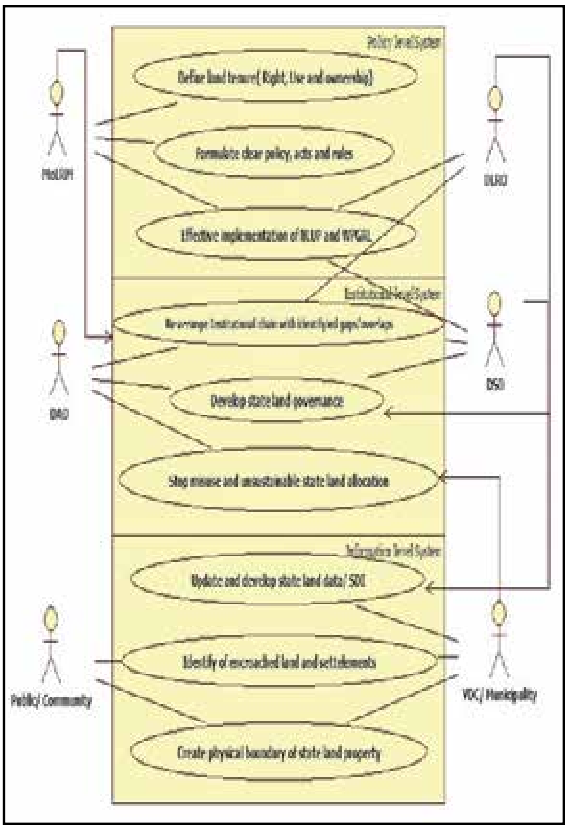


Figure 7: Use case diagram of state and public land protection technique.

This discussion part tries to present state and public land protection technique along with previously identified issues and factors based on policy, institutional arrangement and information aspect. SWOT matrix was performed for identifying key factors of encroachment and SWOT strategy was formulated with fusion of internal and external factors to generate required strategies, which develops overall state and public land protection technique, which is shown in Figure 7. It mainly identifies the key actors and cases of protection technique.

After discussion on factors and strategies, there are some important key actors identified from data analysis and assessment of state and public land. Ministry of Land Reform and Management- MoLRM, District Administration Office- DAO, District Land Revenue Office- DLRO, District Survey Office- DSO, local government i.e. Village Development Committee- VDC/ Municipality and Public or Community are main actors of state and public land protection and its management. The major strategic consideration are classified into policy, institutional arrangement and information aspects in three different system as shown in Figure 7. There are different cases defined for protecting encroachment and management of such land. The relation between actors and cases is also shown in that Figure 7. Defining land tenure as its right, use and ownership aspect is one of the important cases which should be addressed by MoLRM in policy level. There is also need of formulation of clear policy, acts and rules and effective implementation of NLUP and WPGRP for good governance of such land, which will support in eliminating encroachment of land and motivate to effective management.

There is need of re-arrangement of institutional chain for identifying gaps and overlaps in involvement of MoLRM, DAO and DSO. Development of state land governance is also important case with involvement of DLRO, DSO, and DAO. There is fast need of stopping misuse and unsustainable allocation of such land in institutional level. In information level, updating and developing state land SDI is crucial. To protect encroachment, there is need of identifying encroached land and settlements and creating boundary of state land can directly protect and manage state and public land.

7 Conclusion

State and public land management is a critical factor for ensuring good governance in the land administration of any country. There are common factors involved in poor state and public land management. There is commonly ambiguity in institutional roles and responsibilities, a lack of accountability or methodology in the systems of allocation, appropriation, disposal or use of state and public land, and a lack of information on state and public land. Weak governance in this area has direct and indirect implications for citizens, and broader effects on economic development, political legitimacy, peace and security and development cooperation.

State and public land are generally badly managed throughout the world because of its low national priority agenda and insufficient policy, process and institutional framework. Badly managed state land and low priority agenda is not only decreasing its efficiency but increasing encroachment options also. Protection of state and public land is important issue of every national land administration. As main conclusion, respecting objective of the study, is to identify issues of encroachment and developing protection technique, it is clear that the policy, institutional arrangement and information issues are major factors of management of such land which directly lead to minimizing encroachment of such land and also it should be kept in mind that timely address of these issues should help force to protection and effective management of such land.

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Identifying Suitable Areas for Urban Development in Rampur Municipality of Palpa District, Nepal

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KEYWORDS

Site Suitability, Land Use, Land Cover, GIS, Suitability Criteria, Weighted Overlay Analysis

ABSTRACT

Identifying suitable areas for urban development is one of the critical issues of urban planning in hilly areas in Palpa district. The study illustrates the use of GIS suitability criteria and weighted overlay analysis technique for selection of suitable areas for urban development in Rampur municipality. The main objectives of this research is to identifying suitable areas for urban development of Rampur Municipality, Palpa. For this purpose panchromatic and multispectral satellite image data were used to generate for land use land cover map using digitalization and visual interpretation method in ArcGIS software. The criteria using five parameters i.e. geology, elevation, slope, aspect, and Land Use Land Cover (LULC) and the method of Suitability Criteria and Weighted Overlay Analysis were used for identifying the suitable areas for urban development. The eight categories are Agriculture, Commercial, Forest, Industrial, Public Use, Residential, Road and Water Bodies were used for LULC map. The result of this research shows highly suitable areas of Rampur municipality is 5.54 Sq. Km. and it covers 4.49% for suitable areas for urban development.

1. Introduction

Land is one of the important and precious natural resources of the earth surface. The demands for arable land, grazing, forestry, wild-life, tourism and urban development are greater than land resources available. In the developing countries, these demands become more pressing every year and the population dependent on the land for food, fuel and employment will double within the next 25 to 50 years (FAO, 1993). The economic and social lifestyles of most of the Nepalese are intimately related to land. Hence, urban planning for making the best use of the limited land resources is inevitable. However, space science technology known as satellite remote sensing (RS) and the Geographic Information System (GIS) can be helpful in acquiring spatial/temporal data, and preparing digital data base. These spatial databases together with data on different land characteristics that could be collected from field survey certainly will be helpful in decision making support system for an efficient management of resources in municipality level.

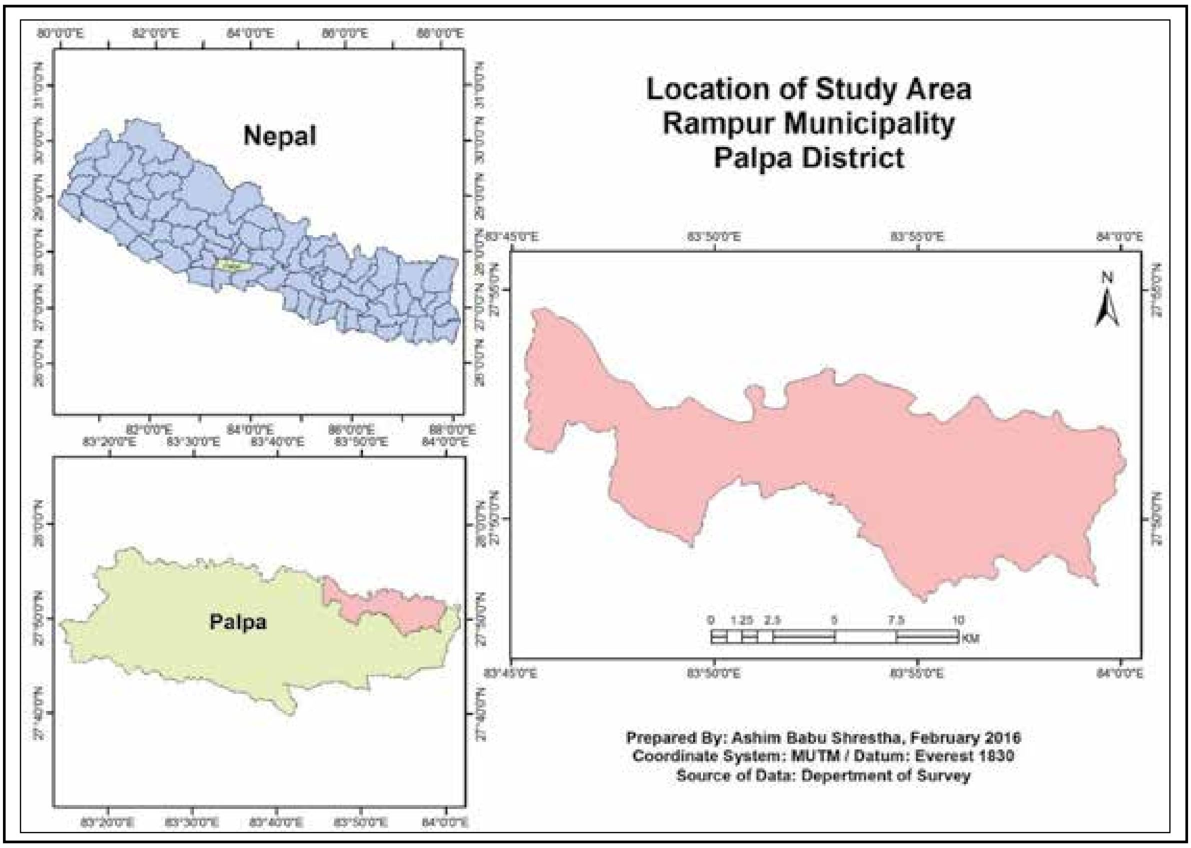
On the April 16, 2012, the Government of Nepal has approved the National Land Use Policy, 2012 with an intention to manage land use according to land use zoning policy of the Government of Nepal and outlined six zones such as Agricultural area, Residential area, Commercial area, Industrial area, Forest area and Public use area. The policy has defined the respective zones as per the land characteristics, capability and requirement of the lands. The

VDCs and municipality of Nepal lack proper base map. They are mostly dependent on 1:25,000 or 1:50,000 scale topographic maps, Land resources maps or other available analogue maps which is not sufficient or too coarse to use for municipality level planning. The available maps are also not much useful for proper decision making process of the municipal development activities. The lacking of digital geographic information in Nepal, particularly large scale, has resulted ineffective and inefficient planning activities in urban development. Thus, this result could play vital role in the planning activities.

3. Study Area

Rampur Municipality is located in northern part of Palpa district. It covers the area of 123.34 sq. km. The municipality is surrounded by Wakamalang VDC in east, Heklang VDC in the west, Chapakot Municipality, Sekam, and Sakhar VDCs of Salyan district and Gajarkot VDC of Tanahu district in the north, and Birkot, Ringneraha, Siluwa, Galdha, Jhirubas and Sahalkot VDCs in the south. It is situated at the altitude 250m to 1850m and 27º 48' 9.84" to 27° 55' 38.32" N latitude and 83° 39' 23.73" to 84°' 8.57" E longitude. The location map of study area Map 1 as below.

Map 1: Location Map of Study Area



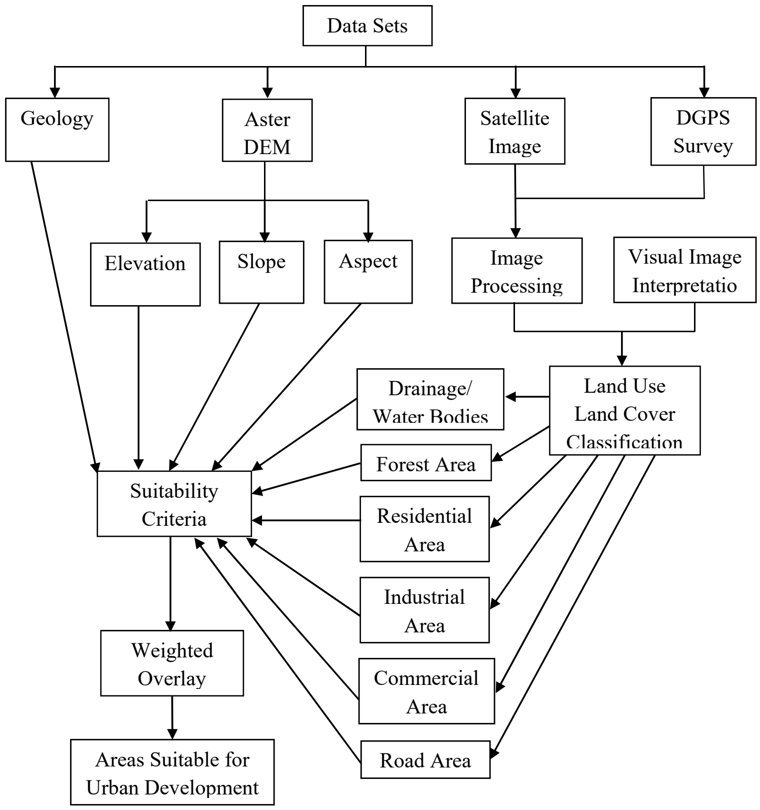
4. Materials and Methods

The Topographical Maps of the Study area are covered under 2880 04D, 08A, 08B, 08C, 01C, 05A, 05C in the scale of 1:25,000 scale bearing supplementary contour of interval 10m. These maps are published in 1996 and are compiled from 1:50,000 scale aerial photography of December, 1990 and field verification done in December, 1991. The Topographical Maps were used for planning process of GCPs collection with DGPS survey and also used for feature extraction of dataset such as Municipality boundary, location name, and additional data for GIS based analysis. The list of data types and sources as below in Table 1.

Table 1: Data Types and Sources

Data Type	Year	Scale / Resolution	Source
Topographical Maps	1996	1:25000	Department of Survey
Geology Map	1978/79	1:125000	Department of Survey
Digital Globe 4 Band Satellite Image, PAN & MSS	March 07, 2015	1m PAN and 2m MSS	National Land Use Project
Aster DEM	2011	PS. 30*30	Download from USGS Website
DGPS Survey for GCPs and field verification	2015	Boundary & Land Use	ERMC team including me

The research work is basically spatial data preparation from the high resolution satellite image by visual image interpretation method. The suitability analysis and weighted overlay analysis is the specific approaches and methods adopted to identifying the suitable areas for urban development of the study area. The work flow diagram in Figure 1 as below.



Suitability Criteria for Urban Development

The urban development carried out on the basis of GIS based spatial analysis using weighted overlay analysis on several available data sets. The data files comprised the various parameters like geology, elevation, slope, aspect, and land use land cover parameters used for identifying the areas for suitable for urban development. A rule base was developed by using multiple-criteria on the basis of research knowledge for land use planning. These criteria were used to identifying a suitable areas for urban development area. The ArcGIS 10.2 software was used for GIS analysis. The process for identifying the suitable areas map begins with ensuring all data are in the appropriate raster format. The polygon shapefiles such as geology buffer, forest area buffer, drainage/water bodies buffer, residential area buffer, commercial area buffer, industrial area buffer and road area buffer should be converted from vector to raster using Feature to raster tool. A slope raster was created using the elevation raster using spatial analyst tool. All raster files should be reclassified using reclassify tool. The appropriate distance values were binned into four classes based on Table 2 and favourability values were assigned. The all criteria types (1-4) elevation and slope raster were assigned to correct favourability classes, which is started were: 1= not suitable, 2= least suitable, 3= moderately suitable, and 4= highly suitable. All reclassified raster were added as inputs in the weighted overlay tool. This resulted in a final suitability raster for suitable areas for urban development final map production.

Table 2: Weight for Identifying the Areas Suitable for Urban Development

S. N.	Category	Criteria	Value	Suitability Level
1.	Geology	Unconsolidated Sediments	4	Highly Suitable
		Sallyan Series	3	Moderately Suitable
		Midland Metasediments Group	2	Least Suitable
		Thrust Buffer 100m	1	Not suitable
2.	Elevation	< 500m	4	Highly Suitable
		500 – 750m	3	Moderately Suitable
		750 – 1000m	2	Least Suitable
		> 1000m	1	Not Suitable
3.	Slope	0 – 10 Degree	4	Highly Suitable
		10 – 20 Degree	3	Moderately Suitable
		20 – 30 Degree	2	Least Suitable
		> 30 Degrees	1	Not Suitable
4.	Aspect	157.5 – 202.5	4	Highly Suitable
		112.5 – 157.5 and 202.5 – 247.5	3	Moderately Suitable
		90 – 112.5 and 247.5 - 270	2	Least Suitable
		0 – 90 and 270 - 360	1	Not Suitable
5.	LULC	Agriculture	4	Highly Suitable
		Buffer of Forest 100m, River 40m, Stream 20m, Commercial 20m, Residential 20m, Public Use 20m, Industrial 20m and Road 20m	1	Not Suitable

Weighted Overlay Analysis

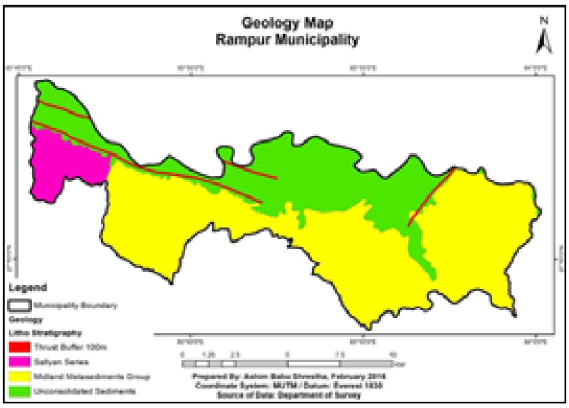
Weighted Overlay is a technique for applying a common measurement scale of values to diverse and dissimilar inputs to create an integrated analysis (ESRI, 2015). Weighted overlay only accepts raster input such as geology, elevation, slope, aspect, and LULC in this research. The raster is required to reclassify before they can be used. The values of raster are grouped into ranges must be assigned a single value before it can be used in weighted overlay tool. The assign weights at the time of reclassifying the cells in the raster will already be set according to suitability. The output raster can be weighted by importance and added to produce an output raster using weighted overlay tool using in ArcGIS. The tool was used for to locate suitable areas, higher values generally indicate that a location is more suitable.

5. Process

The weighted overlay analysis process used for identifying the suitable areas for urban development. In this research, the five subjective criteria ware used for urban development area selection. These five subjective criteria are geology, elevation, slope, aspect, and LULC description with map as below.

5.1 Geology

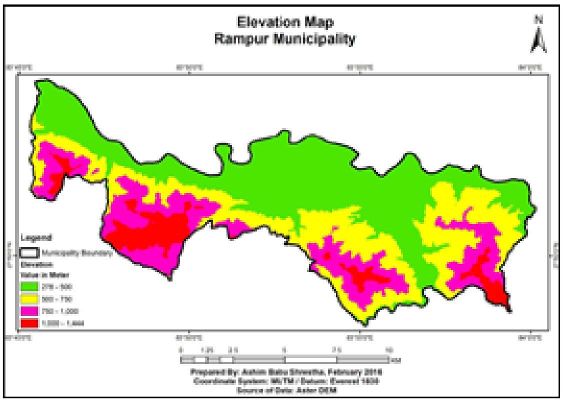
Rampur Municipality of Palpa district is mainly composed of red soil and clay in the Lesser Himalaya. Geologically, it has 1) recent and Pleistocene formation by alluvium, the work of water including river terraces. It also has 2 major fault along the Kaligandaki River and foot of the hills in the south 2) Southern Part of the area consists of Precambrian to recent Cambrian with Jarbutta formation with shale and lime stones. In this research geological data has been used for the analysis of terrain and slope of study area which is helpful for the analysis of urban planning at present and future urban development. In the base of geological map study identified the suitable area of urbanization and other infrastructure development. According to the analysis thrust area is identified which can support the development process. The Geology Map 2 is as below.



Map 2: Geology Map

5.2 Elevation

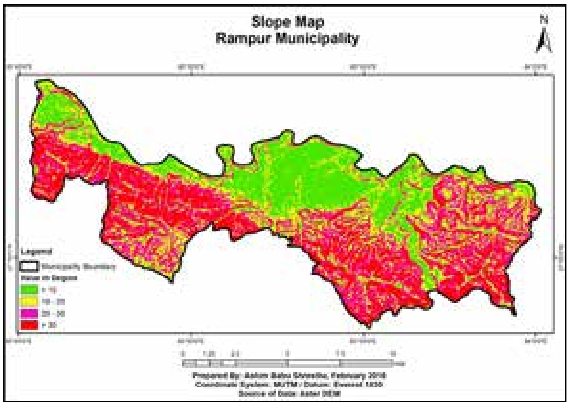
The elevation will show the elevation situation of the Rampur municipality. Almost all the area of Rampur falls under the slopping land. Elevation of this municipality ranges at the altitude 250m to 1850m above mean sea level. There are four class of elevation i.e. < 500m, 500m – 750m, 750m – 1000m and > 1000m. The elevation of < 500m is useful for residential, commercial, and industrial suitable areas for urban development. The < 500m is highly suitable areas for urban development and it gives the high weight and > 1000m is not suitable for urban areas so it gives the low value for planning criteria. The elevation situation of Rampur municipality Elevation Map 3 as below.



Map 3: Elevation Map

5.3 Slope

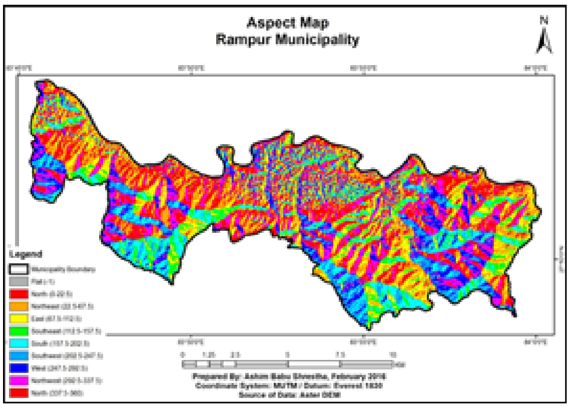
The terrain of middle hill of Rampur municipality is flat to very steep. The slope degree (°) of this municipality is 0° to 84°. There are four class of slope i.e. 0° – 10°, 10° – 20°, 20° – 30° and the maximum gradient is 30° and above. The slope of 0° – 10° is more useful for residential, commercial and industrial areas suitable for urban development. The > 30° slope is not suitable for planning. The suitable area slope is high weight value and not suitable areas for low weight value. The Slope Map 4 as below.



Map 4: Slope Map

5.4 Aspect

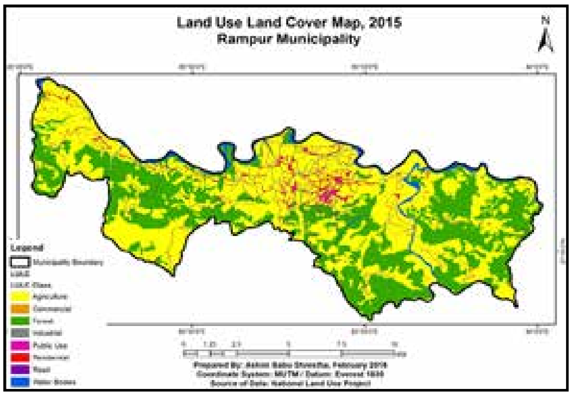
Aspect identifiers the downslope direction of the maximum rate of change in value from each cell to its neighbors. Aspect can be thought of as the slope direction. The values of the output raster will be the compass direction of the aspect (ArcGIS ESRI, 2016). Aspect is better for urban development as a face of East or South direction according to sun light direction. Sun always rise from East direction and set in West direction. According to the sun light direction East and South face sufficient light for winter season. North face very poor light so it is always cold. So, South direction is highly suitable i.e. high weight and North direction not suitable i.e. less weight. The Aspect Map 5 as below.



Map 5: Aspect Map

5.5 Land Use Land Cover

The land use land cover map is the basic criteria for identifying suitable areas for urban development. The criteria parameters as geology buffer, forest area buffer, drainage/ water bodies buffer, existing residential area buffer, existing commercial area buffer, existing industrial area buffer and existing road area buffer are not suitable for urban development. The Land Use Land Cover Map 6 as below.



Map 6: Land Use Land Cover Map

6. Result and Discussion

Suitability Analysis for Identifying Suitable Areas

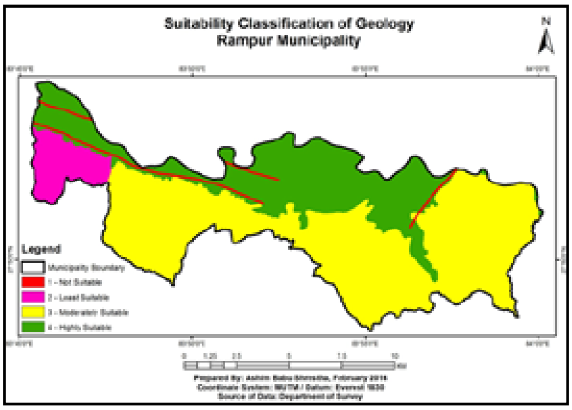
The weighted was provided to the criteria on the value of 1 to 4 based on the research knowledge. 1 is being assigned to completely restrict for weighted overlay analysis. The suitability level and values of identifying suitable areas for urban development Suitability Level and Value Table 3 as below.

Table 3: Suitability Level and value

S. N.	Value	Suitability Level
1.	4	Highly Suitable
2.	3	Moderately Suitable
3.	2	Least Suitable
4.	1	Not Suitable

6.1 Geology

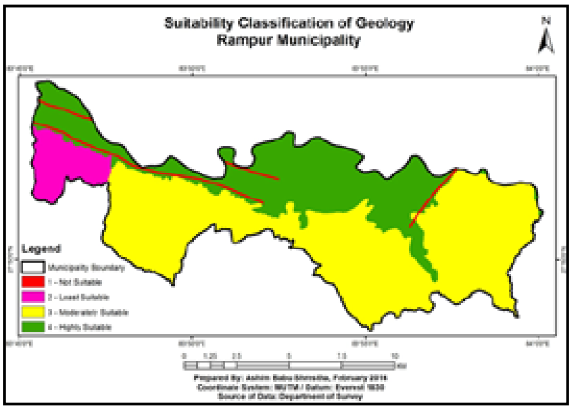
The geological categories with weighted value as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. not suitable to highly suitable. The presented Criteria for Geology Weighted Value and Suitability Classification of Geology Map 7 as below.



Map 7: Suitability Classification of Geology Map

6.2 Elevation

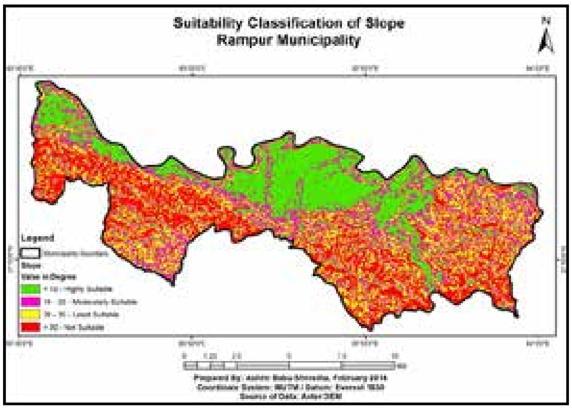
The elevation categories with weighted value as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. not suitable to highly suitable. The presented Criteria for Elevation Weighted Value and Suitability Classification of Elevation Map 8 as below.



Map 8: Suitability Classification of Elevation Map

6.3 Slope

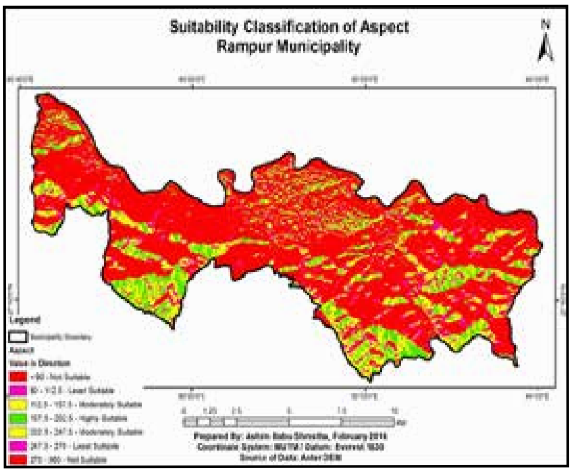
The slope categories with weighted value as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. not suitable to highly suitable. The presented Criteria for Slope Weighted Value and Suitability Classification of Slope Map 9 as below.



Map 9: Suitability Classification of Slope Map

6.4 Aspect

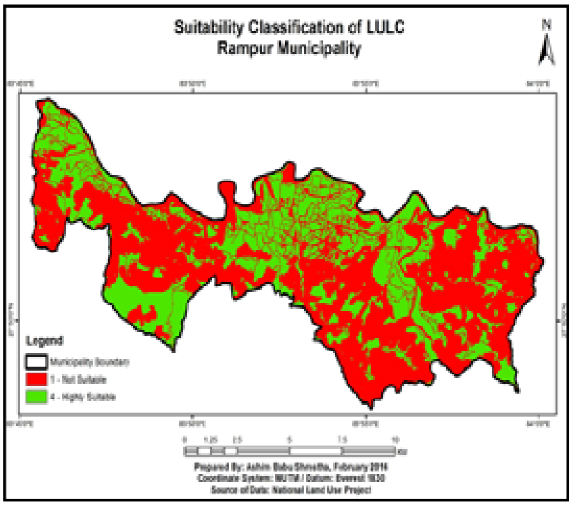
The aspect categories with weighted value as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. not suitable to highly suitable. The presented Criteria for Aspect Weighted Value and Suitability Classification of Aspect Map 10 as below.



Map 10: Suitability Classification of Aspect Map

6.5 LULC

The LULC categories with weighted value as below. The sub-classified into four sub-criteria which are 1 to 4 values i.e. not suitable to highly suitable. The presented Criteria for LULC Weighted Value and Suitability Classification of LULC Map 11 as below.

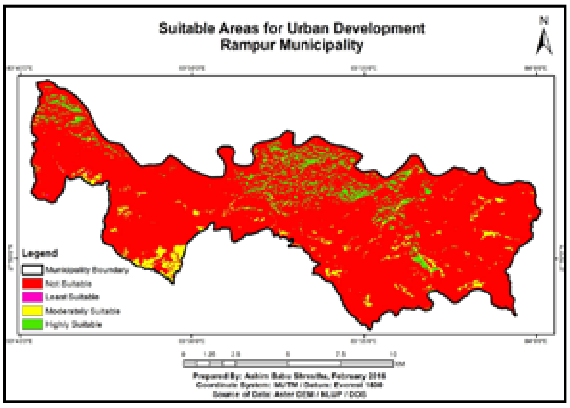


Map 11: Suitability Classification of LULC Map

Suitable Areas for Urban Development

The suitable areas for urban development map was prepared on the basis of geology, elevation, slope, aspect and LULC with weighted value 1 to 4 i.e. not suitable to highly suitable where 1 is restricted value with weighted overlay analysis in ArcGIS software. The suitable areas for urban development map shown as below Map 12.

The Map 12 is the final resulting map which shows that 5.54 sq. km. areas within the Rampur municipality are highly suitable areas for urban development. There are many areas which are not suitable and few areas are least suitable. The weighted overlay analysis and equal influence 20 in each raster.



Map 12: Suitable Areas for Urban Development

Result Analysis

The suitable areas for urban development result analysis:

The summary of total area and percentage of suitable areas for urban development map of study area as below table. The result analysis of suitable areas for urban development as below Table 9, pie chart and bar chart Figure 3 and Figure 4 as below.

Table 9: Urban Development suitable Areas and Percentages

Level of Suitability	Range of Score	Colour	Area in Sq. Km.	Percent (%)
Not Suitable	Class 1	Red	113.71	92.19
Least Suitable	Class 2	Pink	0.10	0.08
Moderately Suitable	Class 3	Yellow	3.99	3.24
Highly Suitable	Class 4	Green	5.54	4.49
Total			**123.34**	**100.0**

7. Conclusion

Urban growth and land use study is very useful in local government as well as in urban planners for the appropriate plans of land use planning in sustainable urban development. Urban development provides the knowledge for the planners and decision makers, the required information about the current state of development and the nature of changes that have occurred, physical conditions, public service accessibility, economic opportunities, local market, population growth, and government plans and policies are the driving forces of planning process. GIS and Remote Sensing provides spatial analysis tools which can be applied at the municipality, city and district level urban development planning. The present land use pattern of the municipality under study is classified by using remotely sensed image with the help of ground based information.

Lack of clear guidelines on the classification system has posed a level of difficulty in assigning the classes of different hierarchy in land use categories. Hierarchical classification system helped in incorporation of complex land use pattern of this municipality. NLUP specification and research knowledge classification system used in the study attribute to standardization in the land use land cover result among this municipality. Digitization and visual image interpretation incorporated with extensive field visit and use of ancillary data such as geology map, and topographical map. The land use classes yield better accuracy because the classes are designated manually based on ground knowledge and visual interpretation rather than automatic classification.

The total areas cover by the not suitable i.e. 113.71 Sq. km. in Rampur municipality that is 92.19% of municipality area. The least suitable area cover of 0.10 Sq. Km. and total percentage is 0.08%. The total moderately suitable area is 3.99 Sq. Km. and its cover 3.24% of the area. The total highly suitable areas of Rampur municipality is 5.54 Sq. Km. and it covers 4.49% for suitable areas for urban development.

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United Nations/Nepal Workshop on the Applications of Global Navigation Satellite Systems Kathmandu, 12 – 16 December 2016

Niraj Manandhar), Er. Susmita Timilsina

Introduction:

The United Nations/Nepal Workshop on the applications of global navigation satellite systems (GNSS) was organized jointly by the United Nations Office for Outer Space Affairs and the Survey Department of the Ministry of Land Reform and Management on behalf of the Government of Nepal. The Workshop was co-organized and co-sponsored by the International Committee on Global Navigation Satellite Systems and GfRmbH Galileo Control Centre, German Space Agency(DLR).

A total of 113 participants from the following 32 countries attended the workshop: Australia, Bahrain, Bangladesh, Brazil, China, Croatia, Egypt, Estonia, Fiji, France, Germany, India, Indonesia, Japan, Lao PDR, Latvia, Malaysia, Mongolia, Morocco, Myanmar, Nepal, New Zealand, Pakistan, Philippines, Russian Federation, Saudi Arabia, Thailand, Turkey, Ukraine, United States of America and Uzbekistan. Representative of the European Commission was also present. Representative of the Office for Outer Space Affairs also participated. The Workshop was hosted by the Survey Department of the Ministry of Land Reform and Management and held in Kathmandu, Nepal, from 12 to 16 December 2016. The Workshop addressed the use of GNSS for various applications that can provide sustainable social and economic benefits, in particular for developing countries. Current

and planned projects that use GNSS technology for both practical applications and scientific explorations were presented. Cooperative efforts and international partnerships for capacity-building, training and research were discussed. Building upon cross-cutting areas, in particular resiliency, including matters related to the ability to depend on space systems and to respond to the impact of events such as adverse space weather, a seminar on space weather and its effects on GNSS was held during the Workshop. The purpose of the seminar was to provide a background on the phenomena

of space weather and illustrate its effects on GNSS. This seminar described the challenging aspects of space weather phenomena, their impact on GNSS users, the variability of these impacts and the actions that may mitigate their effects. Seminar on GNSS spectrum protection and interference detection and mitigation was also organized during the Workshop. The purpose of the seminar was to highlight the importance of GNSS spectrum protection at the national level and explain how to reap

the benefits of GNSS. It was highlighted that the seminar was successful in fulfilling its intended purpose of educating participants on the importance of GNSS spectrum protection, and challenging them to engage with their respective national spectrum management agencies to ensure continued access to the benefits GNSS provides.

GNSS reference frames, reference station networks and determination of vertical datum were the topics of major discussion, where the knowledge sharing was very essential. It was noted that continuously operating GNSS stations (CORS) play an important role in critical national priorities such as identifying seismic hazards, disaster recovery and mitigation and infrastructure development in developing countries. In order to take full advantage of emerging GNSS technology the development of modernized national horizontal reference systems including deformation models and vertical datum based on accurate local geoid models are essential. Therefore international cooperation in terms of knowledge, resource and sharing of the information in development of CORS networks and geodetic reference systems was emphasized.

RTKLIB (free open source software) demonstrations related with low-cost GNSS receiver system for real time kinematic (RTK) using RTKLIB were made. The system was based on a very low cost GNSS receiver, Raspberry-Pi computer using RTKLIB. The participants found such system very useful for education, training and even for survey and mapping where required accuracy is within a sub-meter level. The participants also requested to improve the system to make it compatible for different types of base station receiver makers. The system will be developed in android platform in future.

Participants learned about the improvement in the existing infrastructure either by launching new satellites (in case of Galileo, Beidou Navigation Satellite System (BDS),Quasi-Zenith Satellite System (QZSS), Indian Regional Navigation Satellite Systems(IRNSS)) or by modernization of the existing signals (as with Global Positioning Systems(GPS) of the United States and Global Navigation Satellite System (GLONASS) of the Russian Federation). Participants took note of the release of new interference control documents (ICD) for all GNSS along with activities for international collaboration on compatibility and interoperability among the GNSS operators.

Participants were also informed about the role of the international committee on global navigation satellite systems (ICG) as a forum for the providers and users to build the basis for compatible and interoperable operations for the benefits of end users. Recognizing that GNSS technology has enormous potential to contribute to the management and protection of the environment, disaster risk reduction, agriculture and food security, emergency response, improving the efficiency in surveying and mapping, and to enhance the safety and effectiveness of transportation by land, sea and air, low cost GNSS receivers, the participants put forward a number of recognitions and recommendations, which are presented below:

GNSS Applications and Technology Development:

Participants recognized that GNSS has very important applications in surveying and mapping and in the precise positioning. It plays a prominent role in every infrastructure development of the country. Participants also recognized the importance of the use of GNSS technology to improve emergency response to natural disasters and reduce the associated risk/impact to human life. This was an extremely important application for GNSS requiring robust information technology and multi-agency cooperation and interoperability that include both governmental and non-governmental organizations

(NGO). Overall the presentations featured works that leverage existing mobile phone and internet technologies coupled with GNSS to provide improved services for disaster management primarily through reducing location uncertainties and information timelines.

Key recommendations included the following: (i) continue the development and integration of information technology, global information system (GIS), mobile phone ,GNSS and remote sensing technologies to achieve improved disaster management tools accessible to the public; (ii) engage public and private agencies and organizations to favourably affect public policy to ensure maximum benefit to the population being served. These activities may include, but are not limited to the following: (a) obtain endorsement for these efforts; (b) enable access to data bases and data sources in support of these efforts; and (c) develop a framework to formally manage requisite cross-agency

cooperative and collaborative efforts needed to adopt and exploit the new capabilities.

Space Weather:

Participants recognized that the space weather seminar was very useful and more programs on the topic should be planned. The importance of space weather to civil aviation and future of space flight was highlighted. In that context, participants in the workshop recommended that: (a) space weather discussion forums should be developed to educate the public as well as policy makers about space weather phenomena; (b) other workshops should provide opportunities for students and professionals to be involved in space weather data analysis and prediction.

Continuously Operating Reference Station (CORS) Network and Reference Frames:

Participants recognized that CORS operators should be encouraged to facilitate earth deformation studies. Participants emphasized the importance of modernizing national geodetic reference system. It was noted that the new geodetic datum of Nepal has made some progress but its completion will require international co-operations.

Capacity Building:

The participants recognized the need for the continuous building of national and regional expertise, through the provision of scholarships, long-term and short-term training and education at the United Nations-affiliated Regional Centres and other academic centres of excellence. In addition, participants stressed the need to make the existing educational opportunities available to a wider university community. Participants recognized the need for additional workshops building upon the results of this workshop, including workshops focusing on training decision-makers(covering the integrated application of combined remote sensing, GIS and decision support systems).In order to enable knowledge sharing, participants recommended that institution exchange programmes, providing opportunities for experts to visit and work with partner institutions. In particular, participants recommended that national, regional and international institutions make every effort to provide support to Nepalese institutions through exchange programme and technical support.

Participants expressed their appreciation to the Survey Department of the Ministry of Land Reform and Management of Nepal for the hospitality, substance and organization of the Workshop. Participants also expressed their appreciation for the significant support provided by the Government of Nepal, the United Nations, ICG and GfRmbH Galileo Control Centre, DLR.

SUMMARY OF THE WORKSHOP: WORKSHOP STATISTICS

1. There were two organizers and one co-organizer of the Workshop

2. Three committees were formed to conduct the Workshop. The name of the committees and their chairpersons are as follows:

Committees	***Chairpersons***
1. Steering Committee	Mr. Krishna Raj BC
2. Organizing Committee	Mr. Niraj Manandhar
3. Preparatory Committee	Mr. Niraj Manandhar

3. The workshop was run for 5 days which had nearly 26 hours of technical presentations and seminar, that is 5.2 hours each day excluding breaks.

4. There was one key note presentation, Ten sessions with total 48 presentations and 7 speeches and remarks made in this Workshop which was to be followed by next 5 remarks in the closing session.

5. In seminar session 23 presentations were made.

6. The number of Technical Papers presented and their repective areas were as follows:

Session	*Number of papers*
1. Overview of GNSS	four
2. GNSS Applications and Technology Development	Six
3. Environment Monitoring and Management Using GNSS	Seven
4. Seminar on Space Weather and its effects on GNSS	Five
5. Seminar on GNSS Spectrum Protection and Interference Detection and Mitigation	
I. Overview	Two
II. Introduction to GNSS	Five
III. Spectrum Management	Six
IV. Spectrum Protection	Four
V. Interference Detection and Mitigation	Three
6. RTKLIB DEMO	Two
7. Space Weather	Five
8. GNSS Reference Frame and Reference Station Network	Thirteen
9. RTK: Technology and Applications	Eight
10. GNSS Implementation and Uses: Case Studies	Six

There were 113 participants from 32 countries in the workshop. Among them, 87 participants were from 17 Asian countries which is a great achievement.

7. The number of national participants from Nepal was 56.

8. The papers were from 28 countries: six continents except from ANTARCTICA.

9. The Workshop started with inaugural session chaired by Mr Krishna Raj BC, Director General of Survey Department and was inaugurated by Honorable Minister of Ministry of Land Reform and Management Mr. Bikram Pandey.

10. The Workshop ended with a closing ceremony chaired by Mr Krishna Raj BC.

Author's Information

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ARTICLES IN PREVIOUS ISSUES

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
By BabuRam Acharya, Nabraj Subedi & Toya Nath Baral

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
By D.M Kayastha, R.R Chhatkuli & Jagat Raj Paudel

Journal 4 (Published in 2062 B.S.)

1. Comparision Of Tin And Grid Method of Contour Generation From Spot Height
By Niraj Manandhar

2. Human Resource Development Policy in Space Technology Sector in Nepal
By Rabin K. Sharma & Babu Ram Acharya

3. Registration of 3rd Dimension: the Context of Nepalese Cadastre
By Ganesh Prasad Bhatta, Giri Raj Khanal & Rabin K. Sharma

4. Spatial Data Infrastructure for Prosperous Nepal
By Rabin K. Sharma & Babu Ram Acharya

5. Study of change in Urban Landuse
By Jagat Raj Paudel & Sudarshan Karki

6. Web-based Metadata Administration System
By Durgendra Man Kayastha

7. One Plus one is more than two- The making of the Population and Socio-Economic Atlas of Nepal
By Suresh Man Shrestha

Journal 5 (Published in 2063 B.S.)

1. Analysis Of 3D Cadastre Situation In Nepal
By Dev Raj Paudyal and Rabin K. Sharma

2. Maximizing Benefits of Space Technology for Nepalese Society
By Toya Nath Baral and Ganesh Prasad Bhatta

3. Principal – Agent theory approach for determination of appropriate 'Activity Model' for cadastral information updating in Nepal
By D. R. Paudayl

4. RS/GIS For Hazard Mapping & Vulnerability Assessment, Earthquake Disaster Management, Kathmandu, Nepal
By Sudarshan Karki and Pramod Karmacharya

5. Technical Deficiencies and Human Factors in Land Disputes: In the Context of Nepalese Cadastral Surveying
By Ganesh Prasad Bhatta

6. The Role of Mapping in Disaster Management
By Kalyan Gopal Shrestha

Journal 6 (Published in 2064 B.S.)

1. A Proposed National Surveying And Mapping Policy In Nepal
By Krishna Raj Adhikary & Dev Raj Paudyal

2. Assessment of the Digital Cadastre in Nepal from the Cadastre 2014 Vision
By Dev Raj Paudyal

3. Astronomy And Gravity Surveying In Nepal
By Punya Prasad Oli

4. Cadastre In Nepal: Past And Present
By Krishna Raj Adhikary, Dev Raj Paudyal & Prakash Joshi

Journal 7 (Published in 2065 B.S.)

Journal 8 (Published in 2066 B.S.)

1. Applications of open source software in land administration: An initiation with land administration education
By Ganesh Prasad Bhatta

2. Development of educational courses on space science technology in Nepal
By Krishna Raj Adhikary

3. Land policy in perspective
By Nab Raj Subedi

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
By Umesh Kumar and Rabin K. Sharma

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
By Madhusudan Adhikari

8. Updating of topographic maps in Nepal
By Kalyan Gopal Shrestha

Journal 9 (Published in 2067 B.S.)

1. Adopting Geo-ICT in Survey Department: Need for Capacity Building
By Kalyan Gopal Shrestha

2. Assessment of Groundwater Recharge Using GIS
By Susheel Dangol

3. Involvement of Survey Professional Organizations in International Activities
By Rabin K. Sharma

4. Land Management: A Global Prospective
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

Journal 10 (Published in 2068 B.S.)

1. A Study on Squatter Settlements of Kathmandu Using GIS, Aerial Photography, Remote Sensing and Household Survey
By Mr. Kiran K.C. and Dr. Krishna Pahari

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
By Niraj Manandhar

6. Survey Department at the Cross Roads
By Rabin K. Sharma

Journal 14 (Published in 2072 B.S.)

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
By Rabin K. Sharma

9. Spatial Structure Of Urban Landuse In Kathmandu Valley
By Shobha Shrestha, PhD

Journal 15 (Published in 2073 B.S.)

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
By Shova Shrestha, PhD

8. Necessity Of Disaster Mapping Unit In Survey Department: The Context Of 2015 Gorkha Earthquake And Disasters In Nepal
By Kalyan Gopal Shrestha

9. Remote Sensing And GIS Application In Landslide Risk Assessment And Management
By Dinesh Pathak

10. Role Of Land Professionals And Spatial Data Infrastructure In Disaster Risk Reduction: In The Context Of Post 2015 Nepal Earthquake: General Review
By Ganesh Prasad Bhatta, Susheel Dangol, Ram Kumar Sapkota

11. Towards A Modernized Geodetic Datum For Nepal Following The April 25, 2015 Mw 7.8 Gorkha Earthquake
By Christopher Pearson, Niraj Manandhar

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
By Krishana Raj B.C., Ganesh Prasad Bhatta, Suresh Man Shrestha, Niraj Manandhar, Anil Marasini

Nepal Surveyor's Association (NESA)

NESA CEC
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Mr. Ambadatta Bhatta
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Mr. Saroj Chalise
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Ms. Geeta Neupane
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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 in 1990, Survey professionals working in different sectors decided to launch a common platform named Nepal Surveyors' Association (NESA) in 1991, as the first government registered Surveyors' Organization in Nepal.

Objectives

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

- To make the people and the government aware of handling the survey profession with better care and to protect adverse effects from it's mishandling.
- To upgrade the quality of service to the people suggesting the government line agencies to use modern technical tools developed in the field of surveying.
- To upgrade the quality of survey professionals by informing and providing them the opportunity of participation in different trainings, seminars, workshops and interaction with experts in the field of surveying and mapping within and outside the country
- To upgrade the quality of life of survey professionals seeking proper job opportunities 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.

Membership Criteria

Any survey professional obey in g 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's Association (NESA) celebrated Surveyor's Day (Bhadra 18, 2073) organizing different social activities including Blood donation in Survey Department Premises and Tree Plantation in Nagarkot.
- NESA celebrated Surveyor's Day (Bhadra 18, 2073) organizing various recreational activities including Volleyball Competition, Quiz Contest and Badminton Competition. Surveyors from different districts participated in those games.

Nepal Remote Sensing and Photogrammetric Society (NRSPS)

Executive Committee Officials

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Silver Jubilee Celebration of NRSPS

On April 11, 2016, NRSPS observed its Silver Jubilee celebration with varieties of programme. Accordingly, on behalf of NRSPS, Mr. Krishna Raj BC; Ditrector General of Survey Department as a chief guest, felicitated past Presidents **Mr. Krishna Bahadur Malla** and **Mr. Buddhi Narayan Shrestha** as well as incumbent President **Mr. Rabin K. Sharma** with a silk shawl and a certificate for their corresponding contributions in promoting Remote Sensing and Space Technology in Nepal. In the programme, **Mr**. **Sharma** presented major achievements of NRSPS of its 25 years duration and **Mr**. **Buddhi Narayan Shrestha** supplemented the information which was missed in the presentation. **Mr**. **Krishna Raj BC** also released **Earth Observation: Volume VIII;** Annual **Newsletter of NRSPS** in which two articles: **Application of Satellite Image in Cadastral Mapping** by ***Eliza Shrestha*** and **Social Media – Effective Means of Communication for Disaster Rescue and Recovery Activities** by ***Laxmi Thapa*** were included. A special message from President of NRSPS **Mr. Sharma** was also included. **Mr**. **Krishna Raj BC** also delivered a very inspiring speech on the topic **Role of Remote Sensing in Land Professionals and Land Management,** as a Chief Guest of the programme. Furthermore, in discussion session, chaired by **Mr. Durgendra Man Kayastha,** Vice President of NRSPS, **Dr. Vishnu Dangol** presented the views in the topic **Geology and Mineral Resources. Mr. Anish Joshi**, Secretary of NRSPS played the role of moderator of the session. The views expressed by the speakers will be used to prepare 10 years vision of NRSPS.

Outreach and Capacity Building Programme

NRSPS organized **a Training Program** on **"Land Cover Classification Using Landsat 8 and Open Source RS/GIS Tools"** at Institute of Forestry, Hetauda, from 27-31, 2016 December for twenty undergraduate students studying Bachelor of Science in Forestry at the institute. This programme is a part of the **Outreach and Capacity Building Programme of NRSPS. Mr. Anish Joshi, Secretary of NRSPS** was the resource person of the training programme.

Photo: Mr. Anish Joshi with the trainee at Hetauda

Visit of ISPRS President in Nepal

On 26th January 2017, **Dr. Christian Heipke, President of ISPRS** arrived in Kathmandu for a mission to know about NRSPS. NRSPS, then organized a special programme on 27th January 2017 at Lalitpur to present the status of NRSPS to him. In this programme, **Mr. Anish Joshi, Secretary,** NRSPS; **Ms. Laxmi Thapa, Regional Coordinator** of ISPRS Technical Committee V, Working Group 7; and **Mr. Rabin K. Sharma, President**, NRSPS presented the **introduction of NRSPS, vision of Working Group in the context of Nepal** and **achievements of NRSPS from its establishment to date** respectively. Then, **Dr. Heipke** briefly introduced the ISPRS including its future programmes. Finally, on behalf of NRSPS, **Mr. Durgendra Man Kayastha, Vice President** of NRSPS expressed sincere gratitude to him for his visit and also mentioned that the discussion programme was very much fruitful to NRSPS.

Photo: Mr. Rabin K. Sharma handing over a memento to ISPRS President Dr. Christian Heipke

" ENCOURAGE APPLICATION OF REMOTE SENSING TECHNOLOGY"

Call for papers

The Editorial Board requests for Papers/articles related with Geoinformatics for the publication in the Seventeenth issue of the Nepalese Journal on Geoinformatics.
Last date for submission of the article is March 30, 2018.
For more information, please contact
Editor-in-Chief

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 soft copy form on CD in microsoft Word or compatible format or 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 0.9", right 0.9", bottom 0.9".

Length of manuscript: The article should be limited upto 6 pages.

Font: Times New Roman "10".

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 Calibri "10" with Upper and lower casing, centrally justified. There should be a gap of two lines between the title and author's name.

Author's Information: The author should provide Name, Academic Qualification, Organization, Current Designation, Work Experience (in years), Published Papers/Article (Number), e-mail ID and scanned copy of author's passport size photo.

Keywords: Four to five keywords on paper theme in Times New Roman "10" with two spacing under the Authors name.

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

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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BulletPoint: Use only (•).

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.

5th Survey Official's Committee (SOC) Meeting on Nepal-Boundary at Dehradun, India from 28-30 September, 2016.

Participants of "United Nations/Nepal Workshop on the Applications of Global Navigation Satellite Systems" Organized jointly by Survey Department and the United Nations Office for Outer Space Affairs held at Kathmandu, Nepal from 12 - 16 December 2016.

Ms. Roshani Sharma and Er. Sushmita Timilsina, Survey Officers participating in "Seminar on Promoting the Applications and Data Sharing of China's satellite ZY-03 in Central and South Asia" from 4 -7 January 2017 conducted by Satellite Surveying and Mapping Application Center (SASMAC), NASG of China at Beijing, China

Joint Secretary, MoLRM (then Director General, Suvey Department) Mr. Krishna Raj B.C. participating in the Group on Earth Observations Thirteenth Plenary Session–GEO-XIII St Petersburg, Russian Federation, 9-10 November 2016.

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

Available Maps and Data

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

Available Services

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

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