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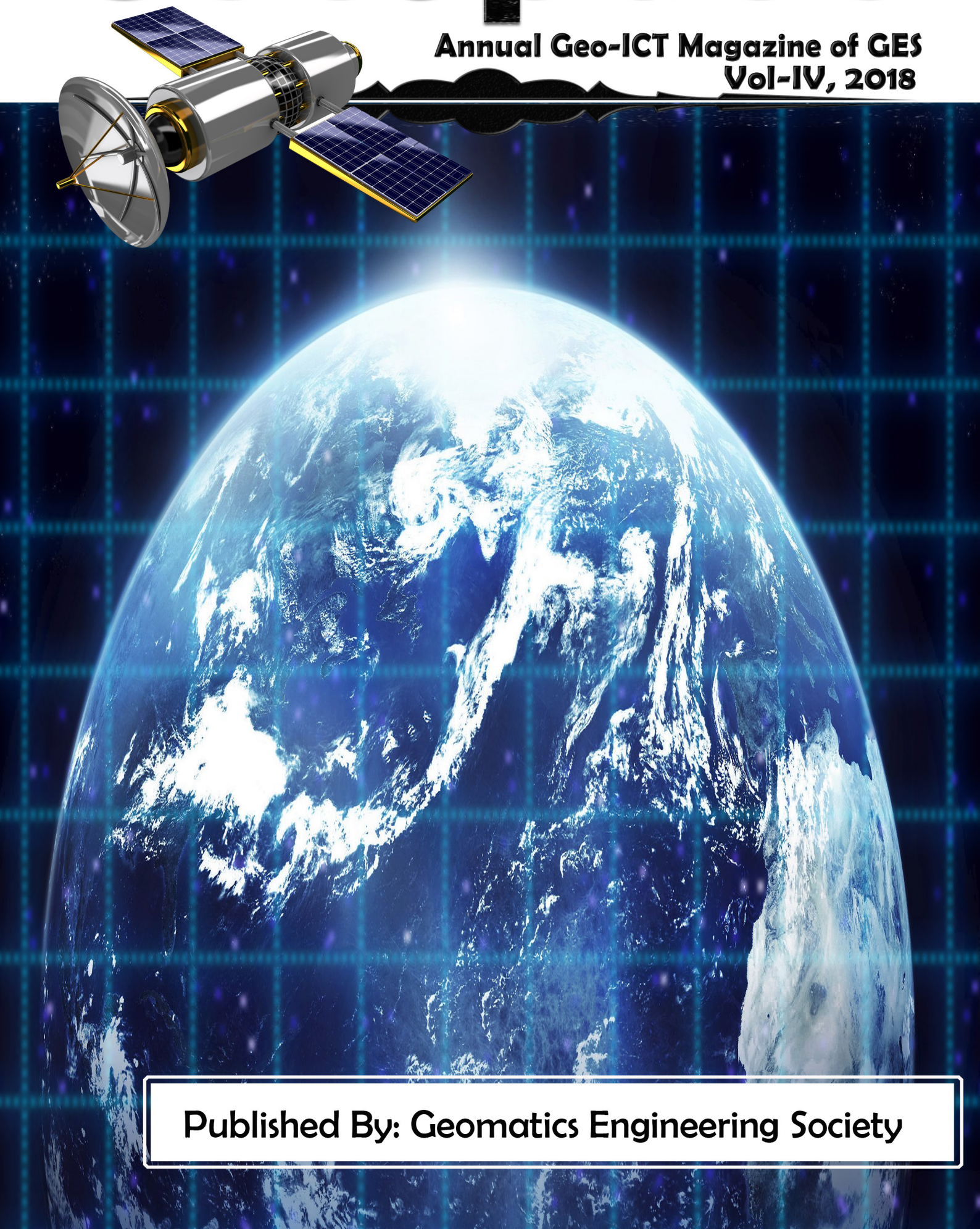
GeoSpace

Annual Geo-ICT Magazine of GES
Vol-IV, 2018



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Volume IV, 2018

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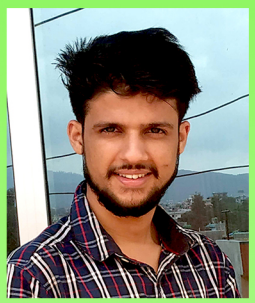

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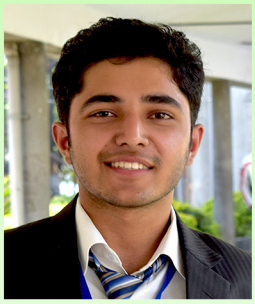

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Editorial

GeoSpace has been acting as a link between students, professionals, researchers and geo-informatics enthusiast. GeoSpace delivers researches, explorations, studies, works and accomplishments in the field of geo-informatics and aims to salute them all. With the objective of succeeding the path led by the seniors by publishing 'GeoSpace Volume-I', 'GeoSpace Volume-II' and 'Geospace Volume-IV' in 2012, 2016 and 2017 respectively, we, 9th batch of Geomatics Engineering, Katmandu university present this pristine 'GeoSpaceVolume-IV' on the occasion of World GIS Day-2018. This volume is the result of unflagging and tireless endeavor of learners and adepts associated to Geomatics field.

The GeoSpace calls for interdisciplinary collaboration and research of involvement of individuals, groups and organizations. The ambition is to support the design of emerging geospatial domain and ripple them within readers which could bring affirmative knock in the society, nation and worldwide as a whole. The collection of research papers and articles is likely to provide insight that brings substantial value from data to information.

Paulo Coelho has said that "When you want something, all the universe conspires in helping you achieve it." Therefore, we would like to thank all the authors, financial supporters, faculties, seniors, well-wishers and all other unseen patrons who assisted us to manifest this ambitious dream into reality.

Message from Vice Chancellor

I am pleased to see the fourth issue of the annual Geo-ICT magazine *Geo-Space* published by the Geomatics Engineering Society of Kathmandu University (GES). This magazine adds to the literature of Geomatics Engineering in Nepal by creating and sharing new knowledge. Furthermore, it complements the initiatives of our University in advancing our institutional identity and in creating impact in the communities.

As our country moves into new era of decentralization that fuels development, the demand of expertise in geomatics is increasing. I am hopeful that our team from Geomatics Engineering will help fulfill this by providing locally suitable, applied skills and knowledge. Together, you will open new avenues of growth and progress in our society. Publication like this helps to communicate these prospects to wider audience.

I congratulate GES and the *Geo-Space* team for this publication and extend my full support for your noble endeavors in coming days.

Prof. Dr. Ram Kantha Makaju Shrestha, MD
Vice Chancellor,
Kathmandu University

Date: 14 November 2018

Message from HOD

I am proud of my Geomatics Engineering Students as they are going to publish “GeoSpace Vol IV” to mark the GIS day 2018, this year too, adding one more milestone. This noteworthy activity is done by them through the Geomatics Engineering Society(GES). I would also like to appreciate the editorial team for their hard work for the publication. The contributing authors also deserve congratulations for their articles getting accepted for publication.

Finally, the entire GES members must be congratulated for their dedication and coordinated teamwork in producing such a wonderful magazine “GeoSpace -IV” continuing the legacy of their seniors. I personally as well as on behalf of the Department of Civil and Geomatics Engineering, wish for the magazine’s success and popularity among the readers.

-Assoc. Prof. Dr. Prachand Man Pradhan

Act. Head of Department

Department of Civil and Geomatics Engineering

MESSAGE FROM DIRECTOR GENERAL OF SURVEY DEPARTMENT

It's an honor as well as privilege to utilize this space to convey my message to everyone involved with the third issue of the "Geo Space", a magazine that reflects how innovative and professionally dedicated our 'Geomatics Engineers-to-be' are. On behalf of Survey Department, the National Mapping Organization of Nepal, and my own, I would like to take this opportunity to congratulate all the young and energetic members of Geomatics Engineering Society of the Kathmandu University (GES), especially the members of Editorial Board of 'Geo Space', for successfully bringing out its fourth issue. At the same time, let me also acknowledge the endeavors of the contributing authors for expanding the horizon of knowledge through their intellectual inquiry. I believe, this issue will be even more useful than the previous ones to the professionals, students and researchers of the surveying and mapping domain.

Survey Department, determined to establish itself as the mother organization of the Geomatics professionals in Nepal, sees its future in the faces of succeeding generation. Not only in capacity of the Director General of the Department but also as a committed Geomatics professional, I have been keenly keeping an eye on the enthusiasm, competency, performances and dedication of the youngsters in professional domain, and I have an impression that the future of the Department is promising, and the profession is getting even stronger with wider scope. The youngsters including former GES members recruited at the Department are testimony to this fact. I have observed that, apart from their regular studies, 'GES heroes' are always doing something different that ultimately contributes in their professional development. Publishing a magazine in such a scientific domain is not an easy task. I respect their devotion towards professional development, which is indeed commendable and encouraging. I wish to see, if not higher, the similar level of contribution, dedication and devotion towards the professional development from them in the days to come too. "Geo Space" is a digest for the beginners, informant for professionals and platform for researchers. Reading "Geo Space" is refreshing yourself. Enjoy Reading "Geo Space"!

- **Ganesh Prasad Bhatta**
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Message from Executive Director

It is my pleasure to be a part of the 4th edition of GeoSpace, which is going to build one step ahead, spraying information and knowledge in sector of surveying, mapping and geo-information technology. I am confident that, this publication will be fruitful to entire researchers, academia, students with concentrating, the land surveying and mapping technology.

Reminding that firstly, Surveying, Mapping and Geo-information Technology is an integral component related to land, water and environmental resources development, generally inclusion of civil engineers, municipal planners, environmental scientists, the construction industry managers and policy makers with inclusion of different lenses of land administration and geo-environment issues.

And secondly, we cannot escape from latest knowledge, experiences and technological development with the emerging issues of boundary management and control, geodetic framework, photogrammetric and engineering design surveys, cadastral mapping sector with demand of engineers, architects, municipalities, and real estate and land developers, along with three tier system: federal, state and local level of country. I am confident that this property will support on geomatics sector for sharing data, information, knowledge and building wisdom.

Congratulations on getting your journal published! Precious views and ideas will encourage to booming the sector of geo-information, land surveying and mapping technology. Of course much of the subject reflects dedicated experience in the matter.

I honestly appreciate the effort and hardworking devoted by the Advisory Council, Editorial Board and precious Authors to bring out the 4th issue of "GeoSpace". Taking the opportunity, I would like to extend heartiest congratulation to the entire team for publication of this issue.

Thank you and enjoy reading.

- Karuna K.C.
Executive Director
Land Management Training Center
Dhulikhel, Kavre

Message from President

The annual event of Geomatics Engineering society (GES) Kathmandu University, GIS Day, is one of the benchmark event of the society. It mainly focuses on the major theme to LEARN, SHARE and CONTRIBUTE in the field of geospatial science and technology. Every event of GES targets wide range of participant from all sectors, from very young school students to entrepreneur and highly acclaimed geospatial professionals in the country. GES always act as a platform to develop the skill of students apart from their educational activities through technical training, talk programs, interaction with experts, sport activities etc.

As a president of the society, I feel so proud to say that I have got good team members contributing in every events whether it be Map Literacy, GeoSpace, GIS Day and several other events. Publishing GeoSpace is not surely an easy task as it requires a high level of passion and my team totally deserves it. GeoSpace began with an aim to give exposure to student's project and to help them express themselves to a wider audience. It even aims to encourage students and researchers for their innovation and creative ideas and increase their analysing capacity. Keeping these things on mind GES is publishing GeoSpace **"Annual Geo-ICT Magazine of GES, Volume –IV"**.

I am therefore eagerly looking forward to the event, **GIS DAY 2018**, and to get the annual magazine GeoSpace Volume-IV. And I would like to thank all the concerned sectors in making the event successful and supporting for the magazine. It will be great encouragement to our juniors to do further research and project in days to come.

- Nabin Raj Bhatta

President,

Geomatics Engineering Society

Contents

Present State of Surveying/Geomatics Engineering

Punya Prasad Oli

The transformation from analogue to digital technologies is being implemented fully in private sector and gradually in government sector. Analogue machines, accessories, material were phased out in 2014 i.e. accessories, spare parts and maintenance services are no longer available. Operators and mechanics of older technology are retired. The status of the Geomatics technologies may be described as following:

1. Standards:

Earlier survey specification is no longer valid. It needs to rewrite all standards as per requirement of technologies. It should also valid with the 4th industrial revolution. The national standards which are parity with ISO standards will be general. It will include quality control of surveying and spatial data generation (mapping). It will include geodetic or precise survey, spatial data acquisition (imaging, photogrammetric and GIS works) symbolization and coding, reproduction and storage of data. The standards are mostly needed and used for national development projects, so that the quality of work should be maintained and important study or factors are not missed such as standardization of instruments, machines or checking procedures of working are not missed.

2. Geodesy:

Manual geodetic instruments like theodolites, levels are replaced by Global Navigation Satellite System (GNSS), total stations, astrofix, gyroscope or inertial positioning system. Precise leveling network is gradually replacing by gravity model- equipotential surface, precise total station observation or GNSS. Surveying needs to control azimuth every 3rd or 7th stations. With precision of position of stars up to 0.”0001 in right ascension and declination from the observations of Gaia or Hubble space telescope and use of precise total station with time recording facility with or without GNSS, the azimuth determination could be carried out +-2” to +- 0.”2.

Total station (combined theodolite, EDM and computer) could be used for all survey works. It has facility to records by push button of angle, distance, time, coordinate or other parameters.

International terrestrial reference frame (ITRF) or Global Geodetic Reference Frame (GGRF) which was adopted by UN General Assembly in February 5, 2015 to use for mapping sustainable development is required use in mapping. The relation between ITRF or GGRF and MUTM of Nepal is also known via WGS 84.

3. Survey and spatial data:

Survey and spatial data creation needs be in Modified Universal Transverse Mercator Projection in order to achieve precise position of detail to fit the geoid of Nepal even at the scale of 1:500. All the spatial data and sheet number are based on it.

Spatial data creation is now carried out by field survey method using total station of small area and using aerial or UAV(resolution 2.5, 10, 15 or 30cm) is possible with the development of large format digital aerial cameras and satellite imageries (25cm and smaller resolution) for larger area. It is possible to capture 2.5cm resolution aerial imageries with modern camera for engineering survey. Highting is better carried out using Lidar scanning. It is used along with aerial imaging, photogrammetric mapping when high degree DEM is needed. Lidar survey may achieve the spot height accuracy of +- 6-10cm. Dual Lidar sensors red and green are used in coastal areas.

Modern photogrammetric ortho image, DEM and ortho photo generation are usually carried by anaglyph technique viewing stereo pair using red and green lights, fast alternate viewing imagery or other techniques. Stereo image processing software are developed like autometric, BAE system, IPS Match, ER Mapper, ERDAS, ortho mapper used in generation of digital elevation model (DEM), spot height, or ortho photo and vectorisation the details. The closed range (terrestrial) photogrammetric tools are also developed. Generally ortho photo image is generated from aerial imagery which is vectorised manually and contour generated from Lidar data at required vertical interval.

4. GIS

Digital mapping is used to create data base of any

types of maps from new survey field. It may be topographical and plannimetric features data created by digital stereo imagery of aerial or satellite imagery. Topographical maps are used not only local level planning, but they are used in engineering, public work design, exploration and conservation of resources.

Contour interval will be 0.25m, 1m and 5m at the scales of 1:500, 1:1000 and 1:5000 respectively. Plannimetric features created from field data or vectorised from ortho photo are collected, coded, tabulated at attribute tables and symbolized as per the standard as map file. Large scale mapping standard is being prepared.

Topographical maps or ortho imagery works as base map for all other mapping so, it should be carefully checked. Map data base is prepared, checked and stored as safe files and map files prepared converted to pdf format for editing and printing.

Map reproduction and editing is using map file, any error found on the map is corrected on safe file of database, corrected map is again edited and final map is sent for final correction of database. If the map is required to print more than 25 copies, printing plates are directly prepared from digital data database and sent for offset printing.

5. Cadastral Survey

It is recording of right, restriction and obligation on piece of land/parcel with geometric data/spatial data describing it and it is also legal document. Therefore, it will have spatial data describing the parcel boundary and attribute data of owner, restrictions and obligations of the parcel. Appropriate notification, adjudication, allowing complaining on error or omission and decision on complaints is equally important as accuracy of map or spatial data.

Cadastral survey is usually carried out based on national control network and requires high accuracy of parcel dimension. It is also required record right, restriction and obligation of parcel/ property on various strata or floors of building and land with may uses and owners. A high rise building may have private, common land and other type of land on each floor and the surface. In Nepal simply owner of floor is recorded. Some country used the floor plan to register the land owner. It is not so simple that the part of floor is private land and common land like corridor, staircase and lift. So, it is required 3D cadaster even 4D cadaster to reflect the history of parcels which is being used in many countries.

Prof Chryssy A Potsiou, President of FIG stated that “In view of the Sustainable Development Agenda 2030 all UN member states are developing and modernizing their cadastre and land registration systems and in parallel formalizing their property markets. Present land administration systems and cadastres need re-engineering; they must continually evolve to cope with the ongoing megatrends, such as urbanization, demographic change, societal disparities, the digital transformation, volatile global economy, anthropogenic environmental damage and so on.”

6. Engineering Survey

It need surveys for topographical mapping as base map at the scale of 1:500 or 1:1000, geological survey, geophysical study, cross section and profiles, cadastral data for land acquisition, maps and data for social and environmental study and relocation of constructions like building, road, tunnel. They are carried out using total station or aerial mapping with Lidar data and extensive field survey. Survey monuments are very important and should be permanent and at safe places. The control points must be connected to national control point network. The accuracy of survey work is also critical and it will be 1:10,000 at feasibility stage and 1:100,000 at detail project report (DPR) stage.

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Urban Planning and Development in Nepal

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Historic settlements are found along trade routes and river banks (fertile lands) but urbanization, in global context, started to increase exponentially with industrialization in the 1950s. In the current scenario, infrastructure development and economic activities are considered as major factors for urbanization after population growth. Urban and rural areas are basically distinguished with respect to population size, settlement area, administrative area, infrastructure development, agricultural/non-agricultural activities, the number of jobs available, land use and other relevant parameters. After the construction of east-west Highway and eradication of widespread malaria in flat land (Terai) region in around 1950 in Nepal, a large number of people from high hills migrated to Terai and established dense settlements. Following this flow, declaration of 75 districts as administrative units in 1960 made decentralization of government services in every district which eventually decentralized urbanization. Since then, the concept of urban area and municipal was introduced in Nepal. Along with, ten-year long armed conflict (1996-2006) was also one of the major reason for the migration of rural population towards perceived safe urban areas. Nepal is ranked one of the ten least urbanized countries in the world and the least urbanized in South Asia (World Urbanization Prospects: The 2014 Revision 2015). For the period 2014-2050, Nepal is projected as top-ten fastest urbanizing countries in the world with a projected annual urbanization rate of 1.9 percent (ibid). Government standard classifies urban cities into five classes - market center, sub-city, city, sub-metro city, and Metropolitan. Planning Norms and Standards (DUDBC 2013) defines urban units as:

- Market Center: a Lowest urban unit with minimum 50 shops or outlets within 100m.
- Sub-city: Small towns with population from 10,000 to 40,000.
- City: Municipals with a population ranging from 40,000 to 100,000.
- Sub-metropolitan city: Cities with an urban area with a population from 100,000 to 300,000.
- Metropolitan city: Highest urban area in urban area hierarchy with a population above 300,000.

Recognizing the need of a strong organizational structure for urban planning, Nepal Government, on May 18, 2012, decided to establish "Ministry of Urban Development (MoUD)". With the vision of "Managed, clean and beautiful cities and settlements with infrastructure, service convenient" (MoUD 2016), this ministry is responsible for developing plans and manage urban/city development, housing, and building construction. For urban planning and development, some instruments and policies formulated and implemented by this ministry in coordination with other government and non-governmental organization are described below in brief:

1. Housing and Building Construction

The term "Housing" for the first time was recognized by the government of Nepal in the seventh five-year plan (1985-1990). This step is considered as a milestone towards the formulation of Laws and Acts related to urban housing. Town development Act 1988 and relevant policies were formulated. In the same time Department of Housing and Urban Development was established to implement housing policies. Currently, Department of Urban Development and Building Construction (DUDBC) under MoUD is responsible for planning and implementing policies, technical specifications and standards regarding housing and building construction. The main objective of housing division is to promote safe and affordable housing by developing planned settlements. Meanwhile, Government, with the support of different NGOs/INGOs, has started to work for squatter and slum settlements considering them as urban housing problems (MoUD 2016).

2. Road networks and Transportation

Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) and the Department of Urban Development and Building Construction (DUDBC) are responsible agencies for urban roads. To maintain uniformity and define standards in road sector, DUDBC, DOLIDAR, and Department of Road (DOR) together came up with Nepal Urban Road Standards (NURS) in 2014. NURS main objective is to develop people-centric transportation system and to improve capacity, quality, and safety of urban transport systems. NURS has classified urban road is in six categories as per their width. In order to provide road access to every construction plot, a minimum setback of the road is fixed 3m whereas the minimum width of the urban road is 4m. Coordination and Cooperation among various urban focused agencies is considered

a major aspect in urban road planning and construction. Multi-sectoral involvement is considered as an opportunity rather than a hindrance for urban road development (DUDBC 2013).

3. Health and Education

Planning Norms and Standards 2013, developed by DUDBC, provides criteria on health and education for an urban area. Minimum criteria for health and education services depends upon the type of urban area, increasing from market center to metropolitan city. Market center, smallest urban unit, must have at least primary school and sub health post within its boundary. Whereas, Metropolitan city with a minimum population of 300,000 has to have University/s and at least four different levels of Health Institutions with several capacities. The rapid rate of urbanization during the past few decades has created a huge pressure on Kathmandu and a number of cities in the Terai. Apart from the obvious health issues, inadequate infrastructure and services, increase in slum and squatter settlements, a decline in the quality of environment, and social conflicts due to overcrowding etc. are considered main threats for the government (MoHP 2016).

4. Sanitation & Drinking water

Department of Water Supply and Sewerage (DWSS) under the ministry of water supply and sanitation is the government body responsible for planning, implementing, operating, repairing and maintaining water supply and sanitation systems throughout the country (DWSS 2004). Supply of adequate amount of safe drinking water to urban areas is one of the major challenges of the government. Most of the major cities including Kathmandu metropolitan, Chautara Municipality, Panchkhal Municipality and much more are facing the problem of safe drinking water and sanitation. Since most of the cities were not planned properly, problem regarding management of solid wastes and sewage along with a supply of sufficient drinking water are raising. The government in collaboration with national and international organizations is conducting various projects for improving water supply system in the cities. For example, Melamchi water supply project, funded by ADB and JICA is one of the major water supply projects which is aimed to solve the scarcity of drinking water in capital.

5. Economic Infrastructure

Planning norms and standards 2013 explains parking space, business complex, industrial areas, sports complex, movie hall, etc. as economic infrastructure in the urban area. According to planning norms and standards 2013, there must be at least one local market (with minimum 50 shops) called ‘haat bazaar’ to declare the area as an urban city.

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LAND ACCOUNTING

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The Sustainable Development Goals (SDGs) (or Global Goals for Sustainable Development) are a collection of 17 global goals and altogether 169 targets set by the United Nations General Assembly which needs to be accomplished by 2030. Thus, also referred as 2030 Agenda. The SDGs cover social and economic development issues including *poverty*, *hunger*, *health*, *education*, *global warming*, *gender equality*, *water*, *sanitation*, *energy*, *urbanization*, *environment* and *social justice*.

However, in this article we will discuss on Goal 15: Life on Land which articulates target for preserving biodiversity of forest, desert, and mountain eco-systems, as a percentage of total land mass so as to combat desertification, land degradation and biodiversity loss.

1.6 Billion	Around 1.6 billion people depend on forests for their livelihoods.
80%	Forests are home to more than 80 percent of all terrestrial species of animals, plants and insects.
2.6 Billion	Worldwide, 2.6 billion people depend directly on agriculture to earn a living.
8,300	Of the 8,300 animal breeds known, 8 percent are extinct and 22 percent are at risk of extinction.
8 out of 10	Up to as 80 percent of people living in rural areas in developing countries rely on traditional plant-based medicines for basic healthcare.
1%	Of the more than 80,000 tree species, less than 1 percent have been studied for potential use.

(UNDP, 2018)

What can we do to achieve this particular goal?

Any part of decision making takes initiations from data analysis. To manage database on land, a term called Land Accounting is introduced whose function is to provide an assessment of the changing shares of different land uses and land cover within a country. Understanding these characteristics and changes is critical to understanding the impacts of urbanization, the intensity of crop and animal production, afforestation and deforestation, the use of water resources and other direct and indirect uses of land.

What to do?

Integrate economic, environmental and social data into a single, coherent framework for holistic decision making.

What do we need?

- GIS and Remote Sensing platform
- Classifications on Land use, Land Cover and Land Ownership and their associated Data
- Expertise: Land managers, Geographers, Statisticians

How it works?

Land accounts consist of two main types of accounts to record land use and land cover and their links to the economy:

1.Physical asset accounts: These accounts describe the area of land over an accounting period by land use and land cover or land ownership. They show the various additions and reductions in land stocks associated with human activity and natural processes.

2.Monetary asset accounts: This set of accounts provides information on the overall value of land for agriculture, forestry, aquaculture and human activity, among other usages, primarily due to the revaluation of land. (UN, 2018)

How to do?

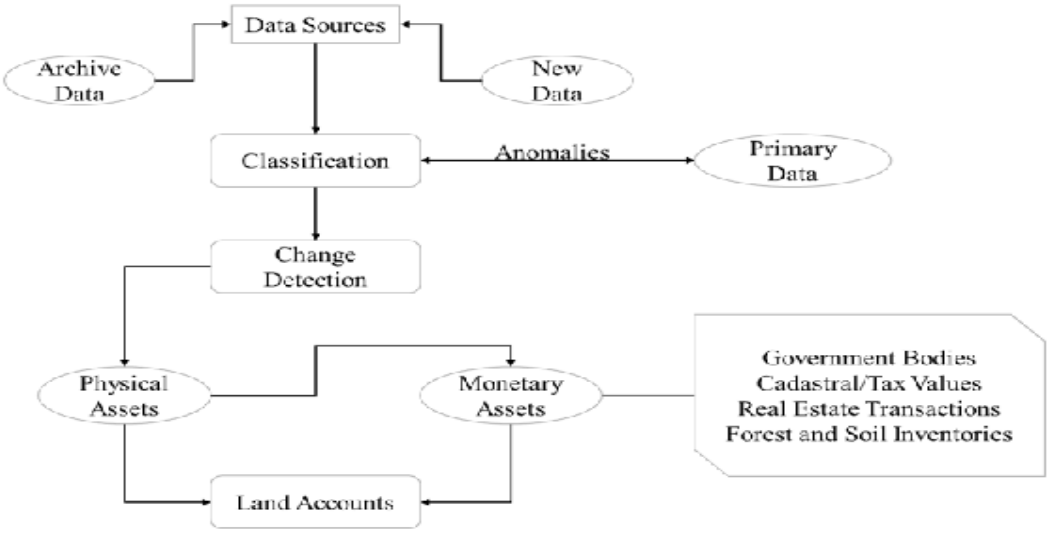

Fig: Framework for Land Accounting

How it looks like?

Physical Asset Account: Each numerical value represents a pixel of size 1m*1m.

Large study area must be first segmented to small clusters of pixel and then change detection should be carried out.

	Closing Land Cover						
Opening Land Cover	Artificial Surfaces	Crops	Inland Waters	Barren Land	Tree Covered	Opening	Reductions
Artificial Surfaces	20					**20**	
Crops	4	28		2		**34**	*4*
Inland Waters			42			**42**	
Barren Land	2			18		**20**	
Tree Covered	4	2			22	**28**	6
Closing	**30**	**30**	**42**	**20**	**22**	**144**	
Additions	*10*						

Monetary Asset Account: Corresponding monetary value of physical asset is considered in this table where each numerical value is the associated monetary value of respective class.

	Closing Land Cover						
Opening Land Cover	Artificial Surfaces	Crops	Inland Waters	Barren Land	Tree Covered	Opening	Reductions
Artificial Surfaces	4000					4000	
Crops	800	280		100		1180	880
Inland Waters			210			210	
Barren Land	400			900		1300	300
Tree Covered	800	20			550	1370	820
Closing	6000	300	210	1000	550	8060	
Additions	2000						

Approximate monetary value for 1 pixel taken for this research is as below:

Class	Value (In Dollar)
Artificial Surfaces	200
Crops	10
Inland Waters	5
Barren Land	50
Tree Covered	25

Monetary Value depends on the following factors:

1. Development Index of the Research Area
2. Geograph Monetary Value depends on the following factors:

1. Development Index of the Research Area
2. Geographical Features
3. Complexity of Classes
4. Availability of the Resources around the Research Area

Things to Note:

- Row total denotes Opening section while Column total denotes Closing section.
- The opening and closing section should always be balanced.
- Sum total of Reductions and Additions should always be balanced.
- Only one entry in corresponding row and column signifies that there is no any changes.

(144 Sqm. Area at Pathum Thani, Thailand was taken as Research Area. Respective monetary values were assigned after consulting local people and some web sources providing information on land and forest value.)

Now what?

After creating Land Accounts, we will get idea on the area or percentage of degraded land during certain time period which we choose to work on along with the approximate monetary values associated with it. It will assist the related governmental bodies or organizations to analyze the problem behind it and cope with it so as to fulfill the United Nations 2030 Agenda: Goal 15 (Life on Land) within the targeted time.

Being student of Geomatics, it would be our duty to explore such topics of interest. So, why stay dull when we can act. Let's start to act locally; take one's respective village/town area as a subject of study and create a land account. To create a land account, what we need is some techniques on image classification, basic knowledge of statistics and our involvement in community.

Believe me! It would be quite interesting along with informative too.

References

UN. (2018). SYSTEM OF ENVIRONMENTAL ECONOMIC ACCOUNTING. Retrieved from https://seea.un.org/content/land-accounts

UNDP. (2018). SUSTAINABLE DEVELOPMENT GOALS. Retrieved from http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-15-life-on-land.html

Deep learning for future Geoscience Studies

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With immense opportunities and with the pedagogical significance, Artificial Intelligence (AI) has gained a rapid growth in advancement all over the world in recent years. The fastest developing countries like China have recently understood the future of AI and have boosted it as top 3 leading industries in China. India being an ore to information technologist, have already advanced toe-to-toe to the rest of the world in the applications of AI towards solving major problems. Nepal on the other corner have minimum concerns for AI. This problem is excitingly frightful for the future of "Geomaticians". Exciting because Geomatics has an immense area of interest and possibilities in AI, and at the same time, frightful because Nepal has not shown its leniency towards such major future. This makes me urge the fellow students and Geomatics Engineers to take a look towards the possible applications of AI in Nepal.

I have tried to show some possible exciting applications of Deep Learning (DL), which is a part of AI and friendly towards Remote Sensing and GIS. I specially urge the students because their sharp minds and creativity comes of great trait in learning DL. Agriculture being one of major source of economy for Nepal, we can combine all our interest area to form a topic: "*Deep Learning for agriculture using UAV*".

Fastest way to learn Deep Learning

As a Geomatics Engineer, I understand that UAV studies have recently been an area of interest to the students. However, any research should focus on its significance to the real world. Since we are already interested in UAVs, why not extend its possibilities by adding up computer vision techniques? Due to the page limit, I would like to suggest readers to have a brief knowledge on DL from internet. Few YouTube videos might be helpful enough to understand the basics. I suggest playlist [1] and this is where I learnt the most about it.

To find out the related research area, I suggest to read [2] which reviews 40 research papers on visual-based DL for Agricultural applications. Other related papers can easily be found on Google Scholar, Scopus and other internet libraries. If someone wants to start a career in Deep Learning, I suggest to follow this course syllabus [3] from Stanford University, where all the materials are provided for free.

Important Architectures and Tools

DL can get more interesting once we start to code, and understanding of Python Programming is of great use for DL. People can argue on choosing any other programming languages, but I have been well adapted to it, and that is enough. To run a python environment, I suggest to use Anaconda, as it provides Jupyter and Conda command-line interface. Things start to get a lot interesting once you hook up into these.

The best frameworks for Deep learning for UAV images is Tensorflow and YOLO. I suggest to go into Tensorflow first to understand how the frameworks work. All the codes, and materials are already existing in GitHub and YouTube recently. To install Tensorflow on Windows, follow [4] and to apply it for images, [5] will be helpful. The details on the errors in installation can be found on the comments of the videos.

Examples on Application of DL

To show an example of DL in Images, I followed [5] and the GitHub directory which the video has provided, to create a card detector. As a final output, I supplied an image of cards to the detector, which gives me the results with the probability score as shown in figure 1. This concept can be re-applied to our application area like counting palm trees (figure 2), classification of crops (figure 3), land cover classification (figure 4), etc.

Fig 1: Card Detector

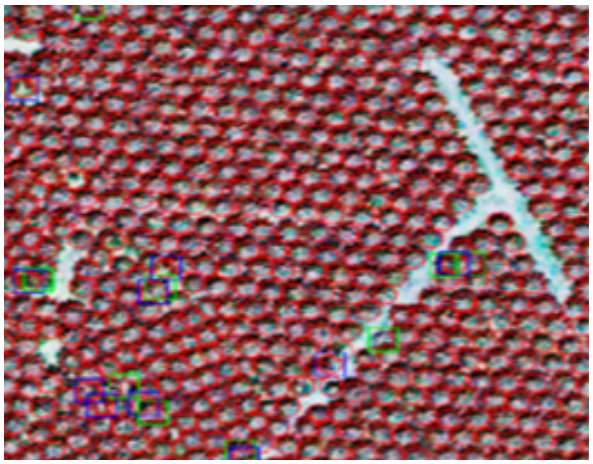

Fig2: Palm Tree Detector

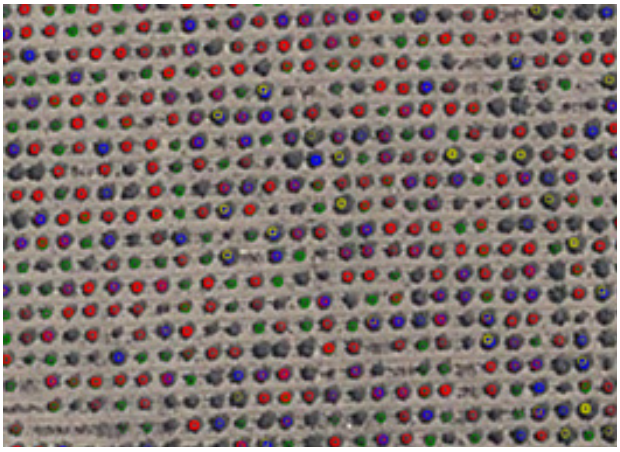

Fig 3: Crop Classification

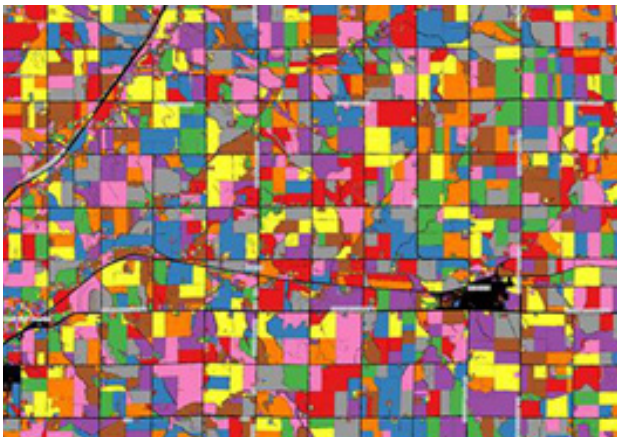

Fig 4: Land Cover Classification

Recommendation

Once the Machine Learning algorithms and architectures are understood, it is learner's curiosity to apply it to an existing significant problem in the real world. Some problems already exists in food security and agriculture in Nepal. But the new algorithms have opened more vibrant gaps in research fields like matter of accuracy, speed and credibility. It is always expected that a new learner can understand the gaps to attack on, which could possibly lead to an important research to solve a real problem.

Links

Accessed on October 13: http://yt.vu/p/PLkDaE6sCZn6Gl29AoE31iwdVwSG-KnDzF

[1]. *Kamilaris, A., & Prenafeta-Boldú, F. X. (2018). Deep learning in agriculture: A survey. Computers and Electronics in Agriculture, 147, 70-90.*

Accessed on October 13: http://cs231n.stanford.edu/syllabus.html
Accessed on October 13: https://youtu.be/RplXYjxgZbw
Accessed on October 13: https://youtu.be/Rgpfk6eYxJA

[2]. *Li, W., Fu, H., Yu, L., & Cracknell, A. (2016). Deep learning based oil palm tree detection and counting for high-resolution remote sensing images. Remote Sensing, 9(1), 22.*

COMPARISION OF DIGITAL TERRAIN MODEL OBTAINED USING UNMANNED AERIAL VEHICLE (UAV) AND TOTAL STATION

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1. Introduction

A topographical map usually represents the topography of the surrounding. It consists of different elevation models. A Digital Terrain Model (DTM) is a bare-earth model that contains elevations of natural terrain features. Unmanned Aerial Vehicles (UAVs) are nowadays widely used in many applications for different purposes. We hope the outcomes of the study will show that the data derived from UAV Photogrammetry have adequate accuracy but not accurate as that of ground survey.

So, it is possible to use the UAV Photogrammetry data as map producing, surveying, and some other engineering applications with the advantages of time conservation, and minimum field work with adequate amount of accuracy but not accurate as that of ground survey.

2. METHODOLOGY

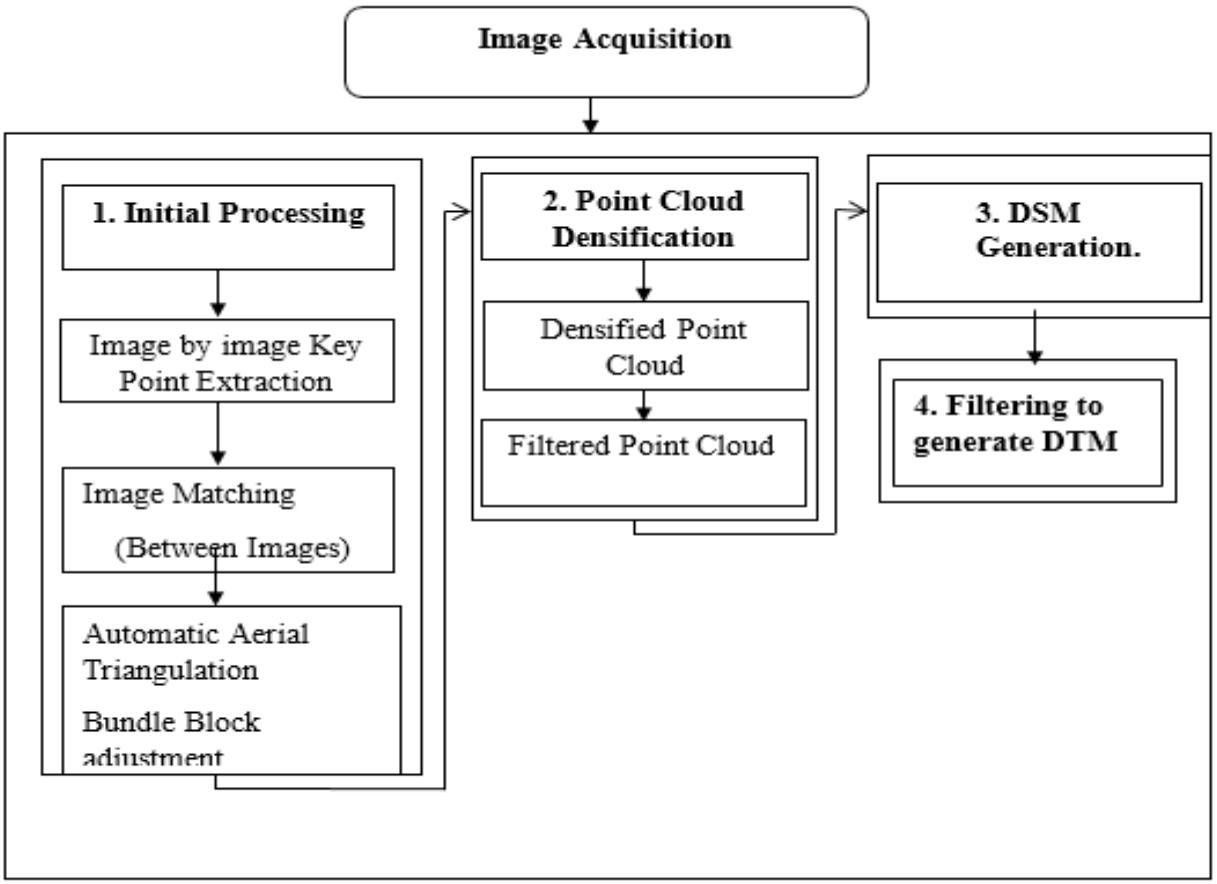

Figure 1: Methodology

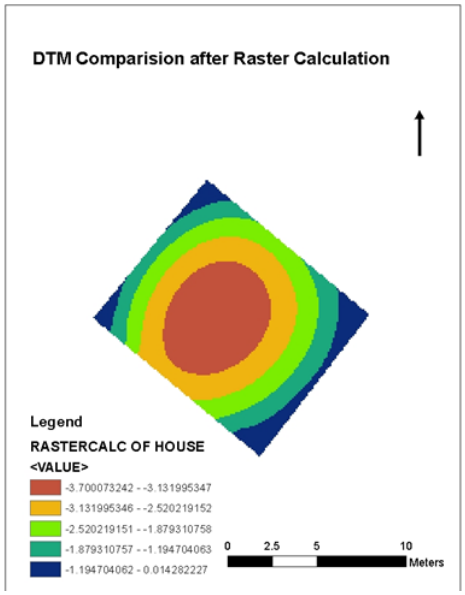

Figure 2: Comparison of DTM of project area

The differences between the highest and the lowest elevation while comparing between the terrain model from ground survey model and the aerial survey ranges from -3.70007 to 0.0142822. This actually happened because the surface was covered by a building when we masked it. It was all due to the algorithm that Pix4D used. The surface might have been cut from the surface below the building was placed.

Originally there was a building in that specific area where we took the sample. The reason behind the variation of the elevation is that the software Pix4D might have taken some space below the house while detecting the point i.e. while converting digital surface model to digital terrain model where the feature points of house must be removed.

Then, we calculated the Root Mean Square Error. Root Mean Square Error (RMSE) (also known as Root Mean Square Deviation) is one of the most widely used statistics in GIS.

S.No.	Point ID	Elevation (Field Data) (meters)	Elevation (Aerial Survey) (meters)	Root Mean Square Error (RMSE) (meters)	Remarks
1	5006	1426.941	1426.06	0.622296	WELL
2	5009	1447.874	1448.602	0.514773	BHOSTELCKP
3	5004	1418.634	1419.823	0.8407	PANITANK
4	5010	1418.553	1420.023	1.039	CKPT4WELL
5	5019	1413.517	1412.3867	0.799242795	EP3
6	5036	1413.432	1414.253	0.580534667	CKPTTTC
7	5058	1429.376	1430.823	1.023183512	
				Mean RMSE: 0.774247	

The root mean square error was found to be 0.774247meters.

3. CONCLUSION

We conclude the project under some limitations. The working methodology and final result suffered from those limitations. However, the results have been satisfactory. In this chapter, we have recommended the points that should be taken into consideration for better results.

In this paper, we compared the digital terrain models from images captured by a UAV platform. The post processing of UAV-acquired images can be done using algorithms ranging from classical photogrammetry to modern computer vision.

The computational time is often very high in case of computer vision algorithms. In case of Pix4D, feature point extraction took hours for processing. However, greater advantage was, thousands of key points were extracted that helped in accurate estimation of image orientation parameters. This further helped for accurate georeferencing of images. The possible cause of errors during georeferencing, has been explained.

The main objective of this project was to compare the digital terrain model obtained from aerial survey as well as from land survey. We succeeded on the data capturing and processing of the nadir images to obtain a working digital terrain model.

4. LIMITATIONS

Data acquisition became a major limitation in this project. We had to fly the UAV above tall trees and from elevated terrain in order to ensure the safety of the UAV and a better signal from the remote. So, the image might suffer distortions from the reality.

The hardware required for processing the images was also a limitation in this project. The processing of images for this kind of project required state-of-the-art hardware with high processing capability which was also a huge limitation in this project.

Thus, in this way we compared the digital terrain model obtained from land survey as well as from the aerial survey.

5. REFERENCES

1)Url 1: ScienceDirect.com http://www.sciencedirect.com/science/article/pii/S0263224115003243

2)Url 2: https://en.wikipedia.org/wiki/Photogrammetry

3)Url 3: Stacksexchange :http://gis.stackexchange.com/questions/5701/what-is-the-difference-between-dem-dsm-and-dtm (accessed on September 23)

4)Url 4: DEM extraction from archive aerial photos: https://www.researchgate.net/publication/236230284_DEM_extraction_from_archive_aerial_photos_Accuracy_assessment_in_areas_of_complex_topography[September 25,2016]

5)"Introduction to photogrammetry."The Ohio State University, Columbus (2005)

6)Juan, Luo, and Oubong Gwun. "A comparison of sift, pca-sift and surf."International Journal of Image Processing (IJIP) 3.4 (2009): 143-152.

7)Gini, R., et al., UAV Photogrammetry: Block Triangulation Comparisons. ISPRS-International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2013. p. 157-162.

Google Earth Engine: A Breakthrough in Geospatial Science

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To paraphrase Rebecca Moore from Earth Engine User Summit 2018: As one of the initial projects on Google Earth Engine (GEE), 5 million Landsat images were analyzed from 32 years of the archive at the USGS Eros data center in South Dakota, 3 quadrillion pixels to shift through and create those mosaics which required more than 2 million hours of computation but because it was run on 66,000 computers in parallel the result was on hands in a couple of days whereas on a single computer it would have taken 300 improbable years to produce the same time-lapse.

This mere statement is enough to convey why GEE is a requisite in today's world where moving the questions is far more efficient than to move the data, that is instead of making everybody around the planet download terabytes or petabytes of data and build server clusters to do the processing, having the data housed in the cloud and move the algorithms and questions in the cloud itself would make it much simpler for everyone to work with this massive scale of data.

GEE is a cloud-based geospatial processing platform that makes it easy to access high performance computing resources. Established towards the end of 2010, GEE portal provides enhanced opportunities for undertaking earth observation studies and provides access to satellite and other ancillary data, cloud computing, and algorithms for executing large-scale data analysis with relative ease.

Potentials of Google Earth Engine:

1. Public data catalog

One does not simply need to store the data in their personal device as GEE has the collection of variety of aerial imaging systems and satellite in both optical and non-optical wavelengths, environmental variables, weather and climate forecasts and hindcasts, land cover, topographic and socio-economic datasets. The satellite imagery ranges over 40-years period for the whole world, with many locations having two-week repeat data for the whole period, and a sizeable collection of daily and sub-daily data as well. The data available is from multiple satellites, such as the complete Landsat series; Moderate Resolution Imaging Spectrometer (MODIS); National Oceanographic and Atmospheric Administration Advanced very high-resolution radiometer (NOAA AVHRR); Sentinel 1, 2, and 3; Advanced Land Observing Satellite (ALOS) etc. All of this data is preprocessed to a ready-to-use but information-preserving form that allows efficient access. Users can access and analyze data from the public catalog as well as their own private data using a library of operators provided by the Earth Engine API.

While the initial setup included remote sensing data only, large amounts of vector, social, demographic, digital elevation models, and weather and climate data layers have now been added.

Most of the images have already been cleaned of cloud cover and have been mosaicked (by previous users) for quicker and easier processing; however, original imagery is available as well and the amount of original imagery far outweighs the amount of pre-build cloud-removed mosaics.

2. Processing power

The programming interface allows users to run custom algorithms, and analysis is parallelized so that many CPUs across many computers in Google's data centers are involved in any given computation, thus speeding up the process considerably. This enables global-scale analysis to be performed with considerable ease, as compared to desktop

computing. This removes the need to store, process, and analyze the plethora of satellite data on an office computer and users do not have to entirely depend on specialist remote sensing software, such as Environment for Visualizing Images (ENVI) and Earth Resources Data Analysis System (ERDAS) Imagine.

3. Interactive development platforms

There are several ways to interact with the GEE platform. The Explorer is a lightweight web app for exploring data catalog and running simple analyses. It is basically 'point and click' platform targeted to non-programmers. On the other hand, Earth Engine Code Editor is a web-based IDE for writing and running scripts, which supports both JavaScript and Python. One can have access to many pre-defined geospatial tools on this platform.

4. Save and share work routines

Users are free to upload their own datasets other than the data in the catalogue. One can choose to share the data that they have uploaded and scripts they have written with others. Hence the capability to import and upload data on the Earth Engine's public data catalogue provides immense opportunities for data updating and sharing, thereby promoting knowledge exchange.

Conclusion

All in all, the benefits of Google Earth Engine can be summed up as:

1) the transition of extensive computer processing to the cloud, which saves time, money, and resources,

2) bridge the digital divide between developed countries which have historically had access to expensive satellite imagery and developing countries which often lack the know-how and resources for complex satellite analysis.

Truly, GEE has been a game changer in the world of geospatial science.

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Silva, B., & Marlay, S. Introduction to Google Earth Engine. Salt Lake City, Utah.

Migrating to ArcGIS Pro from ArcMap

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Heraclitus once said, “The only constant is change”. I highly doubt he had GIS in his mind when he said that, but he would not have been wrong if he really did. Spatial data collection, processing and visualization has been rapidly changing and this decade has seen a lot of new players with new technology entering the GIS industry. Mapping behemoth Esri has followed suit and has come up with ArcGIS Pro as their latest flagship professional software offering.

ArcGIS Pro is a revamped version of ArcGIS Desktop and will be replacing ArcMap in near future. It has been built from scratch as a 64-bit mapping environment and can perform analysis in both 2D and 3D format. For those of us who are used to ArcMap for everyday GIS work, there is no other option than to start adjusting our workflow around ArcGIS Pro. The good news here is that ArcGIS Pro comes in the same package when you install ArcMap / ArcGIS Desktop and hence it is easy to start playing with what is being called the ‘most powerful’ GIS software in the world.

If you are already getting your feet wet with ArcGIS Pro or getting ready to jump into the Pro bandwagon, you might find the following 5 + 1 tips helpful to make your transition easy:

1.Batch ON/ OFF layers

In the good old days, ArcMap had a right click option to turn the layers on and off from table of content. But for some reason, Esri didn’t include this option when they introduced ArcGIS Pro. If you work with a lot of layers in Pro, you might have already noticed this nuisance. But if you don’t know a workaround for this yet, you are in luck.

Just select the layers that you want to turn ON or OFF and hit the space bar. This will do the magic. While you still must go through the excruciating pain of selecting the layers first, this is the best option that Esri provides us with as of version 2.2.

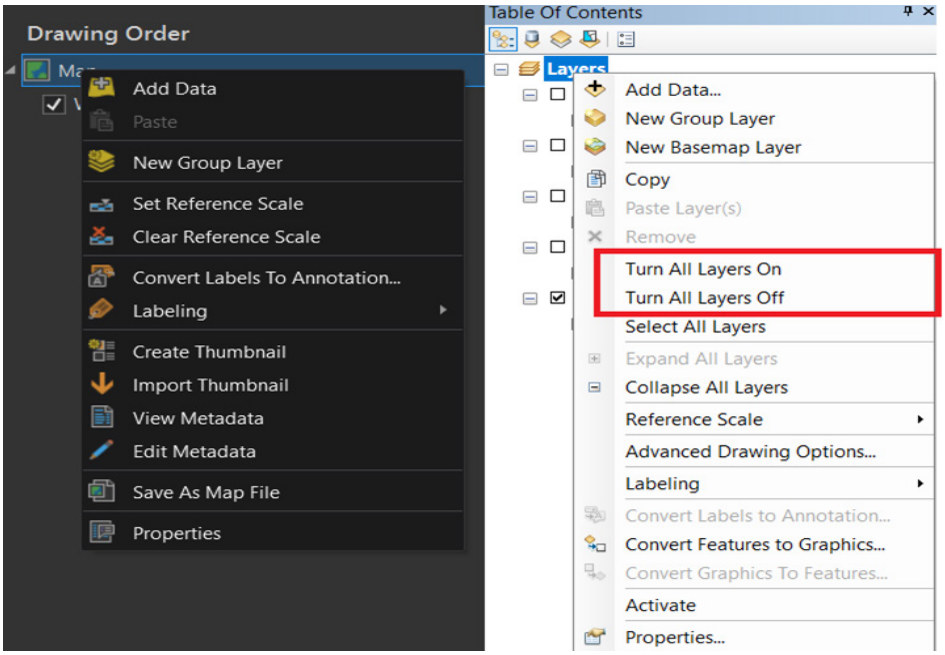
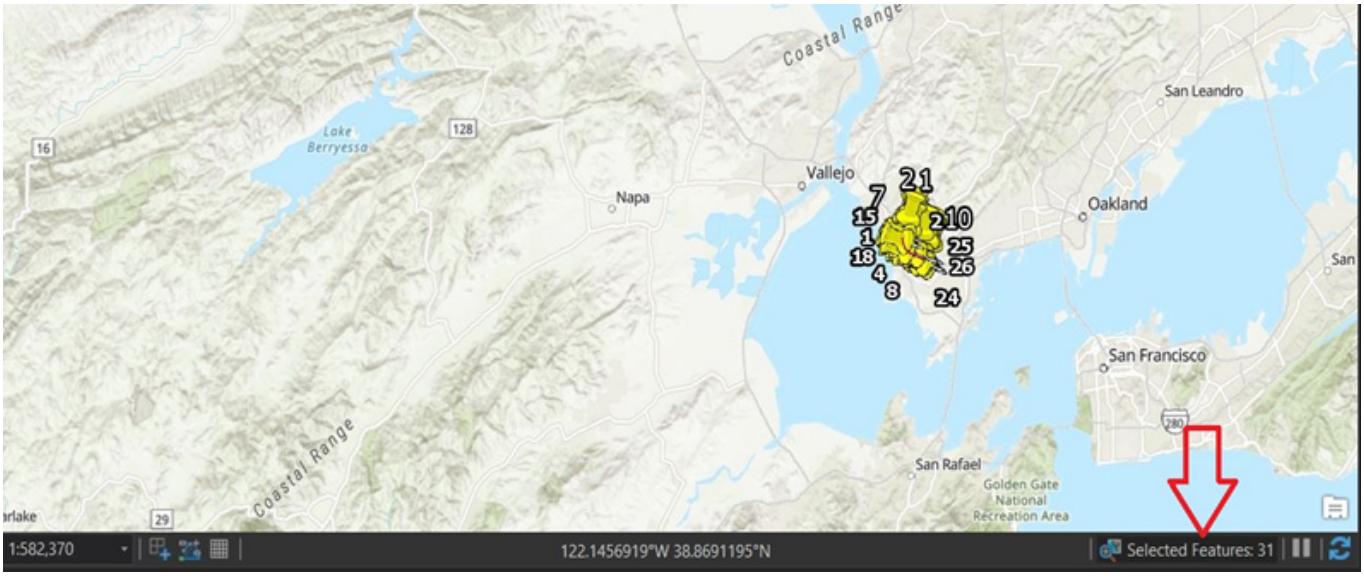


Figure 1 : ‘Turn All Layers On/Off’ option was available in ArcMap (right) and not in Pro (left).

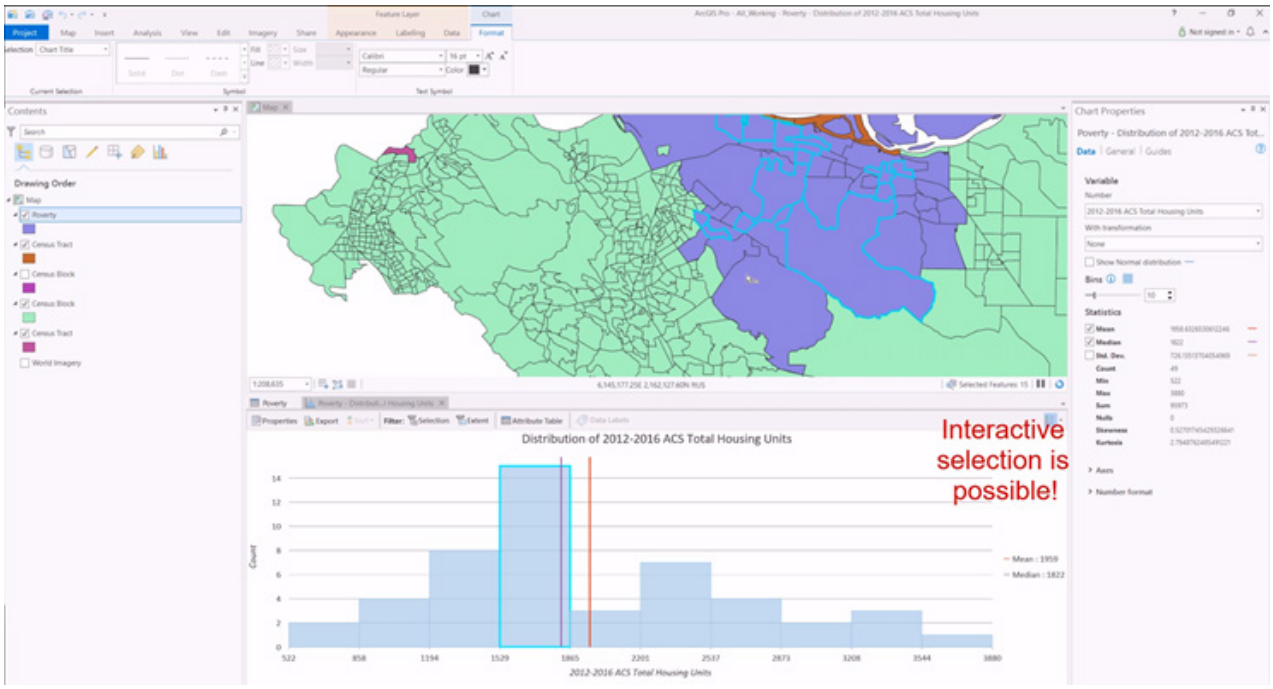
2.Select the Feature button in the lower right corner:

There is a small ‘Selected feature’ dialog in the lower right corner of ArcGIS Pro that shows the number of features being selected in the map view. And it is a button. Use it to quickly zoom to selected features in the map.



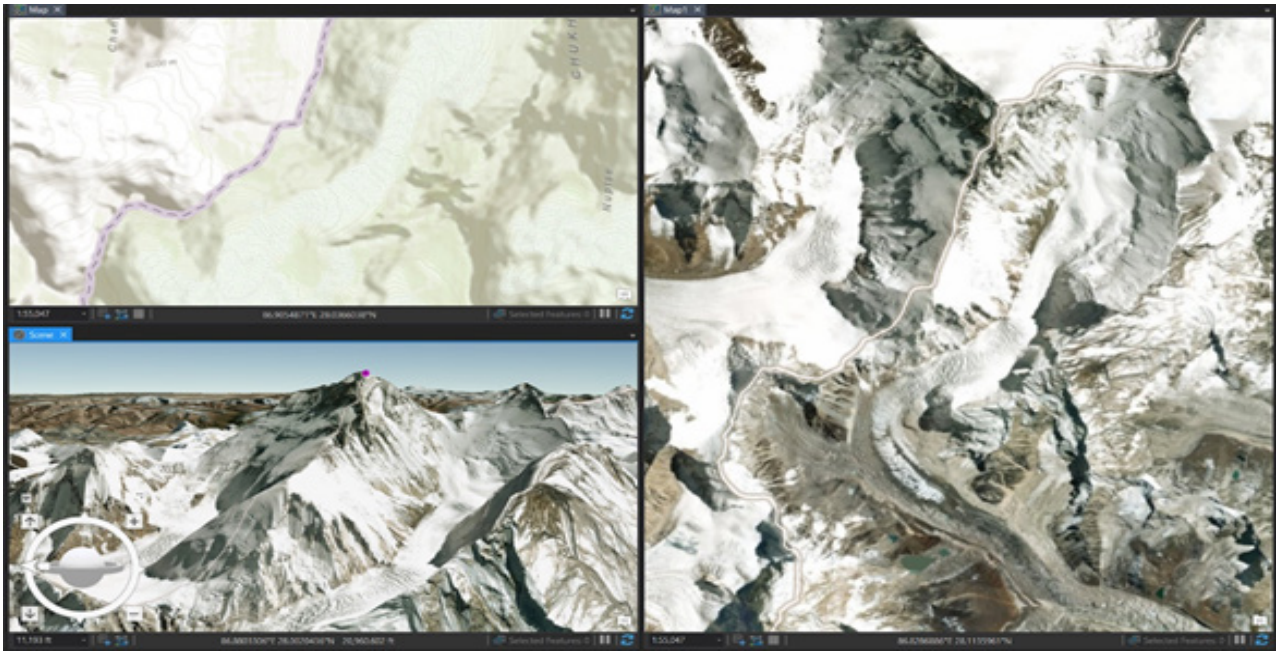
3.Using charts to filter data:

Categorical bar charts can be used to interactively select features as opposed to writing numerous queries. For this, once you create a chart from your attribute table by right-clicking a numerical field/column and selecting Statistics, you can interactively visualize the selected feature in the map view, as shown in the image alongside.



4.Link Views

View linking is a navigation experience and can be used for multiple maps, scenes, or a mix of 2D and 3D views. If your workflow calls for visualizing the same geography from different angles, dimension or overlay, you can link the views (or tab) together.

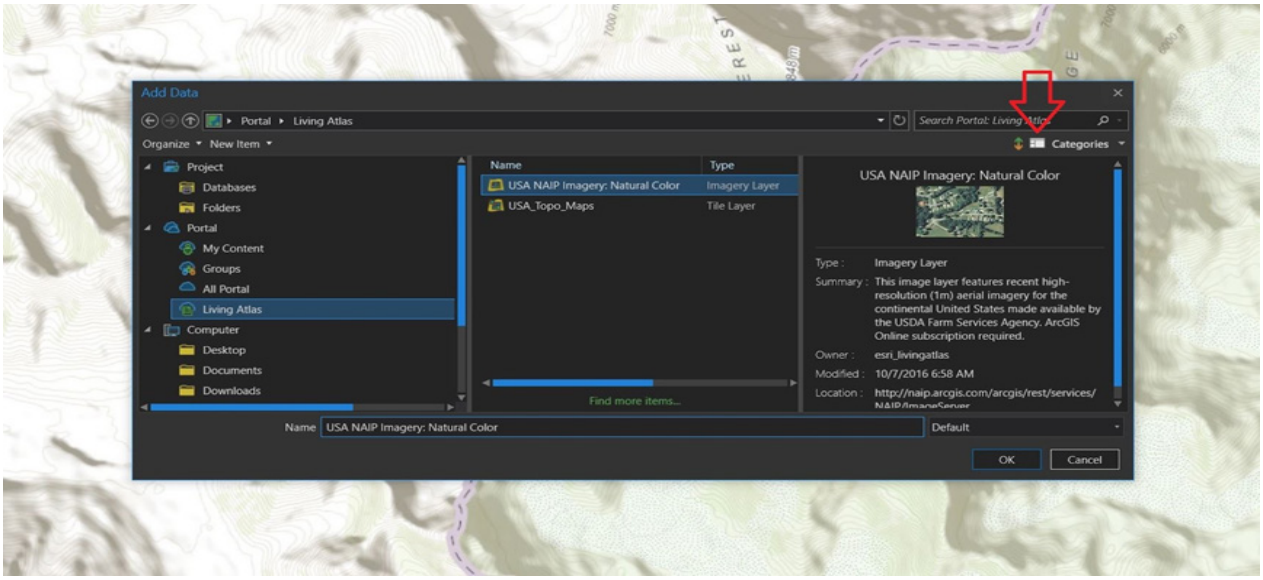


Views can be linked by going to **View >>Link Views >>Center/ Center and Scale.** Link makes more sense when you have two or more views docked side by side. To come out of the link view, simply click on the '**Link Views**' again.

5.Add data Previews:

Since ArcGIS Pro is already following Microsoft Office footstep with the ribbon-based toolbar, Esri developers might have thought, "why not add few other features from them"? The result is the preview pane available in ArcGIS Pro which has been a feature of Windows computer (and Macs) for some time now.

When using the 'Add Data' window, there is a (preview) button in the upper right corner that allows the user to preview the data before adding it to the Pro workspace.



6.The Dark Theme (bonus):

For those of you working in a development environment like Visual Studio, Brackets and Pycharm, this is not new. But dark theme has now arrived in ArcGIS Pro which many in GIS world would appreciate. Dark theme is believed to minimize eye strain when working in dimly lit spaces.

You can activate dark theme in Pro by going to the **Project >> Options >> General >> Personalize >> Dark.**

Now you can focus more on your maps and less on Pro User Interface.

Note: For readers that will like to visualize these tips in a video, here is a Youtube link of the same: *https://youtu.be/3JGa6cs-qz4.*

SUITABILITY ANALYSIS FOR THE SITE SELECTION FOR CEMENT INDUSTRY IN MAKWANPUR DISTRICT, NEPAL

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ABSTRACT

Industrial site selection is a strategic decision that involves several criteria considerations for technical, economic, social, environmental, and political issues. These criteria are generally described using a number of different indicators, expressed in quantitative and qualitative ways with some possible uncertainty. Decision making requires therefore, appropriate tools to enable data collection, storage, analysis, fusion, and knowledge management to address this complex, multifaceted scenario. This paper presents a Comprehensive Method for Industrial Site Selection (CMISS), an innovative approach for reasoning uncertainty and efficiently finding the most suitable solution based on a set of interacting decision support systems. This project is mainly focused to find suitable area for establishment of cement industry in Makwanpur District in Nepal. This study has been done by using Analytic Hierarchy Process (AHP) in which criteria such as distance from residential areas, distance from roads, land use, distance from rivers and pond, geology, distance from sensitive ecosystems, etc. The obtained results of this study may be helpful for establishment of cement industry in Makwanpur District.

INTRODUCTION

Geographic Information System (GIS) is a powerful tool that can be used to analyze spatial data and its sophisticated analysis functionalities with multi criteria evaluation provide a better approach for suitability analysis of site selection for cement industries1. This project aims to do a suitability analysis to identify possible locations for establishment of cement industry in Makwanpur District. Industrial site selection is critical point in the process of starting, expanding or changing the location of industrial systems of all kind. Construction of a new industrial system is a major long-term investment, and in this sense determining the location is critical point on the road to success or failure of industrial system.

One of the main objectives in industrial site selection is finding the most appropriate site with desired conditions defined by the selection criteria. Most of the data used by managers and decision makers in industrial site selection are geographical which means that industrial site selection process is spatial decision problem. Such studies are becoming more and more common, due to the availability of the Geographic Information Systems (GIS) with user-friendly interfaces. Geographic information systems (GIS) are powerful tool for spatial analysis which provides functionality to capture, store, query, analyze, display and output geographic information13. Geographic Information Systems are used in conjunction with other systems and methods such as systems for decision making (DSS) and the method for multi-criteria decision making (MCDM).

The scope of our work is to develop a suitability map of industrial site selection in Makwanpur District using GIS techniques. GIS has long been used to monitor different geographical features for change of nature. It helps developers make informed decisions about the development condition of an area and work out a plan. Since geospatial factors have a considerable impact over the settlement planning to analyze the geo-spatial properties of land including slopes, elevation, land cover, geological formation and other. Hence, the scope of our project is to develop a suitable map for industrial site selection using Analytical Hierarchy Process (AHP).

STUDY AREA

Makwanpur District is in part of Narayani Zone, is one of the seventy-seven districts of Nepal, a landlocked country of South Asia. The district, with Hetauda as its district headquarters, covers an area of 2,426 km² and had a population of 392,604 in 2001 and 420,477 in 2011. Makwanpur holds many religious and natural sites. This location must

comply with the requirements of the existing governmental regulations and at the same time must minimize economic, environmental, health, and social costs in assessing a site as a possible location for suitable site location for cement industry.

Location map for this study area is shown below:

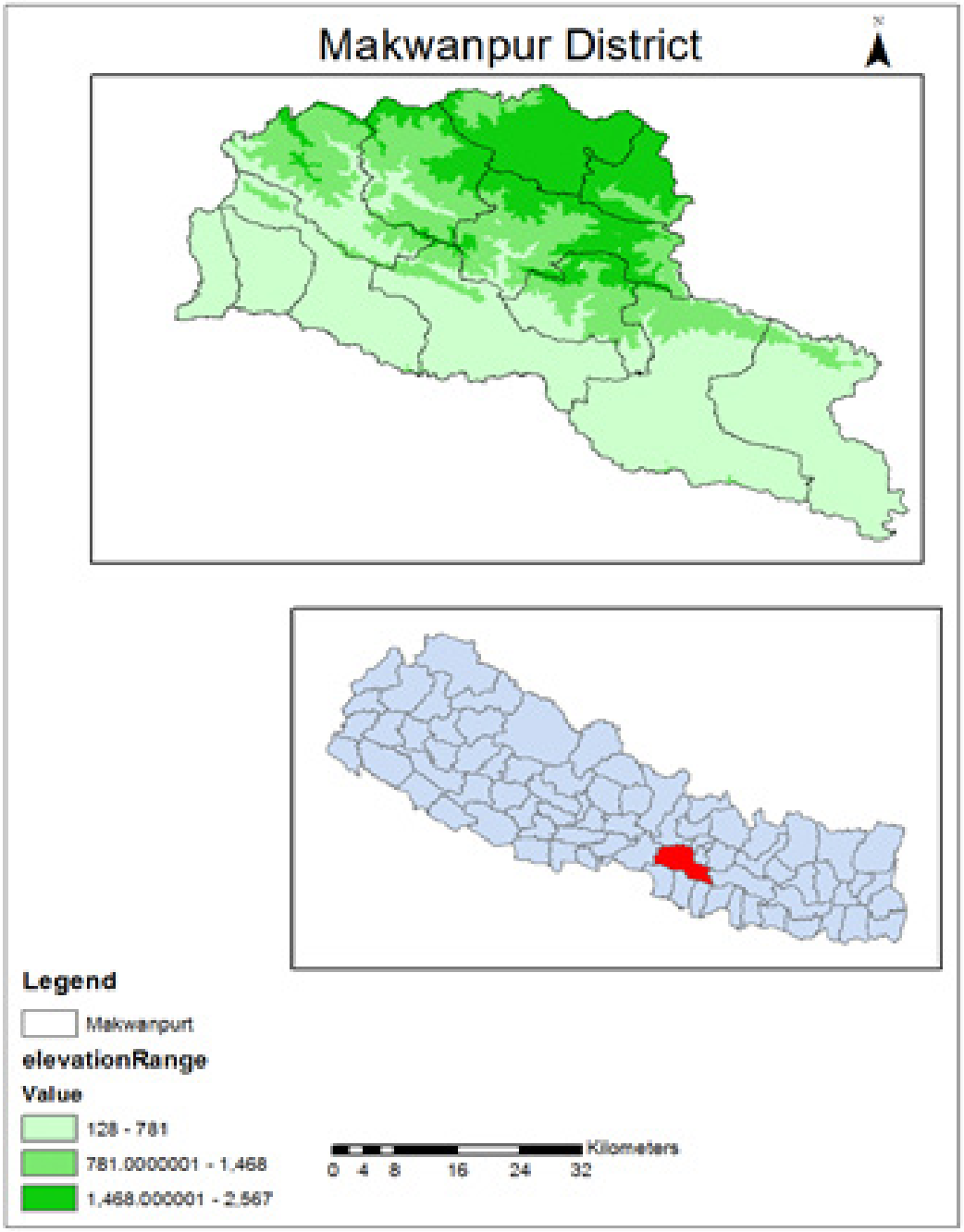

Figure 1: Study area

Elevation ranges are in meter unit.

Methods and Materials

Data required for our study were collected from different sources. For suitability analysis, we need topographic data such as road networks, rivers, settlement, transmission line, land use, slope, and limestone were collected from Survey Department and we used this data as the primary data. With the help of contour data a Digital Elevation Model (DEM) was created which was further used for preparing slope map and elevation map. Other data were also used for generating land use/cover, hydrological map, residential area and road map. The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology3.It has particular application in group decision making, and is used around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare and education.

Rather than prescribing a "correct" decision, the AHP helps us to find one that best suits for our goal and our understanding of the problem. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions3.

In AHP, problem is first decomposed into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem: tangible or intangible, carefully measured or roughly estimated, well or poorly understood, anything at all that applies to the decision at hand4.The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision-making techniques.

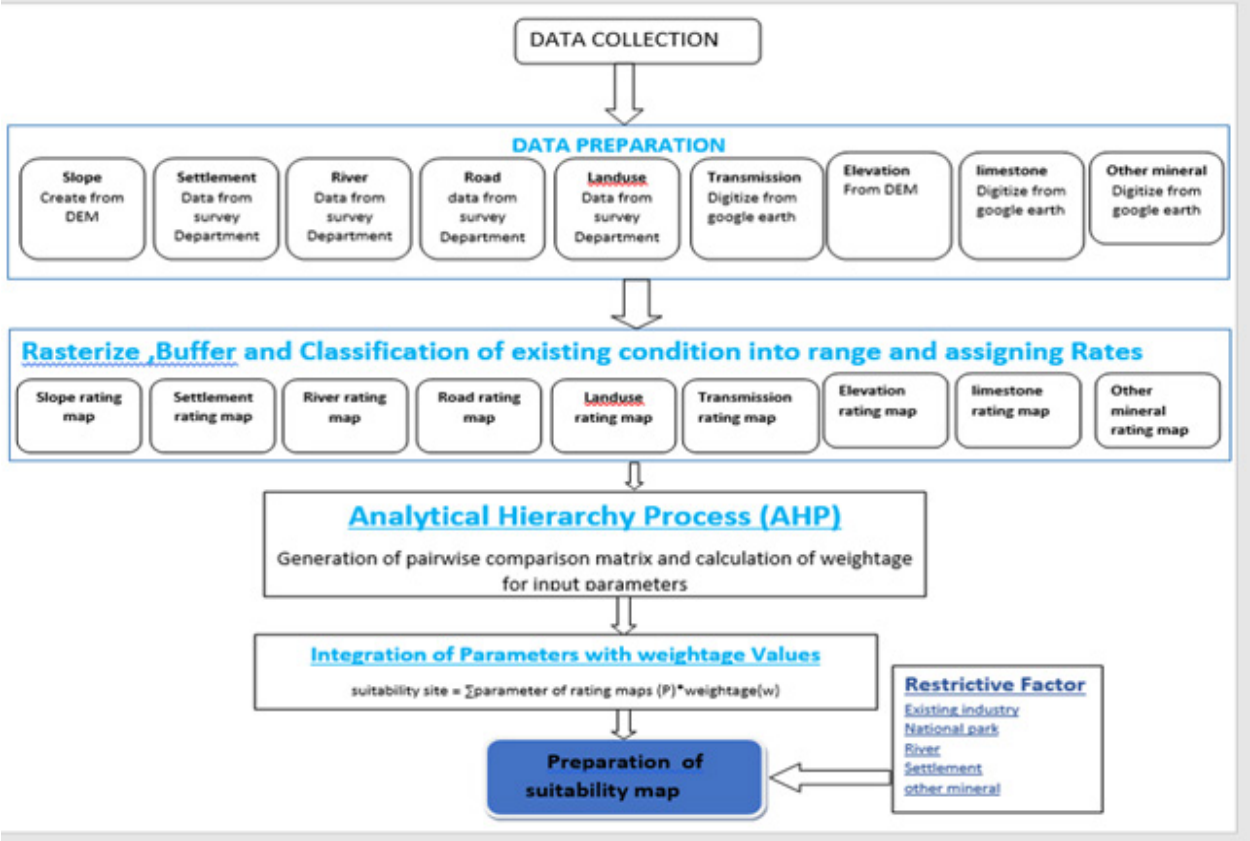

Figure 2: Methodology for suitability analysis

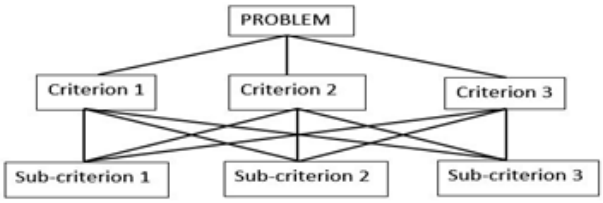

Figure 3: AHP Hierarchy

Pairwise comparison

This is a process of assigning ranks to one parameter with respect to another. Here, we used a scale of 1 to 9 to explain the pairwise rank for every parameter with respect to every parameter. Pairwise comparison is to determine the significance of one factor over another factor for specific goal4. Here our objective is to develop a pairwise comparison matrix for suitability factors for resettlement plan. Hence we used a scale of 1-9 for assigning based upon the expert knowledge and literature review.

Making comparison matrix (reciprocal matrix)

Based on the value obtained from pairwise comparison, we developed comparison matrix. Since we have taken 9 factors as parameters for pairwise comparison, the matrix size is 9×9. The diagonal element of the matrix is always 1.

Eigen value

After determining the relative weights, we checked the consistency of our output. For this we computed Principal Eigen Value which is obtained from the summation of products between each elements of Eigen vector and the sum of column of reciprocal matrix.

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 λmax = n. Then he gave a measure of consistency, called Consistency Index as deviation or degree of consistency using the following formula.

CI = (λmax – n)/(n-1)

	road	river	Land use	Settlement	Slope	elevation	transmission line	minerals	conservation area	Priority vector	Weighted sum vector	Consistency vector	lambda λ
Road	1	0.2	3	0.2	3	3	5	0.2	0.33	0.079404341	0.831753831	10.47491643	9.620144
River	5	1	5	1	5	5	5	5	1	0.215170296	4.183754799	19.44392363	
Land use	0.33	0.2	1	0.2	3	5	3	0.33	0.14	0.061507155	1.434402334	23.3209019	
settlement	5	1	5	1	3	3	5	5	1	0.200787025	2.231210078	11.11232201	
Slope	0.33	0.2	0.33	0.2	1	3	3	0.2	0.14	0.043298719	0.285875002	6.602389317	
Elevation	0.33	0.2	0.2	0.33	0.33	1	0.33	0.33	0.11	0.027253231	0.113907985	4.179613968	
transmission line	0.2	0.2	0.33	0.2	0.33	3	1	0.33	0.2	0.03501381	0.104914419	2.996372499	
Minerals	5	0.2	3	0.2	5	3	3	1	0.2	0.103730252	0.565418292	5.450852413	
conservation area	3	1	7	1	7	9	5	5	1	0.233835171	0.701505513	3	

Table 1: Value of Consistency vector

The Principal Eigen Value is obtained from the summation of products between each element of Eigen vector and the sum of columns of the reciprocal matrix5.

Consistency index (CI) = (λ – n)/ (n-1) = 0.077518

Ratio Index (RI)=1.98(n-2)/n = 1.54

CR=CI/RI = 0.05066329

Therefore, consistency Ratio = 5.06%

If the Consistency Ratio (CR) is found to be smaller or equal to 10 %, the inconsistency is acceptable. If the CR is greater than 10 %, we need to revise the subjective judgement5. I found consistency ratio to be 5.06 %. Hence this evaluation is consistent.

Site suitability formula

After calculating the relative weightage of the parameters taken for the suitability analysis, we determined the site suitability formula as:

Site suitability = ∑parameter (Pn) ×weightage (Wn) - ∑restrictive factors(R)

Weightage values for different criteria for rating maps

Weightage of a factor stands for the value or importance of the factor when compared with another thing. Here I have given weightage to each parameter individually based on the range. The range is determined for each factor with the help of experts' knowledge, literature review and previous studies for land use planning. Besides, that the topography, geology and data availability of the study area is also a key factor in determining the weightage for each factor. The weightage assigned to a factor is also termed as rate of the factor.

Result and Conclusion

The final suitability maps of different parameters are shown in below figure:

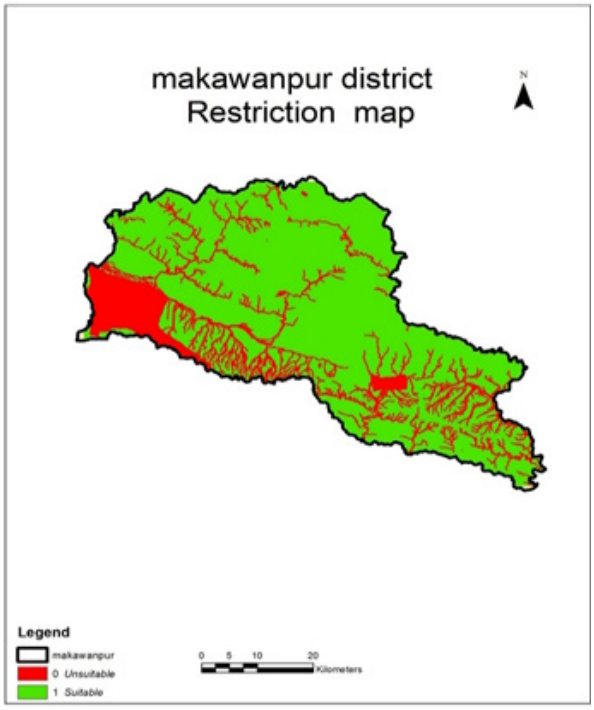

Figure 4: Restriction Map

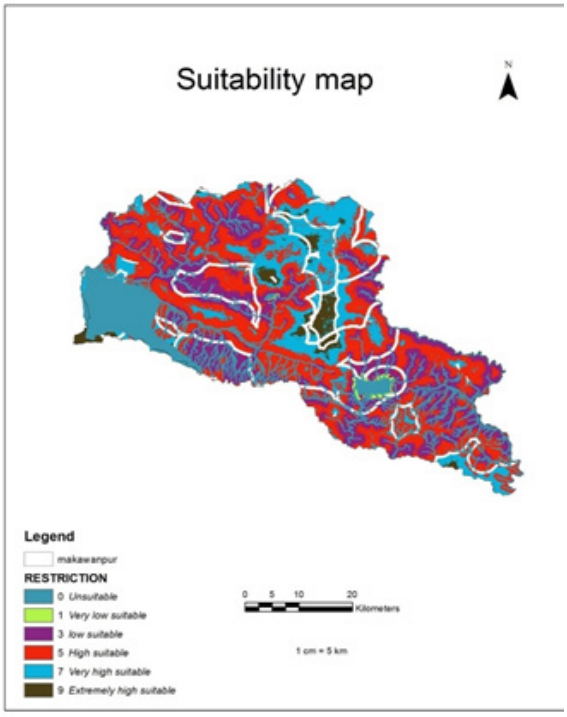

Figure 5: Final Suitability Map

In this study, we found the area to be suitable depending upon one factor may not be the area that was suitable depending upon another factor. Hence the complex decision about the multiple criteria was possible in this study. Since, the factors we considered as the parameters for our study were the geo-spatial constraints; we used the GIS environment for the decision-making process. The results were found to be satisfactory as we validated using the Google Earth image overlay. Since the extent of our study was large, we validated the results using the Google Earth Imagery. It was not possible to check the results by field verification.

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URBAN DENSITY PREDICTION MAPPING OF DOLAKHA DISTRICT USING IMAGE CLASSIFICATION FROM REMOTELY SENSED IMAGERIES

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BACKGROUND

Studies have shown that there remain only few landscapes on the Earth that are still in their natural state. Due to anthropogenic activities, the Earth surface is being significantly altered in some manner and man's presence on the Earth and his use of land has had a profound effect upon the natural environment thus resulting into an observable pattern in the land use/land cover over time.

The land use/land cover pattern of a region is an outcome of natural and socio – economic factors and their utilization by man in time and space. Land is becoming a scarce resource due to immense agricultural and demographic pressure. Hence, information on land use / land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population.

Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. The advancement in the concept of vegetation mapping has greatly increased research on land use land cover change thus providing an accurate evaluation of the spread and health of the world's forest, grassland, and agricultural resources has become an important priority.

Remote Sensing (RS) and Geographic Information System (GIS) are now providing new tools for advanced ecosystem management. The collection of remotely sensed data facilitates the synoptic analyses of Earth - system function, patterning, and change at local, regional and global scales over time; such data also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity.

IMAGE CLASSIFICATION

Image classification is one of the techniques in the domain of digital image interpretation. Image classification is a process of grouping together of similar pixels, separating dissimilar pixels into several classes by the detail study of the spectral reflectance property of several bands of multispectral imagery. If a pixel satisfies a certain set of criteria, then the pixel is assigned to the class that corresponds to that criteria. There are two ways to classify pixels into different categories: supervised and unsupervised.

Supervised means under the supervision by the analyst. Analyst provides the area that the knows the features of the area is known as training dataset. Supervised training requires a priori (already known) information about the data. If the knowledge is not sufficient available or classes of interest yet not defined, an unsupervised classification can be applied.

For this project, supervised classification was used on the Landsat 8 imageries obtained for the year 2013, 2015 and 2017 from USGS website. The area of interest (Dolakha District) was obtained by using clipping technique by providing the shapefile of the Dolakha district using ERDAS. Land cover was classified into 7 different classes as mentioned below:

1. Agriculture land

2. Lake

3. Bare land

4. Forest

5. Snow

6. River

7. Settlement area

URBAN DENSITY

Urban density is a term used in urban planning and urban design to refer to the number of people inhabiting a given urbanized area. As such it is to be distinguished from other measures of population density. Urban density is considered an important factor in understanding how cities function. Research related to urban density occurs across diverse areas, including economics, health, innovation, psychology and geography as well as sustainability. Like the population density map we can obtain it by dividing total population of an area by the settlement area in that region. So, it gives the total number population living per unit area.

Residential density is a quantitative measure of the intensity with which land is occupied by either development or population. Control of residential density is a fundamental component of effective land use planning, as the relative distribution of population has major implications for the provision of public facilities, such as transport, utilities and social infrastructure.

Urban density mapping is very important than population density map due to following reasons and objectives:

- Easy to distribute services that is provided by government such as health, education, drinking water services.
- Easy for quick response in hazard events such as flooding, firing, earthquake.
- Easy to predict no of victims suffering due to hazard events such as epidemic diseases and resolve the situation.
- Urban density map shows the condition and living standard of people in particular society.
- WUrban density map helps to predict the adverse effect from severe use of natural resources and its future consequenses.
- to promote an acceptable standard of environment and amenity for the occupants of residential areas.
- to ensure an appropriate balance between the residential population of an area and the capacity of the existing or planned facilities and infrastructure required to service it.
- to maintain an efficient intensity of land use and make the optimal use of land resources in the context of competing demands on a limited supply of developable land.
- to maintain safe levels of development and population in areas where there may be potential risks due to adverse geotechnical conditions, neighbouring hazardous installations, etc.
- to provide for a variety of urban form for urban design reasons and to satisfy the demands of different market sectors.
- particularly in rural and/or heritage and nature conservation areas, to ensure development is of an appropriate scale in relation to its setting.WW

Urban density is a very specific measurement of the population of an urbanized area, excluding non-urban land-uses. Non-urban uses include regional open space, agriculture and water-bodies.

Urban density is also known as **residential density** i.e. a quantitative measure of the intensity with which land is occupied by either development or population.

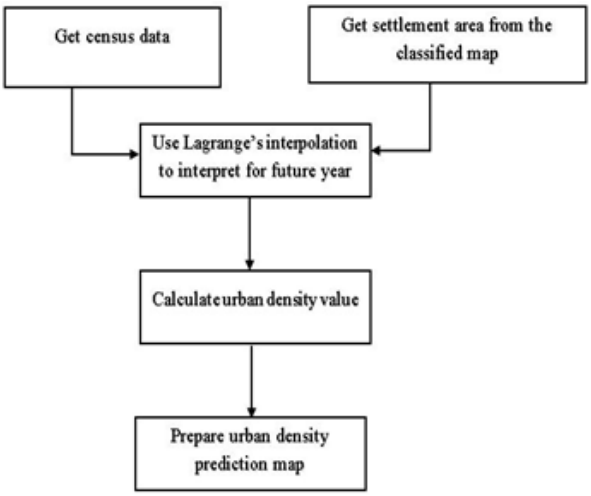

Fig. Flowchart showing the process of the urban density prediction mapping

The population of Dolakha district VDC wise. Then, the population data 1991, 2001 and 2011 from (http://www.cbs.gov.np). According to latest boundary categorization based on rural municipality (gaupalika) and Municipality (nagarpalika), the population for the year 1991, 2001and 2011 was calculated.

Lagrange interpolation method was used for the prediction as we got the settlement area of 2013, 2015, 2017 from classified map. Then the settlement area was obtained using the classified images using ERDAS. Then by the method of Lagrange's interpolation, population of the year 2019 was calculated. Hence, urban density map was prepared using various element of cartography in GIS.

Fig. Urban density prediction map 2013

Urban density prediction map of the year 2013 is shown above by change in the different colors. It shows the number of people living per unit area. It is done from settlement data of various gaupalika and municipality. Similarly, other urban density prediction maps obtained from classified map and Lagrange interpolation.

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Surendra, Bikalpa,Aayush,Tek. (2017). LAND USE LAND COVER CLASSIFICATION AND URBAN DENSITY PREDICTION MAPPING OF DOLAKAHA DISTRICT. Pokhara: Pashchimanchal Campus.

UAV-based photogrammetric approach for cadastral Mapping

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Abstract

This report presents outcome of comparison of datasets using visual and statistical measures. Initially, field observation was carried out using DGPS to establish control points for cadastral survey which was followed by UAV image acquisition. Afterwards, field observation was carried out using TS and DGPS (Post Processing Kinematics Survey) for parcel data collection and analysis based on the data.

1.Introduction

Cadastre means methodically arranged public inventory of data concerning properties within a certain country or district, based on survey of their boundaries. Cadastral maps in Nepal were initially prepared by graphical method using plane table since 1964 after implementation of Land survey and measurement act 2019 though there are records of "Panchali" dated back to Lichhabi period. With gradual improvement in cadastral surveying, first Digital Cadastral Surveying was carried out as pilot project in Kritipur (was unsuccessful) and started in Banepa on 5th Bhadra, 2063 B.S.

2.Study area

The study area situated in ward number - 4, Dhulikhel municipality which covered an area of about 0.0776 Km2, is shown in map below:

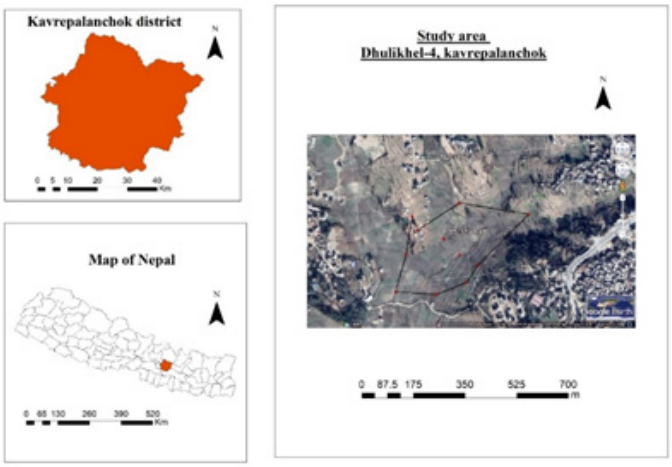

Figure 1: Study area

3.Methodology

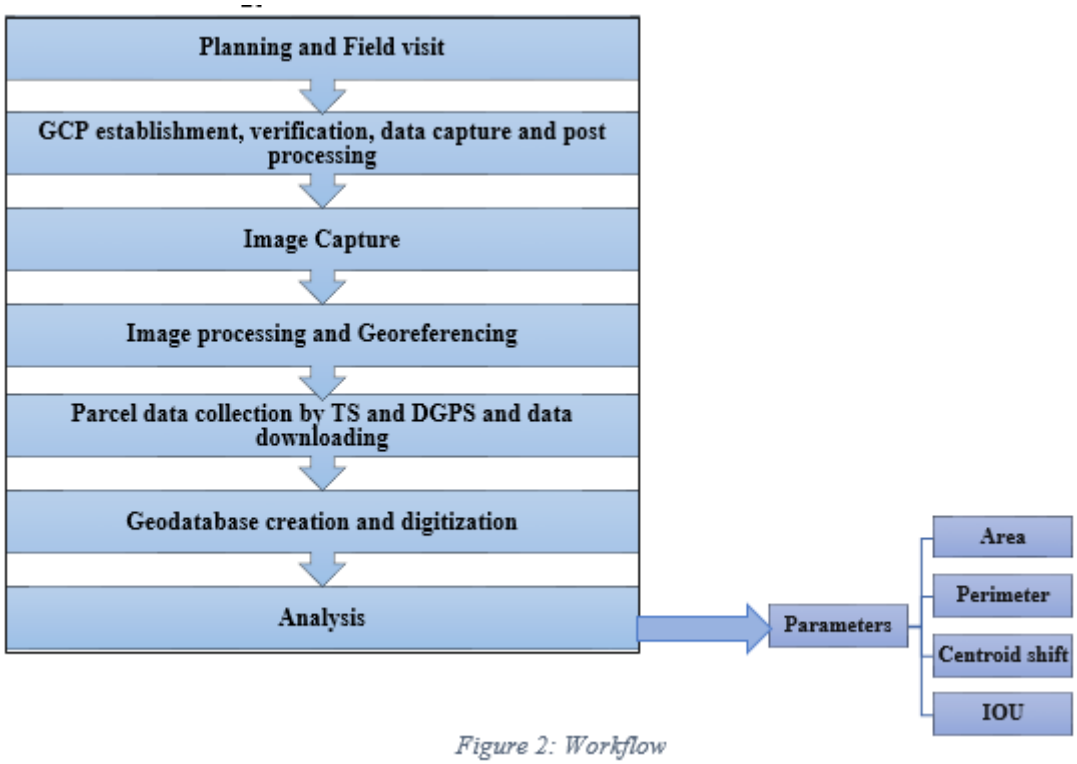

Figure 2: Workflow

4.Analysis

i.Area and Perimeter

Percentage differences of area and perimeter was calculated and classified.

Table 1: Percentage difference classes (TS/UAV)

Classes of % difference between TS and UAV						
Area				Perimeter		
%error	no. of parcels	percentage		%error	no. of parcels	percentage
< 1	19	23.4567901		< 1	37	45.6790123
1-3	23	28.3950617		1-3	30	37.037037
3-5	12	14.8148148		3-5	8	9.87654321
5-10	8	9.87654321		5-10	5	6.17283951
>10	19	23.4567901		>10	1	1.2345679
total	81	100			81	100

Table 2: Percentage difference classes (TS/DGPS)

Classes of % difference between TS and DGPS						
Area				Perimeter		
%error	no. of parcels	percentage		%error	no. of parcels	percentage
< 1	15	18.5185185		< 1	50	61.7283951
1-3	23	28.3950617		1-3	17	20.9876543
3-5	14	17.2839506		3-5	10	12.345679
5-10	21	25.9259259		5-10	3	3.7037037
>10	8	9.87654321		>10	1	1.2345679
total	81	100			81	100

Additionally, skewness was checked in the form of Box and whisker plot showing both datasets to be left skewed. Five number summaries was calculated for both area and perimeter difference for further analysis.

Table 3: Area difference with five number summaries

Area difference		
	TS and DGPS	TS and Uav
Minimum	-267.3722137	-160.5563017
Q1	-7.049411935	-7.135757066
Median	-0.071514837	-0.834940755
Q3	3.668830245	2.470044346
Maximum	49.95409224	336.1587596
Range	317.3263059	496.7150613
IQR	10.71824218	9.605801412
UPPER OUTLIER RANGE	19.74619351	16.87874646
LOWER OUTLIER RANGE	-23.1267752	-21.54445918

Table 4: Perimeter difference with five number summaries

Perimeter difference		
	TS and DGPS	TS and UAV
Minimum	-8.349420378	-37.19557262
Q1	-0.679410187	-1.409828836
Median	0.04013674	-0.495671989
Q3	0.235518981	0.022242816
Maximum	4.66720431	2.917108262
Range	13.01662469	40.11268088
IQR	0.914929168	1.432071652
UPPER OUTLIER RANGE	1.607912732	2.170350294
LOWER OUTLIER RANGE	-2.051803938	-3.557936314

Reliability was also tested using E90 and E95 errors which is shown in the table below:

Table 5: E90 and E95 error result (TS/DGPS)

Result of E90, E95 (TS/DGPS)						
	Area			Perimeter		
	range	parcel count	% of parcel count	range	parcel count	% of parcel count
E90	64.87746	77	95.0617284	3.019151	72	88.88888889
E95	77.3008	78	96.2962963	3.597286	74	91.35802469

Table 6: E90 and E95 error result (TS/UAV)

Result of E90, E95 (TS/UAV)						
	Area			Perimeter		
	range	parcel count	% of parcel count	range	parcel count	% of parcel count
E90	75.92532433	78	96.2962963	7.226219	79	97.5308642
E95	90.46421622	78	96.2962963	8.609963	79	97.5308642

In addition, after calculating SD, RMSE errors and number of blunders it can be concluded that

I. Area differences are higher than perimeter difference.

II. Spread of data is greater in TS and UAV datasets comparison.

III. All five values in five number summary is lesser in TS/UAV dataset that suggests it is better than TS/DGPS dataset.

IV. TS/DGPS dataset has higher number of outliers than TS/UAV dataset.

V. Larger number of parcels fall into range of standard errors (E90, E95) for TS/UAV dataset.

VI. Blunders are higher in area difference.

ii.Intersection Over Union (IOU)

Intersection over Union is an evaluation metric used to measure the accuracy of an object detector on a particular dataset and is given by formula:

IOU=(area of overlap) / (area of union)

Figure 3: Understanding Intersection over Union

After calculation of IOU in %, Mean Intersection Over Union (MIOU) was calculated. As MIOU above 80% suggests that the data is reliable (Rosebrock, 2016) classification was carried out with this threshold.

Table 7: Overall MIOU

Calculation of MIOU (overall)					
TS and UAV				TS and DGPS	
	<80%	>80%		<80%	>80%
No. of parcels	22	59		51	30
MIOU percentage	27.16049	72.83951		62.96296296	37.03704

Since MIOU percentage greater than 80 in UAV (72.83951%) than in DGPS (37.03704%), this implies intersection between parcels is greater in UAV/TS dataset than in DGPS/TS dataset. As the parcels were not continuous and attached to each other but had three varied terrain within the study area, we also analyzed if there is any effect of terrain with MIOU. Terrain 1 had little change in elevation (1422.566m to 1427.717m), terrain two had little more change in elevation (1425.778m to 1433.937m) while terrain 3 had rapid change (1428.563m to 1443.066m).

Table 8: MIOU of separate scenarios

Separate MIOU for different terrain										
TS and UAV										
terrain 1				terrain 2				terrain 3		
	<80%	>80%			<80%	>80%			<80%	>80%
no. of parcels	5	31		no. of parcels	12	10		no. of parcels	5	18
MIOU	13.88889	86.11111		MIOU	54.54545	45.45455		MIOU	21.73913	78.26087
TS and DGPS										
terrain 1				terrain 2				terrain 3		
	<80%	>80%			<80%	>80%			<80%	>80%
no. of parcels	17	19		no. of parcels	12	1		no. of parcels	22	1
MIOU	47.22222	52.77778		MIOU	54.54545	4.545455		MIOU	95.65217	4.347826

And no correlation between terrain elevation and MIOU was found out. MIOU values in separate scenario has followed same trend as overall MIOU i.e., has better results in UAV/TS datasets.

iii.Centroid Shift

Distance shift between the parcel centroid of each dataset was calculated along with its bearing and plotted in AutoCAD which disclosed that all bearing lied within 90º. The shift was in same direction as shown in the figures below:

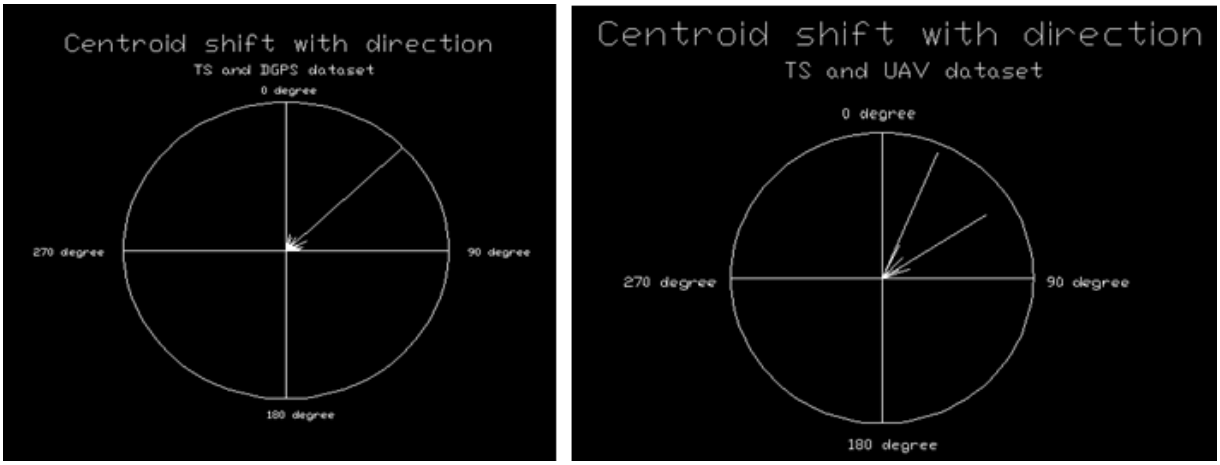

Figure 2: Centroid shift and direction

5.Conclusion and Limitations

In totality, between the three parameters used; area, perimeter difference and MIOU, showed that UAV dataset is better than DGPS dataset. However, value of centroid shift is higher though bearing is within 90º for all dataset. This implies that all parcels have shifted in same direction but the shift is higher in UAV data. The reason behind lesser reliability of DGPS data may be due to less occupation time at each point, errors associated with precise positioning and very small ground Sampling distance (4cm).

The problems and limitations faced in the duration of this research are allotted in points below:

i. Initialization stopped during PPK survey while carrying rover receiver and took another seven minutes to get initialized again.

ii. Insufficient SV being tracked while going near trees due to blocking of radio waves coming from satellites to rover receiver.

iii. Sudden rain and weather change causing problem in UAV image capture and parcel data collection.

iv. Firmware update problem arising time and again that led to UAV returning to home before completion of planned flight.

v. Problem aroused when same point's data collected by DGPS during PPK and TS were not recorded (in one of them) and we had to leave such parcels.

vi. Drainage and road parcels limited the results after analysis since they are linear feature while other parcels are non-linear which aroused outliers and blunders in datasets.

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A PROJECT REPORT ON DATA QUALITY ASSESSMENT OF OSM OF BANEPA MUNICIPALITY

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Abstract

Information is powerful and maps are definitely a good way to convey them. Due to difficulty of using paper maps, online maps are being preferred.

There are mainly three factors to influence the quality of VGI in Nepal. Firstly, data collection and mapping are completed by the nonprofessionals who lack enough geographic knowledge and effective training, resulting manual error. Secondly, the collected data may be collected from different instruments with different precisions. Thirdly, the data collected by different GPS from different volunteers may have different precisions. However, VGI can be the ultimate cost reduction in cases where it is either difficult to automate or expensive to implement. Therefore, this project was carried out to check quality of OSM data by comparing with reference dataset.

The analysis compared the OSM data with the data from survey department of Nepal. The analysis was in general categorized under buildings and roads. More specifically, the length completeness was found 61% for highway and 84% for district road, the name accuracy was only around 19% for the same where 36% of roads within the study area are unlabeled. The average percentage of overlap between the two datasets was more than 80%. Keywords: Open Street Map, Data Quality, VGI, GPS

1. Introduction

Open Street Map (OSM) also called Volunteered Geographic Information, is a collaborative project to create a free editable map of the world where data are uploaded by volunteers using GPS, local knowledge, and other free sources of information. Here we have assessed road and building data

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2.Objectives

2.1 Primary objective

The general aim of this report is to evaluate the quality of the OSM dataset of four wards of Banepa municipality relative to a reference dataset, i.e. Survey Department dataset.

2.2 Secondary objective

The specific aim of this project is:

- Evaluation of positional accuracy
- Evaluation of attribute accuracy

3. Methodology

This project is focused in quality assessment of OSM map. This is obtained by comparing the OSM map with a reference dataset of higher quality.

The steps that were followed for the quality assessment of OSM are as follows:

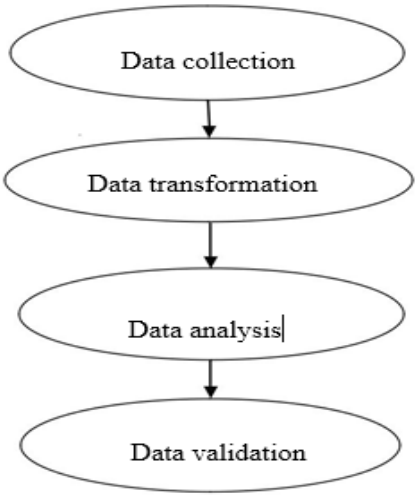


Fig: Flow Diagram showing Study Method

3.1 Data collection and Preparation

OSM dataset was downloaded from the Open Street Map server, exported to .shp format through QGIS while reference data was taken from Survey Department. The geographic transformation method used was MOLODENSKY and parameters used for transformation were: X-axis Translation (meters) = -282

Y-axis Translation (meters) = -726

Z-axis Translation (meters) = -254

3.2 Data Analysis

We have carried out positional and attribute accuracy analysis of both road and buildings.

3.2.1 Road Analysis

a. Positional accuracy check: Positional accuracy check for road was performed using Goodchild and Hunter method of line buffer intersection analysis where we calculated percentage of intersection of OSM road within the buffer around reference road. The intersection percentage of each road category was done by using the following formulae:

Percentage intersection = Length of intersected OSM road/Actual length of OSM * 100

The roads with their buffer width is given in the table below:

Table 1: Buffer Width for Different Road Types

Road Type	Buffer Width
Highway	2 lane (7 meter)
District Road	1 lane (3.5 meter)

The above graph deciphers that 82.76% of total highway length of OSM lies within the buffer of 7 meters of highway of SD. While in case of district road, the percentage intersection is 64.58 for the buffer of 3.5 meters.

b. Attribute accuracy check

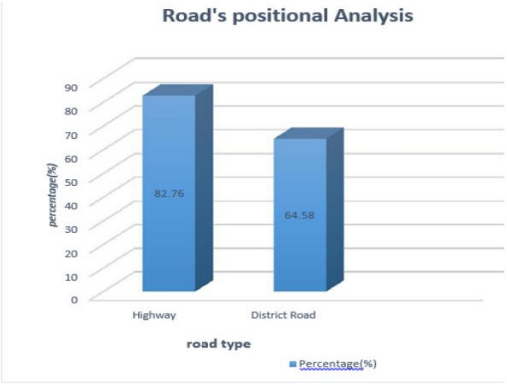
- **Length Completeness**

For linear features, completeness measurement was divided into length completeness and name completeness.

Length completeness = (length difference/length of road of SD) * 100

- **Name completeness**

Under this analysis, we compared the name of road as given in OSM dataset with that of SD. We have considered good for data with same name and categorized bad for that which didn't matched. 1 and 0 is given for good and bad data respectively.



Graph 1: Percentage Intersection

Graph 2: Name Completeness

3.2.2 Building Analysis

From the wards 2, 7, 8 and 9, we have assessed the buildings common to SD dataset and OSM dataset.

We have shown the information regarding the number of buildings in below table:

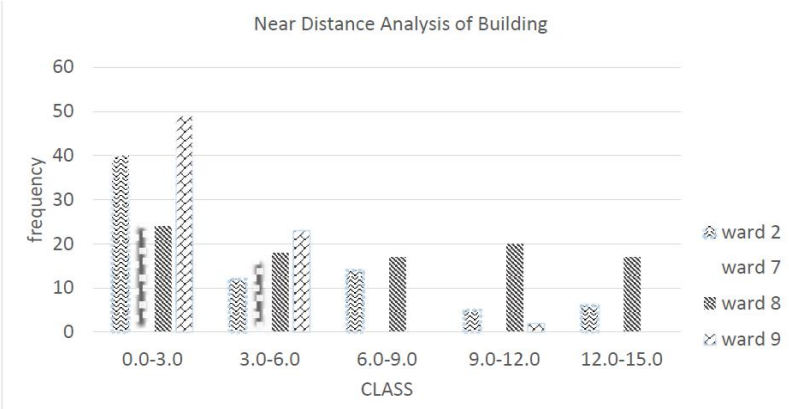
Table 2: Total Building Count in Both Datasets for each Ward

S.N	Wards	No. of SD Buildings	No. of OSM buildings	Common buildings
1.	Ward 2	235	183	80
2.	Ward 7	166	87	44
3.	Ward 8	206	118	96
4.	Ward 9	109	93	75
Total		716	481	295

a. Positional accuracy

Near distance analysis

Near distance method was used to calculate the closest distance between two centroids of the reference and evaluation buildings dataset. The smaller the displacement between the two polygons, the closer the near-distance value tended to zero. Also, the minimum the near distance, the higher the spatial accuracy of the OSM buildings.



Graph 3 Near Distance Analysis of Buildings

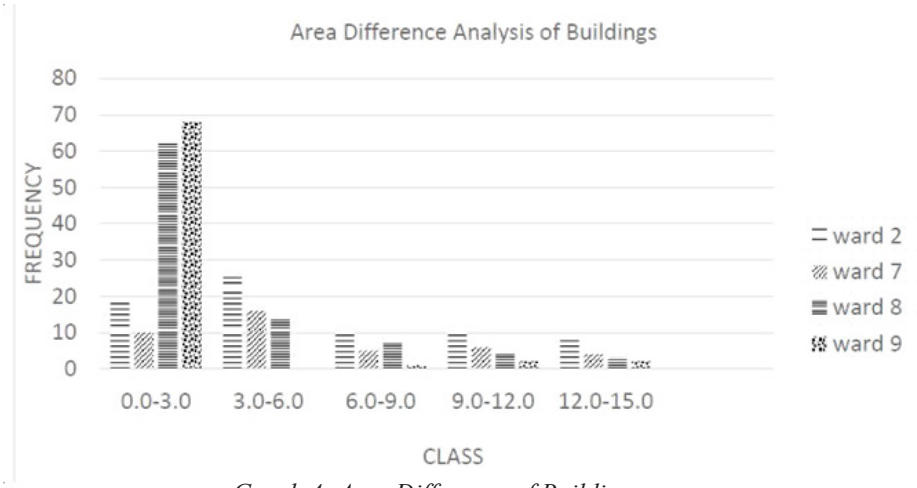
b. Attribute Accuracy

For checking of attribute accuracy, circulatory ratio and area difference were calculated.

□ Area difference

Circulatory evaluation is insensitive to scale change so CR alone is not enough for our analysis. As two rectangles, one big and another small can have same shape but they actually differ on ground by their size.

Here, we calculate the area of reference building and the evaluating building and compare the area difference. The minimum the difference, the more likely the building to be same and accurate.The polygon area comparison is used to examine if there is any tested polygon with identical shape and position, but different in its size.

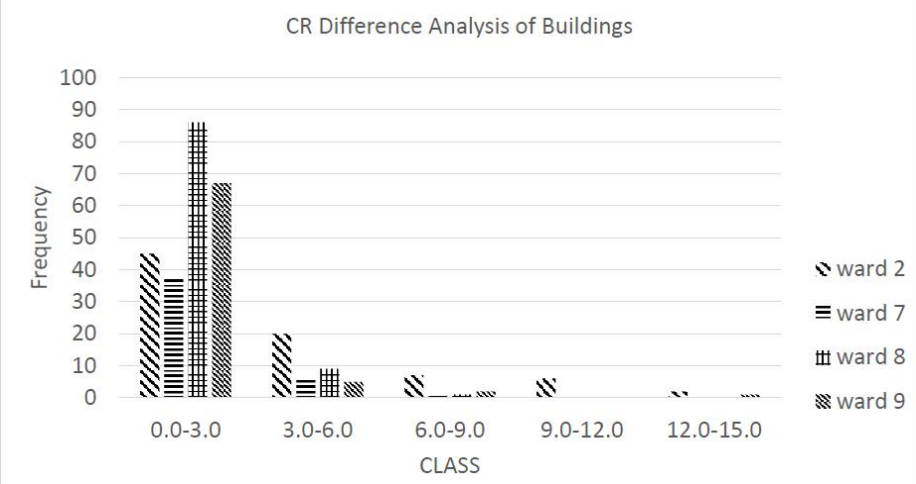


Graph 4: Area Difference of Buildings

□ Polygon Circulatory ratio

Circulatory ratio is used to identify the shape and if two polygons have minimum CR difference, they are more likely to have same shape.

Circulatory Ratio (C.R) = (4 * 3.14 * Area) / (perimeter) ^ 2



Graph 5: Circulatory Ratio Analysis of Buildings

4. Conclusion

The methodology that was carried out compared the quality elements of the OSM data to the SD data. More specifically, the quality elements of the length completeness and of the positional accuracy were found comparatively accurate.

5. References

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धुलिखेल, काभ्रे ।

टेलिफोन नं. ०११-४१५०५५

वि.सं. २०२५ सालमा नापी तालिम केन्द्रको रुपमा स्थापना भएको यस भूमि व्यवस्थापन प्रशिक्षण केन्द्र नाप नक्सा र जग्गा प्रशासनको क्षेत्रमा तालिम प्रदान गर्ने एक मात्र सरकारी निकाय हो। नाप नक्साको क्षेत्रमा हाल सम्म करीव ९,००० भन्दा बढी जनशक्ति उत्पादन गरेको यस केन्द्रले विभिन्न लामो तथा छोटो अवधिका तामलिहरु संचालन गरी नाप नक्सा र जग्गा प्रशासनको क्षेत्रमा दक्ष जनशक्ति उत्पादन गर्दै आएको छ। सन् २००७ देखि यस केन्द्र र काठमाण्डौं विश्वविद्यालयको सहकार्यमा Bachelor in Geomatics Engineering तथा सन् २०१३ देखि Master in Land Administration विषयमा स्नातकोत्तर तहको कार्यक्रम संचालन गर्दै आएको छ। साथै सन् २०१५ देखि यस केन्द्र, काठमाण्डौं विश्वविद्यालय र प्राविधिक शिक्षा तथा व्यवसायिक तालिम परिषद्को त्रिपक्षीय सहकार्यमा Diploma in Geomatics Engineering कार्यक्रम संचालन गरिरहेको छ।

भूमि व्यवस्थापन प्रशिक्षण केन्द्रबाट संचालन भइरहेका तालिम कार्यक्रमहरु

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२) केन्द्र र काठमाण्डौं विश्वविद्यालयको सहकार्यमा संचालन भइरहेका प्राज्ञिक कोर्षहरुः

क) Master Degree in Land Administration (दुई वर्ष)

ख) B.E. in Geomatics (चार वर्ष)– +२(विज्ञान) वा सो सरह उतिर्णका लागि

३) केन्द्र , काठमाण्डौं विश्वविद्यालयको र प्राविधिक शिक्षा तथा व्यवसावयक तालिम परिषदको सहकार्यमा संचालन भईरहेको कार्यक्रमः

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घ) डिजिटल कित्तानापी तालिम– तीन हप्ता

ङ) Remote Sensing and Photogrammetry Training- तीन हप्ता

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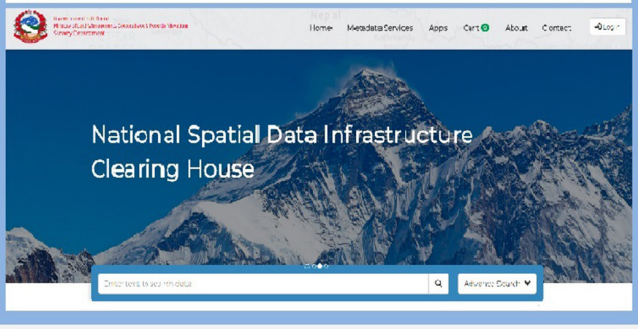

- ✓ Geodetic Control data
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- ✓ Socio Economic Atlas of Nepal

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Hydropower Projects:
Mai Hydropower Plant (22 MW)
Mai Cascade Hydropower Plant (7 MW)
Location: Mai Municipality, Ilam
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Corporate Address:
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KMC-04, Dhumbarahi
Kathmandu, Nepal
P.O. Box: 19737
Phone: 977-1-4372828/ 4373030
Website: www.sanimahydro.com.np
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Geomatics Engineering, Batch 2017

Geomatics Engineering, Batch 2016

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When the workflow is complete, the results are output as a vector file, which can be used in both ENVI and ArcGIS for further analysis and to create an output map

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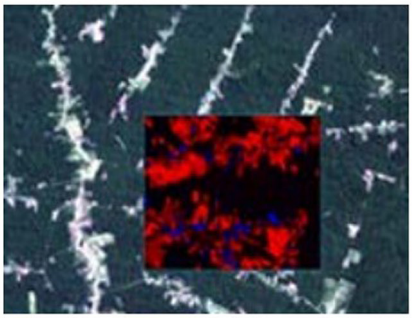

This image previews ENVI change detection results. Using two Landsat images taken at different times, ENVI automatically identified deforested areas (in red). The blue areas indicate new growth/ planting.

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