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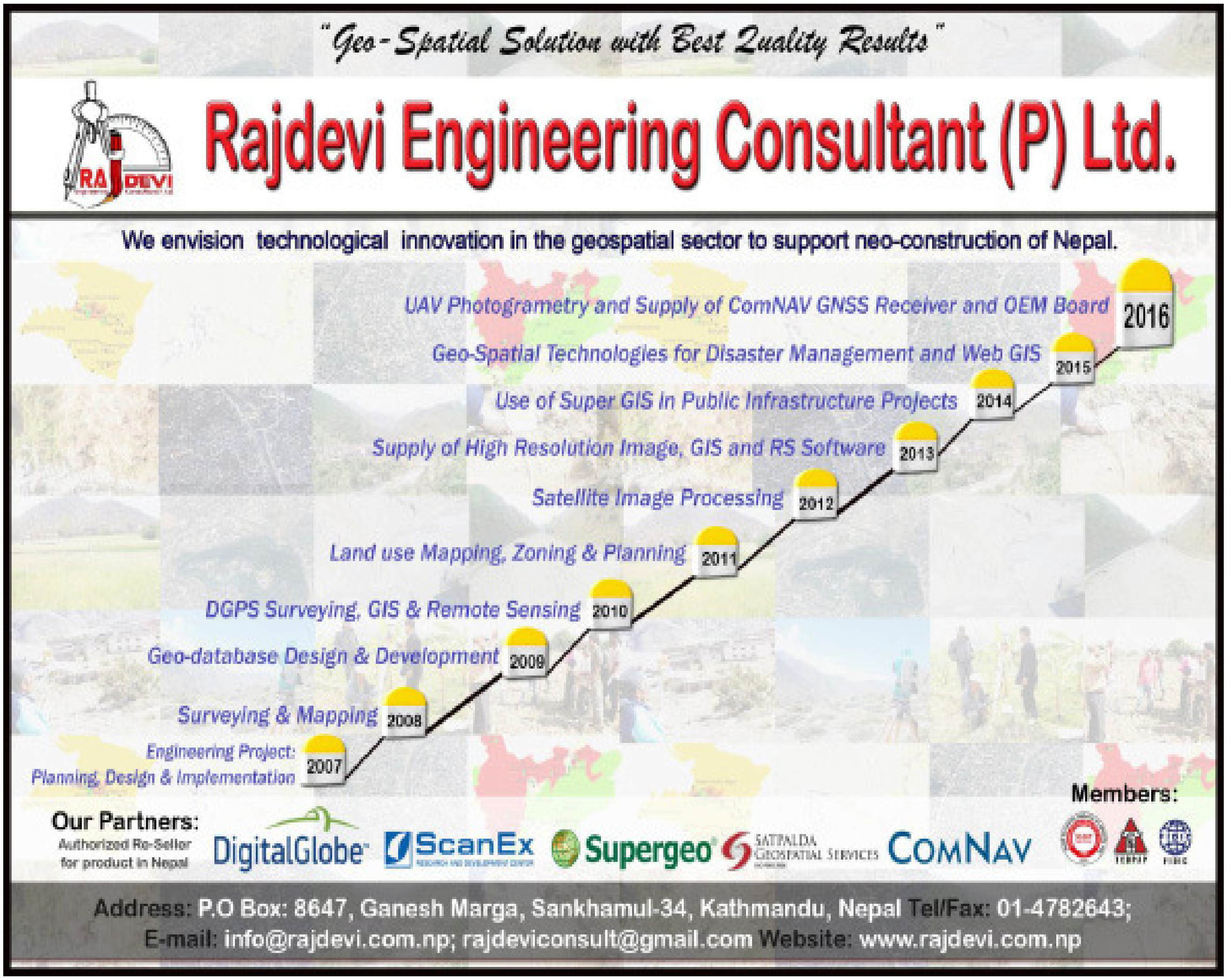
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Editorial

'GeoSpace', is a name that has bridged the gap between educators, professionals, students, newbies with all the achievements, researches, findings in geo-informatics field. With the first and second issue published in 2012 and 2016 respectively we, 8th batch of Geomatics Engineering, now continue this legacy of creating a platform to showcase all the happenings in this realm. With the inclusion of intelligibly selected ardently written articles, we have presented GeoSpace as a single stop to document and develop prowess in the sub domains of Geomatics.

'Creativity is just connecting things.' Here we have done our best to link the incessantly expanding playground of geospatial domain in the magazine so as to create innovations and aid to all endeavors in geospatial market. No doubt lies in the gradually increasing horizons of geo-informatics and its applicability in various sectors. Since the introduction of GeoSpace till now, it has effectively put forward the knowledge and we are treading the same path.

Last but not the least, we place on record our gratitude and heartfelt thanks to all authors, students, faculties, seniors, financial contributors and all seen and unseen helping hands for making this magazine a reality.

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I am delighted that the Geomatics Engineering Society of Kathmandu University (GES) has published the third issue of the magazine *Geo-Space* on the occasion of the GIS day.

I am sure, as the venture of GES, the pioneering organization of Geomatics Engineering students in Nepal, the magazine aims to add some dimension to the literature of geomatics and geoinformatics from the Nepalese context. I am equally aware that the work of this type should prove useful to those who plan to prepare for different examinations to enter public services in survey engineering and other related fields.

It always gives me great satisfaction to see my students involved in creative and scholarly activities. I congratulate the publication team for bringing out this meaningful work, and wish that they continue their hard work.

Prof. Dr. Ram Kantha Makaju Shrestha

Vice Chancellor

6 November 2017

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 third 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"!

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October 31, 2017

Contents

Understanding the Mapping APIs

*Dinesh Neupane**
**dinesh.neupane5@gmail.com*

To create a great web map is never an easy task but in recent years we've seen a lot of excellent examples of geovisualisation. Various map visualization platforms like Google Maps, ArcGIS Online, Mapbox etc provide easy to use set of tools for creating beautiful web maps. These platforms are also used for complex dynamic geospatial data visualization and analysis.
An application programming interface (API) is a set of tools, definitions, and protocols for building application software. The excessive growth of public APIs for geospatial applications, and the accompanying variability in geospatial APIs has created new opportunities and challenges in supporting geospatial services. Expansion of the scope of discovery and accessibility, integrating Application Programming Interfaces (APIs) as a service component in spatial frameworks is much needed for the advanced geospatial ecosystem. Some of the famous mapping APIs are discussed below:

1.The Geocoding APIs:
Geocoding enables us to translate between street address or postal address and latitude longitude map coordinates. So, this basically is the spatial representation in numerical coordinates. Most of the geocoding lookups are done on the server so internet connection is required for this task. Most of the top map service providers like Google Maps, Bing Map, MapQuest and the open source alternative like OpenStreetMap provide the efficient Geocoding services which mainly does two functions: Forward Geocoding and Reverse Geocoding.

Forward Geocoding
Forward Geocoding finds the latitude and longitude of an address for a given location. If no match is found, null is returned. The availability, accuracy and granularity of the geocoding results depend upon the database available for the area of search. When you do a forward lookup to find the geographic coordinates the place specified while instantiating the geocoder is particularly important. The place name provides the geographical context for interpreting the search request because the same location names can exist in multiple areas.

Reverse Geocoding
Reverse geocoding which is rather considered as the difficult task is the reverse process of Forward Geocoding. Description of a place that is usually the name of a location is returned for physical locations specified by latitude and longitude pairs. It's a useful way to get a recognizable context for the locations returned by location based

services. As in Forward Geocoding if the Geocoder could not resolve any addresses for the specified coordinates, it returns null. Both the Geocoding functions return a list of Addresses objects. Each list may contain several possible results, up to a limit specified when making a call. Google Maps geocoding API provide both Geocoding services and additionally addresses can be found for a given place ID. Bing Maps has introduced the Batch Geocoding and Batch Reverse Geocoding to geocode thousands of addresses at the same time. OpenStreetMap uses Nomination for this purpose. Nomination is the Geocoder used on OpenStreetMap data.

2.The Distance Matrix APIs

The Distance Matrix API gives time to travel and distances for a set of origins and destinations. Travel times are based on predictive traffic details, determined by the start time specified in the request. Distance matrices can be calculated for a various set of uses like driving, walking and public transit routes. A request for distance and travel time returns a Distance Matrix resource that contains either an array of Distance Matrix cells or information on the serial request that was made to calculate a distance matrix. The location and index of the origin and destination, the travel time and distance are contained by each of the distance matrix cell.

3.The Direction APIs

The main purpose of Direction API is to help users find their way. It returns multiple destinations for a series of waypoints using several modes of transportation like walking, by bicycle or by car/bus. To calculate the routes using Google's Direction API it is necessary to specify the waypoints for driving walking or bicycling directions. Travel time which is the primary factor is optimized, but other factors such as distance, number of turns and many more are also taken into account.

While specifying origin or destination in a route request a query String is specified as for example 'Anamnagar, Kathmandu' or a latitude/longitude value. The route service returns multi-part directions using a series of waypoints. The route is displayed as the polyline drawing the route on the map or it can also be the series of textual description. In Google Maps the DirectionRequest object literal contains the fields like origin (LatLng, String), destination (LatLng, String), travelMode (TravelMode), transitOptions (TransitOptions), drivingOptions (DrivingOptions), optimizeWaypoints (Boolean), avoidHighways(Boolean), avoidTolls(Boolean), region(String) and other relevant information. As for example if the avoidHighways is set to be true then the calculated route avoids the major highways as far as it is possible.

MapQuest which is based on OpenStreetMap provides the routing service through its Direction API the basic routing service along with Optimized Route, Route Matrix, Alternate Route, Route Shape, Drag Route and Path From Route. You can specify multiple waypoints for a route. For each set of waypoints a separate route leg is created. Between any two waypoints, you can have multiple intermediate viaWayPoints. ViaWaypoints define the route path and do not create route legs.

4.The Geolocation API:

One of the most used API in today's world is the Geolocation API. Geolocation allows an application program to determine physical real-world coordinates and trailor the application to the users. The Geolocation API finds out the location data from cell towers and WIFI nodes. It returns a location and accuracy radius based on information about cell towers and WiFi nodes that the mobile client can detect. The communication is carried out over HyperText Transfer Protocol Secure(HTTPS) using POST (Power-On Self-Test) in most of the mobile devices. In web the Geolocation object is used by scripts to programmatically determine the location information associated with the hosting device. It is necessary that the device provide necessary permission before gaining access to the device location. The location information is acquired by applying a user-agent specific algorithm, creating a Position object, and populating that object with appropriate data accordingly. The API contains various interfaces like Geolocation Interface, PositionOptions Interface, Position Interface, Coordinates Interface and the PositionError Interface. All these interfaces are applied to get the exact location of the hosting device. It is famous because it has the ability to dramatically enhance the user experience.

5.Time Zone APIs:

Google's Time Zone API provides the time zone information for locations around the world by latitude and longitude. It allows the developers to access and integrate the data and functionality of Google. Geonames.org also provides a free web service to get the time zone from a city.

6.Other Web Mapping APIs:

There are other many APIs that define interfaces and bindings to access maps over the web. According to The Programmable Web the top-ten web mapping APIs include: Google Maps, Microsoft Bing Maps, Foursquare, OpenLayers, OpenStreetMap, MapQuest, Mapbox, CartoDB, Esri, and Yahoo. Most of the APIs featured in this article are for gaining access to map libraries or geographically related data. However, the mapping category contains APIs for programmatically accessing map libraries, sources of geographic data, geographic information system and spatial analysis software, location intelligence solutions and more.

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ASSESSING THE IMPACTS OF CLIMATE CHANGE ON THE HYDROLOGY OF THE INDRAWATI RIVER BASIN, NEPAL

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Abstract

This study is assessment made of the hydrological regime of the Indrawati basin under climate change. In this study, Soil and Water Assessment Tool (SWAT)model is used to delineate, discretize and parameterize the Indrawati basin to compute input parameters required for the model run. The model is run for 1990-2014 to estimate the discharge at the outlet (Dholalghat). Model calibration and validation on both hydrologic and sediment components of the basin were also performed monthly to assess the model performance. The future climate change scenario using the RegCM4-LMDZ4 data and the relative changes with the baseline scenarios were analyzed. The comparison suggests that the historical trend of flow is decreasing at the rate of 0.55 m3/s per year. According to RegCM4-LMDZ4 simulations, the trend is going to continue but at a flatter rate. The decreasing trend is observed to be very less.

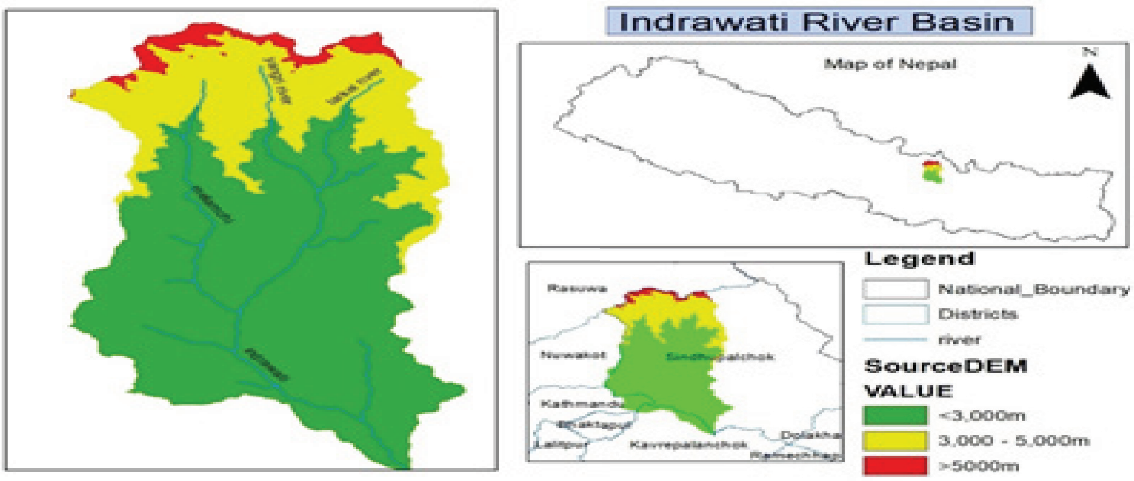
Introduction

Climate in the Indrawati basin is primarily governed by the interaction of the South Asian monsoon system and the Himalayas. Heavy rainfall, relatively high temperatures, and humidity characterize the summer months from roughly mid-May to mid-October; nearly half the total annual rainfall occurs in the months of July and August. The rest of the year is considerably drier, with roughly 7% of the annual total rainfall occurring from November to April. Average annual rainfall has a wide range of 1,100 to 3,800 millimeters; the highest totals are reported at the higher altitude-measuring stations. Temperatures range from 5 degrees to 32.5 degrees Centigrade (Sharma C., 2002).

With the increasing development of infrastructure in Indrawati along with the Melamchi Water Supply Project, the study is highly pertinent to study how the change with climate and development affects the overall natural phenomenon of the river. Moreover, it is necessary to address the climate change impact in the Melamchi Water Supply Project. Thus, this study is made of the hydrological regime of the Indrawati basin under climate change. In this study, Soil and Water Assessment Tool (SWAT)model.

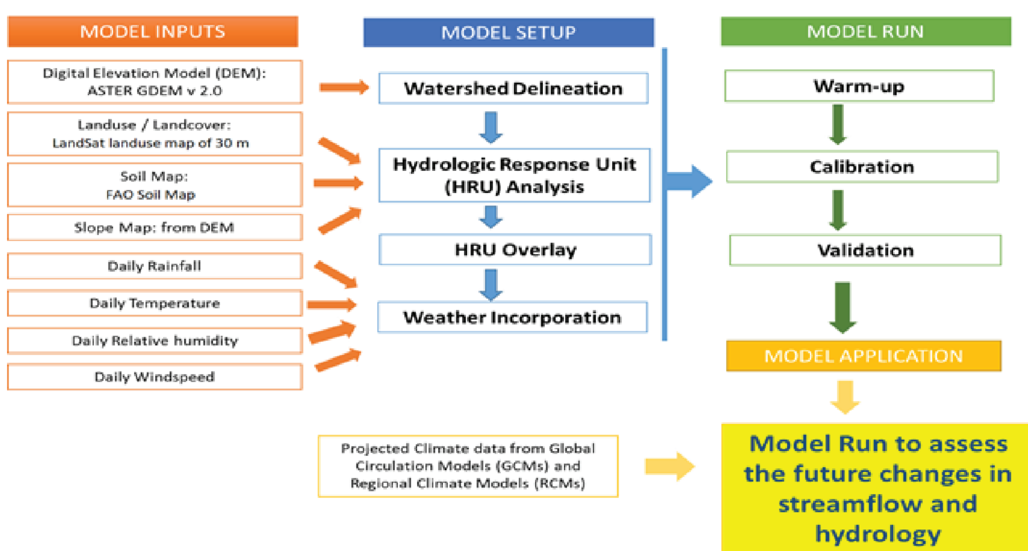
Study Area

The Indrawati river basin is located in central Nepal and part of the larger Koshi basin. The Indrawati River originates in the high Nepali Himalayas, eventually joining the Sun Koshi River . The Indrawati basin (see Figure) has 3 major tributaries that contribute to its flows: the Larke Khola, Yangri Khola, Melamchi Khola. This Basin is located in Bagmati zone, Central Development Region of the country and falls within Sindhupalchowk district.



Methods and Materials

A semi-distributed, time continuous watershed model, Soil and Water Assessment Tool (SWAT) (Arnold et al., 1998; SWAT,2012) was used for rainfall-runoff modeling in this study. Conceptually, SWAT divides a watershed into sub-watersheds. Each sub-watershed is connected through a stream channel and further discretized into Hydrologic Response Units (HRUs). AHRU is a unique combination of soil and vegetation type in a sub-watershed, and SWAT simulates the hydrological variables and runoff results at the HRU level and aggregates these results to the catchment scale by applying a weighted average to the HRU results. The runoff is routed to obtain the total runoff for the watershed at the outlet. The SWAT model for Koshi Basin was set up with the Arc SWAT2009 interface. The data required for the model implementation and the steps involved are briefly discussed below. Coefficient of Determination (R2) and Nash–Sutcliffe Simulation Efficiency (ENS) were used as the goodness of fit measures during calibration and validation of the model.



Data used

Topographic, land use and soil data

Topographic, land use and soil map data are the spatial data required for hydrological simulations using the SWAT model. The topography of the basin is defined by the Aster GDEM v2.01 Digital Elevation Model (DEM) for the Koshi River Basin. It has a spatial resolution of 30 m. The Landsat derived from land use map with a spatial resolution of 30m obtained from ICIMOD's geo-portal was used for the study. The FAO soil map was applied, and the soil data properties obtained from the FAO soil properties database (FAO, 2002).

Historical time series data

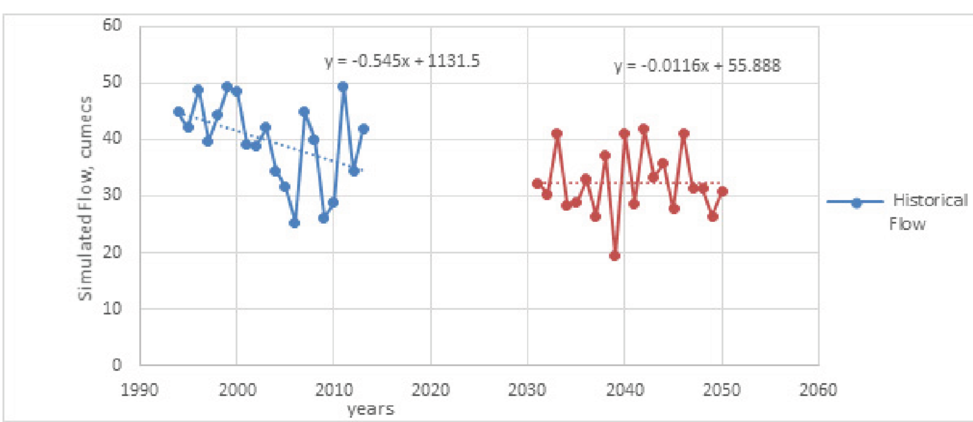
Historical meteorological and hydrological data were collected from the Department of Hydrology and Meteorology (DHM), Government of Nepal (DHM, 2012). The meteorological data used for the SWAT modeling were daily precipitation, daily maximum and minimum temperature, daily relative humidity, wind speed and sunshine hours. Gauged flow data were used in the model for two purposes; first to define inlet discharge points for the basin to simulate the existing conditions and second for performing sensitivity analysis, calibration and validation of the model at the outlet.

Projected future climate data

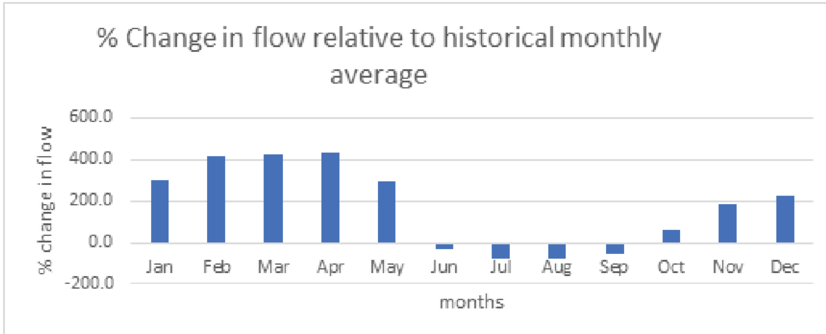
Simulation results for the region from Regional Climate Models RegCM4-LMDZ4 is used in this study to generate the future flows.

Result

The coefficient of determination R^2 and Nash-Sutcliffe (ENS) were used to evaluate model calibration and validation. The results found that were satisfactory for the gauging station R^2 = 0.951 and ENS = 0.901 for calibration and R^2 = 0.937 and. ENS = 0.906 for validation. The comparison of model simulated historical and projected flows suggests that the historical trend of flow is decreasing at the rate of 0.55 cumecs/year. According to RegCM4-LMDZ4 simulations, the trend is going to continue but at a flatter rate. The decreasing trend is observed to be very less. The results with the GCM led simulations in this study have shown a peculiar result. The results suggest a drop-in monsoon flows and increase in dry season flows thereby suggesting a shift in peak flows from August to October. This is an atypical result as compared to the ongoing research in the river basins in Nepal.



The figure compares the annual averages of flow in historical and future conditions



Conclusion

This study shows that robust hydrological models like SWAT coupled with GCM/RCM led projections with ensemble predictions can give a clear indication of the hydrological regime in the future. Considering the time, course and data constraint, the ensembles of the GCMs were not used. With the strategical importance of Indrawati River Basin in terms of water resources development, it is highly pertinent to the ongoing and proposed water projects including the famed Melamchi Water Supply Project as well as other hydropower and irrigation schemes under consideration, to be assessed for climate change impacts.

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S.N. Land Use (Level 1)

1. Agriculture
2. Residential

Measuring the height of Mount Everest

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Mount Everest, also known as Sagarmatha in Nepali and Chomolungma in Tibetan, stands as the world's highest mountain. Mount Everest situated in northern part of Nepal along the border of Nepal and China and is measured as 8848 meters above sea level. In 1715, China surveyed the mountain for the first time while mapping Chinese territory and depicted it as Mount Qomolangma. In 1856, the Great Trigonometrical Survey of India published the height of the mountain, then known as Peak XV, at 8840 meters (m). The peak was named as Mt. Everest in honor of Surveyor General George Everest of (the then) British India for his special contribution to Great Trigonometrical Survey. The current official and recognized height by China and Nepal by a 1955 Indian survey stand at 8848 m. In 1975 Chinese Survey reconfirmed the height. In 1999 an American team surveyed the height using latest technology GPS and published the rock height as 8850 m and snow height of 1 m. In 2005, China re-measured the height of mountain using GPS technology and claimed the rock height of the mountain to be 8844.43 m. Both the surveys of 1999 and 2005 are doubted on accuracy due to geoid uncertainty. There have been a long argument on snow height and the rock height, which one to be considered while measuring height of peaks. Following long arguments on this, Nepal hasn't recognized both of the 1999 & 2005 surveys. Meanwhile, Nepal has not officially surveyed the height of Mount Everest on its own till date.

Research has shown plate tectonics movement of the Himalayan region are adding to the height and moving the summit northeastwards with rates of change 4mm upward per year and 3-6 mm northeastward per year. With the Gorkha earthquake 2015, many researchers has doubted, change in the height of mountains. With the growing number of interest regarding re-measuring the height of Everest from all over the world community, Nepal Government decided to carry out the survey work and measure the exact height of the Everest on its own. Nepal Government gave the responsibility to Survey Department to carry out this task of great national pride.

Survey Department, the governmental mapping agency responsible and capable of handling this kind of task, duly followed government's order and began its work immediately under the direct leadership and supervision of Director General of Survey Department. The initial work regarding Everest Height measurement include Reconnaissance of the Levelling Network up to Namche Bazzar, Solokhumbhu. Survey Department deployed a small team to carry out the task and the team reported that the levelling network up to Namche is not a feasible task. The team suggested carrying out the levelling network is feasible just up to Taksindu, Solokhumbhu from where trigonometric levelling should follow to hill stations and then to Everest peak.

Survey Department then form a methodology drafting team under the leadership of Deputy Director General, Survey Department to draft the methodology for measuring the height of Mount Everest with detailed cost and working personnel's estimate. After a month long research and studies, the team submitted a detail methodology work plan with full detailed cost estimate and work schedule.. Survey Department is going to present this full report in a workshop to be scheduled at the end of 2017. International experts on geodesy, geodesists, scientist, researchers, survey professionals, national experts, will be the invited to the workshop to pitch their ideas on Everest height measurement.

The authorized height recognized by Nepal is 8848 meters as published by Indian Survey in 1954 as reflected in B.L. Gulatess's paper (1954). Thus, Survey Department plans to measure the Everest peak from the hill stations used by Indian Survey. The methodology to measure the Everest height consist of six main tasks: Precise Levelling, Trigonometrical Levelling, GPS Survey, Gravity Survey, Meteorological data collection and Data processing.

i. Precise Levelling : Expansion of precise levelling network from nearest Benchmark to feasible hill stations (at least three hill stations)

ii. Trigonometrical Levelling: Trigonometrical levelling from the precisely levelled hill stations to remaining hill stations (from where the peak will be observed) and trigonometrical levelling of Peak of Everest from those hill stations

iii. GPS Survey: GPS measurement at the Permanent Bench Mark (PBM) along levelling networks, and at all hill stations and the Everest peak

iv. Gravity Survey: Gravity survey at PBM along levelling network and at feasible hill stations

v. Meteorological Data Collection: Line of sight for Trigonometrical levelling are more than 70 km which needs to be corrected for refraction which require atmospheric data: temperature, pressure, humidity etc.

vi. Data Processing and Publication of Final Results:

Geometrical levelling can't be carried up to the peak of Everest and it is difficult even to carry up to Everest Base Camp. Thus, height will be measured by trigonometrical levelling from nearest possible hill tops. Survey Department proposes to use 8 hill stations used by Indian Survey along with four new hill stations which, Survey Department will monument as new hill stations. Survey Department will send a mountaineering team with the survey professionals to the peak of Everest to keep a special type of signal at the top of the Everest. The signal can be observed from all far hill stations. The signal will be designed in such a way that it will contains GPS antennae as well to make GPS measurements at the peak. At the time of measurement of peak of Everest, 8 well spread stations will be chosen to make trigonometrical levelling to the peak of Everest and remaining 4 stations will be continuously occupied by GPS at the same time.

The height computed by trigonometrical levelling is subjected to high refraction error. For longer rays as this, longer than 70km, there will be high percentage of error in height measurement. The curvature of ray of light and its refraction depends upon the temperature, pressure and temperature gradient of atmospheric layers through which a ray passes and is changing all the time. Hence, to obtain accurate height measurements, it is required to have air density measurements, temperature and pressure measurements at the time of trigonometrical levelling at both sides as far as possible. To overcome irregular effects of refraction, the best is to observe at near mid-day, where variation in temperature gradient is minimum thus minimum refraction. Another important aspect to consider during height measurement is the datum. The height of Everest is the height above sea level. Mean sea level is considered geoid surface. Precise/Geometrical levelling up to any place or hill station gives the geoidal height. But during trigonometrical levelling of peak of Everest, for longer rays, where reciprocal levelling from peak of mountains is not possible, provides weak geoidal heights. When trigonometrical levelling is used, corrections for deviation of vertical, geoidal rise and curvature of plumb line has to be considered. Thus, measurement of deflection of plumb lines, gravity measurements and GPS surveys are required to be done in those areas to determine the accurate geoid for that area to reduce the height to mean sea level.

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नेपाल सरकार

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धुलिखेल, काभ्रे ।

टेलिफोन नं. ०११-६६१४५५, फ्याक्स नं. ०११-६६२०७८

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

१) लामो अवधिका तालिमहरु :

क) सिनियर नापी तालिम (एक वर्ष) – विभागिय कर्मचारीहरुका लागि

क) जुनियर नापी तालिम (एक वर्ष) – विभागिय कर्मचारीहरुका लागि

२) केन्द्र र काठमाण्डौं विश्वविद्यालयको सहकार्यमा संचालन भइरहेका प्राज्ञिक कोर्षहरु:

क) स्नातकोत्तर भूमि प्रशासन (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

क) Diploma in Geomatics Engineering (तीन वर्ष) – एस.एल.सी. उत्तीर्णका लागि

४) क्षमता अभिवृद्धि एवं पुनर्ताजगि सम्बन्धि छोटो अवधिका विशेष तालिमहरु :

क) भूमि प्रशासन तथा व्यवस्थापन तालिम (सहायक स्तर)– दुई हप्ता

ख) भूमि प्रशासन तथा व्यवस्थापन सम्बन्धि अभिमुखिकरण तालिम (अधिकृत स्तर)– तीन हप्ता

ग) Geographic Information System (GIS) Training- तीन हप्ता

घ) डिजिटल कित्तानापी तालिम– तीन हप्ता

ङ) Remote Sensing and Photogrammetry Training- तीन हप्ता

च) Real Estate Valuation Training – ३० कार्य दिन

छ) Digital Cadastre and Office Management सेवा कालिन तालिम – ३० कार्य दिन

Land Information System in Nepal

Ashutosh Bhandari

Background

Nepal's land administration system, which keeps the information on land and its owners, including tenants, is largely traditional. Information is acquired, stored, updated, collated, and retrieved manually in rudimentary fashion in paper form, with a low level of precision and high risk of distortion and duplication. Consequently, land records are not reliable, land disputes are common, land registries are overwhelmed with associated problems, and integrated reliable land information is almost impossible to obtain. Land administrative services are costly for both the government and the people. Moreover, the people are rarely satisfied with the quality of the services. Because they are in paper form, the major land records are deteriorating due to storage under unsuitable conditions and constant mishandling. In addition, there is no provision for recovering many of these records in the event of disasters such as the destruction of land offices during an insurgency. There is no overall strategy for managing land records. While a survey map serves the purpose of a graphic index, lack of accuracy and geo-referencing could inhibit its future role in the spatial data infrastructure. During the last decade, Ministry of Land Reform and Management (MOLRM) has undertaken efforts and initiatives to modernize land administration and develop institutional transformation. The focus is to computerize the alphanumeric data of the cadastral parcels, managed by district land revenue offices. The integrated land information system (LIS) aims to integrate the spatial aspects of land administration data managed by district survey offices. In 2000, the Department of Land Information and Archive (DOLIA) was established with objective to manage all aspects of LIS.

Currently, DOLIA is pilot-testing the computerized LIS in four districts with varying degrees of success; however, progress has been slow. There is a serious lack of trained staff to work on the development and maintenance of the computerized system. In addition, funding shortage have delayed the engagement of contractors to carry out data collection work. The computerized system is still in a basic form and should be further developed to handle the volume of work and also to add more functions. Currently, it is only an information system running as an adjunct to the manual system. It needs to be developed into a transaction processing system to aid all aspects of the work flow. In addition, the official procedures for land administration, which were developed to suit manual processing, have to be reviewed, simplified, and standardized to suit computer processing. The computerization effort to date has been ad hoc and seriously lacks structured planning and clear strategies. There is a serious lack of an overall strategy for information technology (IT) in land administration. There should be an extensive review of the way the department has been managing the resources to build and operate LIS. In addition, lack of clarity in overall goals, cadastral and land information standards (data, process, and technology) are nonexistent and must be defined before further data development. Other matters requiring clearer definition are overall management responsibility for spatial and attribute data, policies for land information access and sharing between stakeholders, land information fees, data custodianship, and privacy.

History of Land Information System in Nepal

In 13th conference of United Nation Regional Cartographic Conference for Asia Pacific held in May 9-18 in Beijing and 14th United Nations Regional Cartographic Conference for Asia and Pacific in 3-7 February 1997 at Bangkok and 1st Cartographic Conference of south Asia Association for Regional Cooperation (SAARC) countries held during 14-15 March 1995 in Kathmandu, application of land information system (LIS) was committed by the member countries. The international initiatives such as Bathurst Declaration (FIG, 1999) and other international workshops on land administration focus on development of land information system (LIS). In Nepal, government has realized the importance of LIS as an important tool and proposed in 8th five years plan (1992-1997) to establish LIS in Nepal. In 1993 government introduced information technology in land administration in Nepal. A unit called Central Integrated Land Information System was established within the Department of Land Revenue under MOLRM. A new project Integrated Land Information System (ILIS), directly under the MOLRM was set up for incorporating the spatial and attribute aspects of land administration. Various studies and piloting was done to develop at that time. The Swedish International Development Agency (SIDA) had provided the technical assistance in that period. Later, in 9th five Years Plan (1997-2002), government had realized to strengthen LIS activities in Nepal thence the council of ministers decided to establish a well dedicated Department in 2000 A.D. and gave the name Department of Land Information and Archive (DoLIA). From the date of establishment of Department, DoLIA has been working with full dedication and efforts for establishing LIS system in Nepal.

Archive in DoLIA:

Besides, DoLIA had also given the mandate of maintaining the central archive of cadastral maps and supporting documents. Initially maps and other important land records were archived in Survey Department from 2050 B.S. After the establishment of DoLIA , it started to keep archive of such cadastral records and also gave initiation for making complete archive of cadastral maps and field books from different survey offices throughout the countries. This process is still in process of collection of cadastral maps ammonia copies and images of field books. Collection of ammonia copies for archive is almost complete except Achham district. DoLIA is also collecting the ammonia copies of cadastral maps prepared from resurvey.

In addition, archive after preparation of images of field books of 37 districts has been almost completed and preparation of images of field books of 36 districts is in progress. Other old maps Mauja Naksa of Kathmandu are also archived in DoLIA. Also, microforms of cadastral maps and field books of Kathmandu Valley and field books of Kavre, prepared in assistance of German government have also been archived in DoLIA. In these days in unclear, doubtful, torn office records and in remaining parcel registration, microform verification and image\written copy of those records are being provided as per official request. Ammonia copies of cadastral maps in archive play a very important role on recovery of maps of survey offices from being torn, unclear and lost. DoLIA is also working on preparing hard copies to soft copies making image and store in DVD and Hard Disk. This archive will play a vital role for recovery of records, if such records at concerned office damaged from terrorism activities, are, "good and other natural calamities.

LIS Activities in Nepal:

For the effective and efficient land management LIS has been proved as an appropriate tool. According to the FIG (International Federation of Surveyors) LIS is a tool for legal, administrative and economic decision making and for planning and development which consists on the one hand of a database containing spatially referenced land related data for a denied area and on the other hand of procedures and techniques for the systematic collection, updating, processing and distribution of the data. The base of a LIS is a uniform spatial referencing system for the data in the system which facilitates the linking of data within the system with other land related data. So, for establishing LIS, both spatial data and aspatial (attribute) data are necessary. DoLIA has developed different software for handling spatial and attribute data, and support in establishing LIS in Nepal.

1. DLIS (District Land Information System)
2. SAEx (Spatial Application Extension)
3. IRMS (Image Reference Management System)
4. PRMS (Plot Register Management System)

1. DLIS:

DLIS (District Land Information System) is an application software designed and developed for handling the attribute data of land revenue offices. Basically, details of the Moth Shresta and Rokkas are captured by the DLIS system. It has been designed not only for data capture but also for the various queries e.g. searching by parcel number, searching by owner name, searching by Moth pana numbers etc as well as data retrieval and ultimately providing the computerized land ownership certificates to the general public in a quick, prompt and computerized system. Previously BhuLaxmi software was made in 1995 by LIS project based on Windows 95 through National Computer Center which was not so advanced and user friendly. Then after DLIS was made in Microsoft Office 97 version having database in MS-Access. At that time Land Revenue Offices; Kaski , Chahabil and Bhaktapur were chosen for attribute data capture and transactions. Being some limitations, again DLIS was modified and upgraded to Microsoft Office 2000 with MS-Access database. It was in implementation for many years for attribute data capture and transactions. Again, there had been realization of some limitations in application having database in MS-Access in the context of database storage capacity, multiuser capacity, data security and integrity. The DLIS system has then upgraded to MS- SQL having the large database capacity, high data security and integrity with the platforms of dot net and C$ frameworks in 2010. The entire MS- Access databases prepared before are then migrated to MS-SQL database.

2. SAEx (Spatial Application Extension):

SAEx is an application software and is an extension of ArcGIS. Initially it was customized as an extension version of ArcGIS 8x. This extension has been developed for acquisition of the spatial data from the hard copy of cadastral sheets that is digitization and geodatabase Creation in a very consistent way maintaining the uniformity and integrity, and ultimately for providing the quick, prompt and qualitative computer based cadastral services to the general public and other stakeholders from survey offices. Piloting was done in Bhaktapur and Chabahil survey offices in 2000 B.S. Later SAEx was then upgraded to ARcGIS 9x due to some limitations in functionality and user friendliness in old version. Basically, SAEx consists of three features classes

1. Parcel
2. Construction
3. Segments

3. IRMS (Image Reference Management System) :

The IRMS is a MS-SQL based software for the reference entry and management of the pages of field books images. The field books images collected from the different survey offices are reference entry in IRMS giving District Code, VDC Code, Ward number, field book page number, parcel number so that image can be retrieved on database concepts without one by one opening of the field books pages. With the information of District code, VDC code, ward number and parcel number we can easily retrieve the required field book pages that can be provided to general public

in printed forms. Finally, after reference entry of all the field books images of all survey offices we can merge individual database of each survey office and make a single database so that information of field books of all over the country can be obtained from a single computer.

4. PRMS (Plot Register Management Software):

PRMS is also a MS-SQL based application designed and developed to capture the information of plot register of survey offices. After data entry and update of PRMS we can have the information of the history of any parcel; what is the origin parcel? How many parcels are formed after parcel split (kittakat)?, what are the original parcels of the merged parcel (Before kitta Akikaran)? through PRMS. We can easily have information of all the intermediate parcels, origin parcel and present parcel (kayam kitta) through this application. It will maintain all the parcel history after transactions. SAEx will maintain the parcel history only after operation or update on this application. It will be more useful for origin parcel information and until parcel history is maintained through the operation of SAEx application.

NEPALESE EFFORTS IN BUILDING LIS AND INSTITUTIONAL TRANSFORMATION

During the mid-1990s, the computers were quite new tools to our Nepalese society and there was severe shortage of the skills required to operate these technologies. The computers were considered as the sufficient tool to solve the problems, and there were very few private companies engaged in the field of computer science. In 1993, His Majesty's Government started putting resources to introduce the information and communication technology (ICT) in land administration in Nepal. A unit called "Central Integrated Land Information System" was established within the Department of Land Revenue under MOLRM. The focus was to computerize the alphanumeric data about the cadastral parcels, which were and is being managed by the district land revenue offices. It continued till 1995 until the council of ministers formed a new project as Integrated Land Information System (ILIS) directly under the MOLRM. The intention of the change was to incorporate the spatial aspects of land administration data, which was and is being managed by district survey sections. In 2000, the council of ministers decided to establish a new dedicated department called Department of Land Information and Archive (DoLIA). The figure no. 1 shows the current organizational structure of MOLRM.

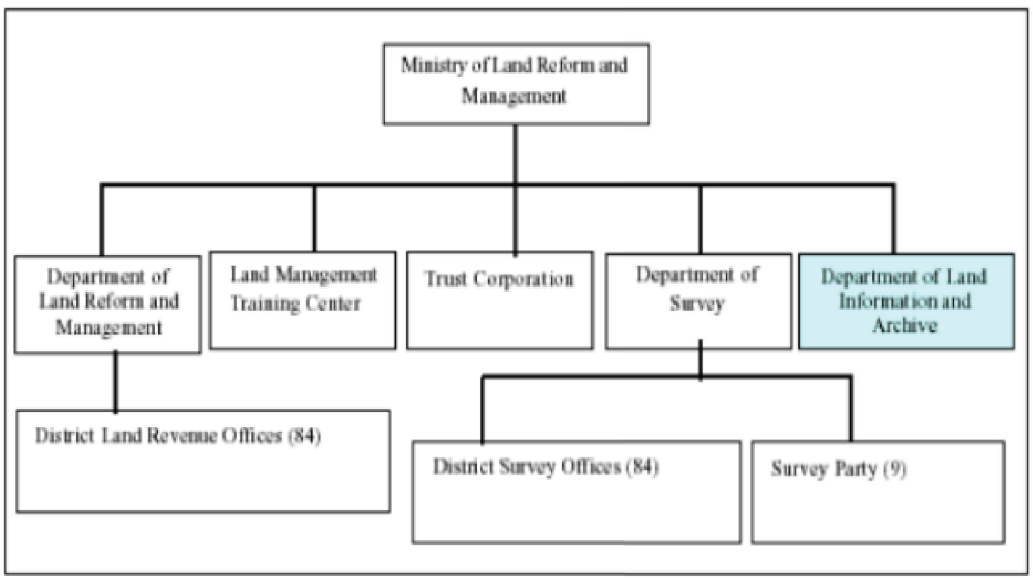

Figure no.1: Current organizational structure of MLRM

During the last decade effort, MOLRM has undertaken a number of initiative/activities to modernize land administration according to the needs of the Nepalese society. In a broad sense, the current progress of LIS project based on ICT in Nepal may be seen in three consecutive periods on the basis of our national plans. These periods are initial period (1993-1995), intermediate period (1996-2000) and current period (2001 to date) after establishing DoLIA. The following table no. 1 compares eleven elements, which can be considered to be the important factors in building LIS (DoLIA 2001, NPC 2000 and Swede survey 2002). Currently, DoLIA is heavily involved in piloting the LIS in two districts: Bhaktapur and Kaski. Bhaktapur is the small district that share boarder with Kathmandu whereas Kaski is 200 km away from the capital. In both of these districts, its effort has been focused on the nonspatial part of the cadastral parcels i.e. land revenue offices. In both of the offices, a private company is being used for data conversion. It is expected that the attributes of all the parcels in these two offices will get digitalized within next four months. The three other offices in the Kathmandu Valley have also got small set up established with few computers and other accessories

	Initial period (1993-1995)	Intermediate period (1996-2000)	Current period after establishment of DoLIA(2001 to date)
Government policy	Eighth national plan (1992-1997) envisioned to introduce computerization of land records.	Ninth national plan (1997-2002) has emphasized on the computerization of land records and map, and simplification of land administration procedure.	Tenth national plan (2002-2007) has given priority in the accessibility services through computer based system, and centrally developed archives of land records and cadastral maps with modern technology.
Scope of the task	To computerize non spatial aspects of cadastral parcels.	To computerize both non spatial and spatial aspects of cadastral parcels.	To build LIS by incorporating both non-spatial and spatial aspects of cadastral parcels. In addition develop the central archives of land records.
Implementing agency	The then Department of Land Revenue of MLRM	Land Information System project (LISP), within MLRM	DOLIA
Structured coordinating mechanism	None	None	Council of ministers (Cabinet) decision for steering committee with MLRM Minister's chairmanship.
Human resource recruitment and development	40 technical positions were created and recruited.	No recruitment but trainings were organized for developing the skills and creating awareness at different levels.	Department was established with 21 technical and 17 non-technical positions including the Director General.
Budget	?	0.565 Million (US dollar)	0.535 Million (US dollar)
Foreign assistance	None	SIDA's (1999-202) support basically for the transfer of technology and experience	SIDA's support continued till 2002 march
Research and studies	Computerization of land Recording	Detail study report in developing an integrated	Studies have been carried out by short term Swedish consultants in
	system in Nepal by spice info Tech	Land information system in Nepal by Bhumichitra company. Design and Development of District land information system (DLIS) APROSC	Certain aspects of LIS. A few studies have also been carried by DOLIA staff together with the local consultants.
Software development	Although LIS was quit new technology, an application software was developed by NCC with an aim of handing the non spatial data.	Developed District land Information System (DLIS) software	Refined the DLIS software and developed customized application to handle the spatial aspects of LIS
Data capture	Started in few districts with government staff	just continued	Use of private companies
Concept of data sharing	None	Discussion started	Exists; developed an understanding with Kathmandu Metropolitan city
Awareness and understanding	Not that high as it was just the beginning	Increased Level of awareness	Significant understanding about the complexities in building and operating LIS.

Table No. 1: Overview of efforts in building LIS during three different periods

PROPOSED VISION AND STRATEGIES OF LIS

The ideal situation for a nationwide LIS and dissemination of reliable and up-to-date land information could be through the integration of both land revenue and surveying offices. However, in the context of the organizational set up within the ministry, the DoLIA as a permanent Department can play the leading role for building and maintaining a nationwide LIS. After the system is built and placed on operation, DoLIA would have responsibility to managing information system in terms of database security, data protection and archiving all related documents, while land revenue and survey offices uses the system in order to update data in the LIS and delivers the quality services. In the following figure no.2, the proposed vision consists of two sets of users for LIS (BC, 2002). Internal users are responsible to provide efficient land administration services delivery and maintain data in the system. For the external users, DoLIA would be responsible for the timely supply of land information at affordable cost to all users. This is very important to generate the income and sustain the system economically.

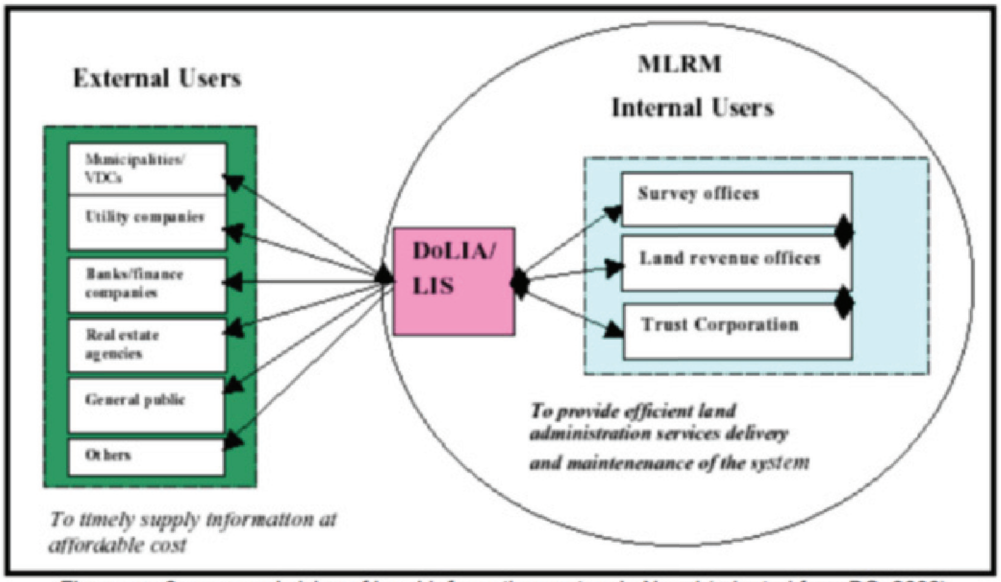

Figure no. 2: proposed vision of Land Information system in Nepal (adopted from BC, 2002)

Conclusion

Thus using various software DoLIA is vigorously working on modernizing land administration and approaching towards paper and pencil free land administration and establishing Land Information System (LIS) in Nepal with full effort and dedication with limited manpower and resources. As spatial data and attribute data are the fundamental components of LIS, DoLIA has been focusing on capturing, storing, processing, and bringing them in operations or transactions for computer based service delivery to general public till these days from the date of establishment. Now DoLIA is also taking steps towards Central Integrated Land Information System (CILIS) maintaining a central server with network connection so that live or updated information from the district land revenue offices and survey offices can be obtained from the central server of DoLIA. Initially land revenue offices of Kathmandu valley are connected to the central server. Gradually other land revenue offices will also be connected to the central server. A study is being done for maintaining single database of the cadastral geodatabase with the network connection of district survey office and central server located at DoLIA and integrating with the DLIS database. With this integration we can have Central Integrated Land Information System (CILIS), we can disseminate the data to various stakeholders' e.g. local bodies (municipalities\VDC), financial institutions, real estate agencies and other stake holders and can have good revenue generation through data dissemination. DoLIA is on the way.

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Prospects of GIS; The SMART Ways

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Introduction

GIS stands for 'Geographic Information System'; is a tool for creation, manipulation, analyzation, storage and display of location based information. It is a system for displaying and analyzing data related to positions on Earth's surface. GIS has a wide scope of applications in like agriculture management, land use zoning, coastal management, urban planning, property records assessment, planning and zoning, health and public safety, economic development planning, natural resource management etc. Also, GIS is a tool which allows users to visualize and analyze the relation of location based information of features. In other words, GIS is a tool used for capture, storage, retrieval, manipulation, analysis and display of spatial data via computerized database management system (Clarke, 1986; Parker, 1988; P. 9) and has its wide usage to envision digital maps, create new spatial information on the maps, print the custom-built mapsperformingspatialanalysis.

Evolution

Cholera Clusters Paper mapping by John Snow in 1850s is accredited for the inception of GIS. He mapped outbreak locations of cholera hit city of London along with features like roads, property boundaries and water lines (Source: EA Parkes, 2014) where he found that the choleracasesweremajorlyfoundalongthewaterlines.

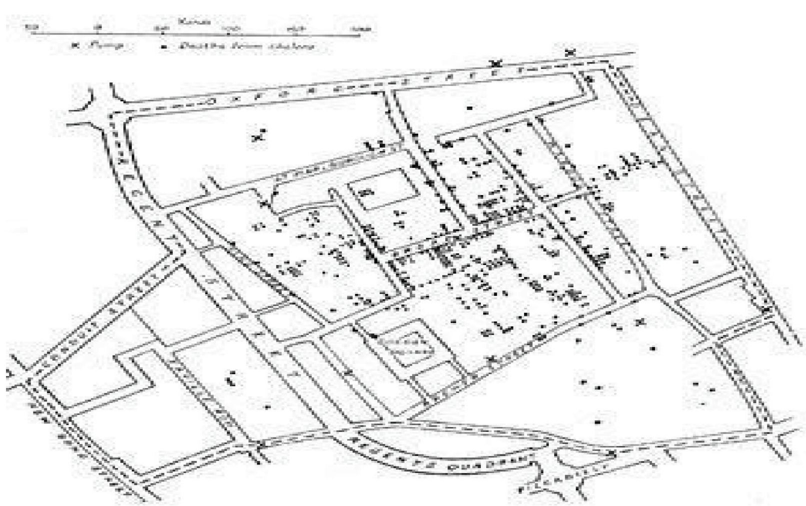

Figure 1 E. W. Gilbert's version (1958) of John Snow's 1855 map of the Soho cholera outbreak showing the clusters of cholera cases intheLondonepidemicof1854

From the time of John Snow's paper map to present day's 4D concept, GIS has propagated massively. Initially, during 60s, GIS was used by North American organizations like US Bureau of Census, US Geological Survey, Harvard University Laboratory etc. used computer based GIS. Roger Tomilson, father of GIS, in his paper named 'A Geographic Information System for Regional Planning'; coined theterm'geographicinformationsystem'in1968(Source:https://www.gislounge.com/history-of-gis/). The Environmental System Research Institute (ESRI) has primary role in developing GIS software for commercial purpose and making common usage of GIS for dealing spatial data. 1970s can be termed as the decade for the starting of the blueprints of GIS system when topology was introduced into GIS to store and analyze stable data structures in a map (Source: http://gis.usc.edu/blog/a-changing-world-ways-gis-has-changed-over-the-years/).Personalcomp-uters were introduced in 1980s which made possible to execute programs of mainframe computers as well. GIS reached adulthood when Spatial database was brought together with relational database technology as a result of immense growth in demand for mapped data to visualize the world better. Object oriented system was introduced in 1990s and was a major bre akthroughintherecognitionofgeo-informatics,theantecedenttopresentGIS.Nowadays, GIS has developed in a colossal manner by virtue of readily availability of data and its visualization not limited within 2D format but also in 3D and possibly in 4D as well. There are numerous ways in improving skills in data analysis, modeling and mapping of digital geographicaldata.(Source:https://docs.qgis.org/2.8/en/docs/gentle_gis_introduction/int-) roducing_gis.html). Today, GIS users are mature enough to build their own GIS software in an open collaborative way (Source: http://gisgeography.com/history-of-gis/) and is termed as open source which is available free of cost. Open source software such as QGIS and Web GIS are also being endorsed along with ESRI's commercial ArcGIS software. More lights are shining on the negotiationsregardingReal-TimeGISandVirtualReality.

FutureExtrapolation

According to Michael F. Goodchild; Professor of Geography at University of California, Santa Barbara; it is perilous to prognosis the future and the act to speak up about it is apprehensive. However; he also can't deny that it is always decent to envision where the GIS community might be headed and with this input, always there remains the likelihood that the othermemberswillalsobeenthusedtosearchfortheGISpossibilities.

As a matter of fact, it can be comprehended that GIS is being evolved from a simple desktop application to social technological tool as a result of incredible progression in communication technologies and data visualizations. It can also be perceived that advancement in IT may stimulate the developments of GIS in virtual reality and language interface (voice control, eye control etc. for example); the smart ways. GIS interfaces are being apposite for big data processing with real time analytics thereby making it a prodigious tool to be used for the development of smart cities. Moreover, this may enhance towards the unexplored scopes of GIS which is currently being usedremarkably in planning and management sectors only.

In fact, the U.S. Department of Labor has designated Geotechnology as one of the three "mega-technologies" of the 21st century—right up there with Nanotechnology and Biotechnology. This broad acceptance and impact is in large part the result of the general wave of computer pervasiveness in modern society. We expect information to be just a click away and spatialinformationisnoexception.

Today, the 'look and feel' of the GIS has been amended amply due to advancement in the user interface. The scope of GIS has been enriched with the disappearance of raster and vector data differences, enhancement of object oriented databases and programming, being easier to install and maintain etc. The future of GIS is seem more towards smart technological application with fast algorithms able to process big data in minimal time with required data products. Jack Dangermond, president of Esri in his blog Five GIS Trends Changing the World at http://geoawesomeness.com/five-gis-trends-changing-world-according-jack-dangermond-preside nt-esri/) believes big data analytical capability of GIS to be one of the major factors for changing the world. He also believes the Software as a Service (SaaS) has widened up the scope of GIS where users can share and pool data resources mashup them and connect to cloud server and henceforth bonding to wide network of devices. His view can be supported by the fact that GIS has now slotted in the distributed systems and databases and microcomputers have conceived new fields of GIS. Moreover, GIS use have been amply influenced by the mobility of portable GIS systems. The next generation GIS is adopting virtual reality, 3D and 4D visualization as a product utilizing high resolution images. Thus, it seems Remote sensing images will be the major feeder providing big data for GIS in a wide network of devices providing real time data. The good news is the cost of imageries are shrinking with increased accessibility. Hence, it will not be exaggerated to assert that the following advancement in technologies will devise new stories of GIS few years from now.

- Virtual reality and INdoor GIS:- Virtual Reality GIS has been expanding its applications in the area of spatial analysis, touch-less interaction to manipulate a 3D scenario, reading complex scientific data in a given spatial regions etc. beyond the traditionalwayofmerelyfocusonapplicationofurbandata.
- 3D and 4D visualization:- 3D visualization employs integration, management and analysis of both spatial and attribute data processing platform in three mutually perpendicular axes. 4D visualization also does the same including schedule information as well thus making 4D visualization a overriding tool for visualization and animation of data.
- Image processing: Typically imageries are taken by satellites or UAVs on quest of discoveries on earth, however, now focus is for out of the earth as well for example in searchofwateronMars.
- Big data processing:- as a part of data science- programming, statistics:- As the workstation and hardware experienced tremendous upgrading in the technology, now every PCs accept big data processing as a part of data science viz:- for programming and statistics. Microcomputers have done enough to advertise GIS education and expand the domainofGIS.

- Web mapping:- Focus is shifting towards real time simulation and analysed products in thewebbeyondmeredatadelivery.
- GIS movies/ time sequences:- Spatial analysis are now inevitably linked to time dimension thus creating story maps of events of different time.Spatial patterns are changed as time progresses in a sequence of events. Traditional pan and zoom functions are now overridden by well equipped fly-by ability for users to navigate in simulating space.
- Augmented reality:- The world-wide crave for newly introduced computer game Pokemon Go has risen the question is the technology of superimposing the user's view of real world by PC generated image the next generation of technology advancement? If thatisthecasethenAugmentedRealityiscertainlygoingtorocktheGISworld.
- Mobile GIS:- Mobile GIS integrates mobile devices with GIS, GPS and Internet allowing data to get edited and changed on the field and thus increasing accuracy, saving time and decreasing cost. On field data can directly be uploaded on various online tools like google earth, open street maps, GPS Visualizer etc. and hence Mobile GIS has taken GIStoanewlevel.

In short, the latent prospective of these technologies to upsurge the influence of GIS is one of the stirring features about the future of GIS. However, the locus of technological advancementissettoenhancefollowingapplicationsofGIS

- e-commerce : The integrated GPS/GIS system is used for navigation purpose where GPS system provides spatial data required. GIS can be used to manage spatial information to devise an ultimate way out and effective transportation route of goods which is cost effective (Source:- Heng Li ; C. W. Kong ; Y. C. Pang ; W. Z. Shi ; and Ling Yu, Page 689).Henceforth,overallmarketanalysisofe-commerceactivitiescanbem adeviaGIS.
- Disaster management and climate change modeling : Database management functionality of GIS is an important tool in strategic decision making for disaster management and climate change modeling and can be used to predict risk and vulnerabilities associated with these. Web GIS system coupled with GPS can be used for real time monitoring of disasters and climate change and thus helpful for planning of rescue and relief operations with sustainable recovery and rehabilitation approaches (Source:-ShumanBARAL,JanakPARAJULI,Page46,2016).
- Space exploration: NASA uses GIS to prepare interactive and dynamic maps of planets with zoom in features on landmarks and tracking the path of rovers on planet's surface from the current and previous images taken by satellites (Source:- http://gis.usc.edu/blog/how-mapping-is-used-by-nasa-applications-of-gis-in-space/). GIS is important tool to make dynamic maps of universe based on the astronomical projectionsandsatelliteimageries.
- IVNS (in-vehicle navigation system): The development of Mobile GIS technology can be used to devise and execute the feasible methods for vehicle orientation, control and monitoring system in order to gain high precision, fast and accurate GPS vehicle monitoring system or intelligent transportation system (Source: Zechun Huang, Dingfa

Huang, Zhu Xu, Zhigen Xu, Page 2499, 2011). GIS and GPS can be integrated on vehicles monitoring and tracking system from the visual display of information on spatial data using GIS obtained from accurate, clear and precise geographical positioning of tracked vehicle (Source: AfërditaQekaj-Thaqi,Page45,2015).

● Geomedicine: Geomedicine is the integration of GIS software with clinical database which is useful in revealing hidden disease patterns linking patients health and contextual factors like workplace, habitat, feeding habits etc. to improve public health. Geomedicine associates geographic history of a place to calculate health risks via maps that shows the risksofdiseasesattheplace.

● Indoor GIS: Indoor GIS is useful tool for navigation in large covered areas such as railway stations and airports to find a service, determine a route between stations/airports, trace railways/airplanes route and to notify movement of railways/airplanes (Source: Candy J.). Indoor GIS relies on receiving GPS satellite signals via indoor systems such as Wi-Fire-transmitters.(Source:http://governement-2020.dupress.com/driver/geospatial-technology/).

● GIS enabled intelligent infrastructure: Gov2020 by Deloitte University Press (which explores the future of US Government in 2020) claims that GIS usage in infrastructure is safer and more energy efficient in transportation and energy sector (Source: http://government-2020.dupress.com/driver/geospatial-technology/)..

● Urban planning and Smart cities: Sanskriti Shukla, on her blog GIS brings out the best in Smart Cities on 13th July 2016, sees smart cities as the developed urban areas enabling integrated automation and real time having sustainable economic development and high quality of life. GIS provides a centralized framework for integrating the various aspects of smart city processes with concerned individuals, agencies and authorities (Source: Shukla S., 2016). On the steps of smart process suggested by ESRI, the role of GIS in finding right sites, boundaries and valuation of sites is crucial. The share of GIS in further steps of planning, designing and constructing is significant during which GIS is required to determine optimal solutions and management of project and finance. Thus, GIS provides a single point entry for the entire project document and files from the inception, planninganddevelopmenttomaintenance.

ConcludingInference

The technology does not remain static or stagnant and hence one replaces the other. These technologies are backed by the innovative minds working in the field of geospatial science. The capability of human resources, software and hardware have been upsurge amply in the course of advancement of technologies from labor-intensive manual system to digital and now smart technologies. Based on this fact, the conceiving of the ultra smart technologies in the future can't be denied. However, the perception of human resources towards technologies is pivotal to further innovations. Geospatial professionals should be ready to go beyond GIS as a toolbox to GIS as a method for dissecting the problem and finding and a solution. Besides, Privacy and data ownership will become critical issues for GIS usage inhibiting legal applications. Standardised data exchange practice is one effective solution to future issues of GIS practice. Further, the black cloud of lack of funding hovering over GIS research should be addressed by GIS community instantaneously. Further, GIS community can enrich the GIS with the wise mobilization of the power of GIS to counter world's problems exploring the trending technologiesinGIS. Insummary,thefutureofGISisinthehandsofGIScommunity.

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Scope of Land Management in Nepal

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The importance of land and land management was realized before centuries and legalized in the first land related act, Land (surveying and mapping) act 1963.Whereas, it is expedient to make arrangements for the survey and measurement of lands and for determining their grade in order to maintain cordial relations between people of different classes, communities or regions in Nepal and to maintain the convenience of the citizens of Nepal generally (Land (survey and management) act 1963). It implies the relation between people, community and geography should be maintained for a better yield. The Constitution of Nepal under article 25(4) empowers the land management declaring, "The provisions of clauses (2) and (3) shall not prevent the state from making land reforms, management and regulation in accordance with law for the purposes of enhancement of product and productivity of lands, modernization and commercialization of agriculture, environment protection and planned housing and urban development."

Land and its management form the basis of all societies. "A sound land policy, good governance in land tenure, land use and land administration, and the sustainable management of natural resources are critical success factors in ensuring economic growth, food security, nature conservation, the protection of vulnerable groups, poverty reduction and housing" (GAF AG 2017).

Land management today is just not an issue of land registration and tenure security. It implies to multiple sectors ranging from global issues like global warming to promotion of livelihood. The scope of Land Management is increasing as the relation between land, people and environment have been dynamic and these relations are meant to act globally. In Nepal, land management as the globalcontext is also taken as an emerging issue since government and people realized the importance of land in social, political and economic development. Some important scopes of Land Management in Nepal are discussed below.

1.1 Agriculture

Agriculture is the backboneof Nepalese economy.It provides employment opportunities to 66 percent of the total population and contributes about 33 percent to the GDP(MoAD 2016). However, the proportion of land distribution is not equitable. According to the national agriculture census of 2058, out of total 3364100 farmer families, landless farmer families (less than 0-0.1hector) are 227100 (8 %) in number and marginalized farmer families (up to 0.1-0.3 hector) are 670000 (20 %) in number (MOLRM | Nepal 2016). To improve the situation, the constitution of Nepal 2015, focusing on land reform for increasing agricultural production have enforced modernized and commercialized agriculture.

Land, both in the Terai and in the mountain, is being fragmented with the split of the ownership. Normally, a family holds many parcels but of different land use and in different locations. As a result, the production efficiency deteriorates. In order to enhance agricultural production, land should be consolidated and be utilized to the fullest of its capacity. On the other hand, global warming and climate change caused by haphazard land use and unplanned land activities another factor to decrease agricultural production. Sustainable Agricultural Land Management is a better way to cope this problem. Sustainable Agriculture Land Management (SALM) is a methodology developed to increase agricultural production and yield the better crops in a different climate or agro-ecological zones (Amos Wekesa & Madeleine Jönsson 2014).

Along with production, agriculture is also associated with internal migration. Most of the rural population in Nepal is engaged in subsistence farming. Across Nepal, the population suffering from acute food insecurity is estimated by WFP to be 3.48 million (15.4 percent of the total rural population), out of which the population in the Mid- and the Far-Western Hill and Mountain districts account for 0.40 million(MoAC & WFP 2011). There is a high rate of migration of poor landless people from the mountains to the plains and from rural to urban areas in search of better land for farming, job market and better livelihoods (B.R. Acharya 2009). In order to balance urban-rural population, increase food production and conserve ecosystem, land management is only a tool if formulated and implemented properly can change the situation.

1.2 Natural conservation and Tourism

Nepal is ranked in the fifth number in the list of country to visit in 2017 by lonely planet, one of the world's best travel publisher. Although the physical geography has turned the daily lifestyle difficult, thousands of travelers around the world travel Nepal per year. This is regular tendency because of land, land cover and natural resources available in Nepal. Currently, 34,193 sq.km, more than one-fifth area of the country is protected area as conservation areas, national parks, hunting reserves and wildlife reserves. By 2020 Nepal government has set a target of conserving at least 17 percent of terrestrial and inland water and 10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services. This goal is expected to achieve through effectively and equitably managed, ecologically representative and well-connected systems of protected and other effective area-based conservation measures, integrated into the wider landscape and seascapes(H.B. Acharya (DoNPWC) 2014).

Land is a common share to animal along with every creature that survive in the land including human. Programs intended for the conservation of ecological lands are not only related to wildlife but also has multidimensional aspects of forestry, agriculture, settlement development, soil conservation and so on. Land management can be used as a suitable tool to maintain balanced ecological and environmental relation between all these features.

1.3 Urban development

After increasing the number of municipalities from 58to 217 in between 2012-2015, urban population in Nepal increased from 17 percent to 43 percent (Ministry of Finance 2016). This decision of increasing the urban territory and population without considering the necessary infrastructure by Government are often criticized by urban planners. Capital city Kathmandu is ranked as world's third polluted city by Numbeo.com which demonstrates the status of urban cities in Nepal. Poor infrastructure, uncontrolled increase in real estate, lack of land use policy, an increase in pollution, lack of drinking water, poor transportation system, etc. are the key challenges of urban areas. Increasing pattern in squatter settlement and lack of clear policy to manage existing one is also one of the burdens to urban development. The government still perceives these issue as individual and is trying to find one to one solution, which indeed will be another catastrophe to the urban population.

Spatial planning along with consideration of current and possible issues in future can drive the situation towards precise urban development. Along with the planning tool, collaborative implementation ofthis framed plan and policy should be carried beneath single legal framework. Land Management as an integral component of urban planning and urban development is a better option to bring these challenges together and sort out with a better solution. To build a better settlement, different sectorial agencies working in cities must come together and coordinate to each under a roof of sustainable planning.

1.4 Rural development

Agriculture in Nepal as to global context is a reflection of rural area. As migration to cities from the village has increased, the rural area suffers from a lack of sufficient manpower to work in agriculture. Lack of agricultural reform, low quality of life, lack of irrigation channel, haphazard land use, unemployment, lack of physical infrastructure, small parcel size, lack of proper market for agriculture production, etc. are reasons to migrate population from rural areas. Land in this areaneeds to be consolidated and restructured. On the other hand, proper irrigation facilities and modern technologies for agriculture should be introduced to enhance agriculture. Along with agricultural reform, village renewal program, proper land use policy and spatial planning with infrastructure development are necessary for rural development.

1.5 Land Use Zoning

In this article, various argument confirms that the social and economic life of the Nepalese people is very closely linked with the land. So in order to uplift the life standard of the Nepalese people, the land should be managed efficiently. For the efficient management of the land, land use zoning is a must. When the land has been differentiated into different zones, planners and decision makers can take the right decision instantly and effectively. Differentiating of zones require various criteria along with different spatial layers. GIS-based multi-criteria analysis would be the effective method to differentiate land into different land use zones(Malczewski 2006). The land use zones determine the land use practices to be followed in the land and the land use practice is governed by the physiographic, soil characteristics, climate, cultural as well as socio-economic factors (Joshi2007).

Although a major portion of the population in Nepal (66%) is involved in agriculture, 3.7 million people are at risk of food insecurity(MoAC & WFP 2011). Due to the ineffective and improper use of land the optimum productivity, as per the land capability and population involved, has not been gained. The well suited available land for agriculture has been encroached by the uncontrolled and unplanned urban settlement. Similarly, the wetlands, forest, and cultural heritage need to be conserved. The National Wetland Policy 2003 has been formulated for the planned conservation, maintenance, and development of country's wetlands. The Ancient Monuments Preservation Act was introduced in 1956 AD for the conservation of the heritages. Also, the urban settlement has been haphazard, degrading the quality of land. The managed and well-planned settlement can reduce the encroachment of agricultural lands.

African chiefs often quote that the land is not only property of living beings alive today but also is a share to thousands still are to born. This statement focuses on the sustainable distribution of land and other natural resources. Development activities on land shall be made sustainable so that ecosystem continues for generations. Proper planning of the land for its optimal utilization is necessary for better future. Thus, in order to save the environment as well as land and its use considering its capability and suitability, land use zoning, a land management tool is essential.

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Spatial Database for Hydropower Projects In Nepal

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1.SUMMARY

Nepal is facing shortage of electric power and having load shedding up to 3-8 hours/ day from many years. Although with the total capacity of generation of 84000 MW hydropower, it has only been able to produce around 800 MW hydropower at the moment and planning to generate 10,000MW in a decade for which detail topographical and other surveys are prerequisite for planning and construction of hydropower project.

Apart from topographical survey, geological, seismic, hydrological, environmental, land acquisition (cadastral) surveys are also necessary to be carried out for a hydropower project. These survey activities are conducted in feasibility and detail project design(DPR) or tender document preparation phases. The accuracy of such survey is much higher than in feasibility phase.

The topographical survey techniques usually involves acquisition of very high resolution imagery, extension of national network control points by DGPS, establishment of control points by precise traverse, leveling, detail survey by field or LiDAR survey method, bathymetric survey, demarking the land to be acquired and identification of land owners, land valuation. Geological, hydrological, environmental and seismic surveys spatial data are also linked to topographical survey data as spatial data base of the project.

This article briefly describes the method of preparation of spatial data base and their contents for hydro power project in Nepal.

2.BACKGROUND

Water resource is important natural resources for economic development of a country. Nepal has 2,27% of world resource, 8185Km2 of total water surface area, about 6000 rivers and streamsof total 45,000 km in length and is second richest country in inland water resources. Availabity of aboundant water resource geophysical features provide opputunity for hydropower production in Nepal. Out of total hydropower generation capaciityof about 84,000 MW of power generation in the country about 42,000 MW of power generation is financially and tecnically fasible. Less tha 1% of total potential i,e 800 MW is developed till now. Government of Nepal has top priority on hydropower generation. The demand of electricity is projected for National Planning Commission; Nepal is shown in the following chart No.1.

The policy of Government of Nepal is expidite the generation electricity 10,000 MW in this decade through public and private efforts . In the couse of licensing hrdropower projects for survey or development for generation,transmission and distributionof electricity, the quality, volume and depth of study are needed to have same standard quality and fulfill the requirement, Department of Electricity Developmen has issued “Guidelines for Study of Hydropwer Projects” in 2003 which provides the formats and specific details for reconnaissance, prefeasibility and feasibility studies and detail project report(DPR)/ tender docunt preparation is also prepared for each specific project. They also include the detail topographical, geological and other surveys which are prerequisite for planning and construction of hydropower project.

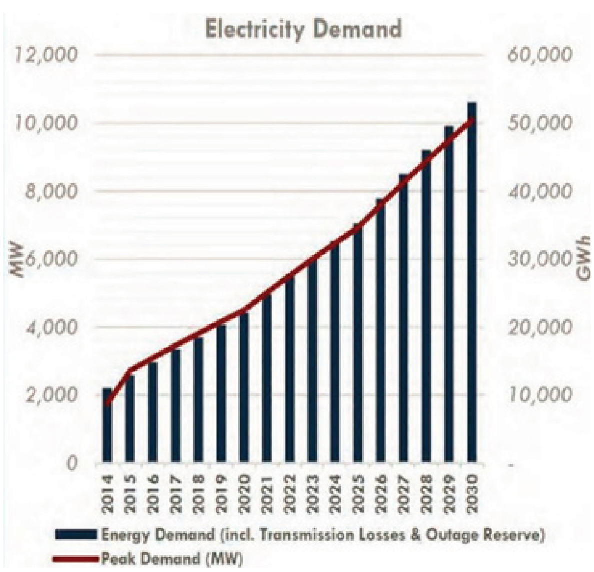

Chart No.1: Electricity demand forcaste

3.STATUS OF MAPPING IN NEPAL

Topographical map coverage of Nepal is available at the scale of 1:25,000-1:50,000 with the assistace of Government of Finland. The 3rd order trigonometrical control points at about 5km interval and precise level at an interval of 2km along the main highways are also exist. Cadastral survey of private land was carried out at the scale of 1:500- 1: 4800 of the country was carried out from 1964 to 1998 and is updated daily by local offices as and when trasanction and mutation of parcels occour. Land resources maps – Land utilisation, land system and land cability maps were produced at the scale of 1:50,000 and geology maps were produced at the scale of 1:125,000 and climatic maps were produced at the scale of 1:250,000 -1:2000,000 with the assistace of Government of canada.

Land resources maps are being compiled at the scale of 1:10,000. It is expected the tarai area about about 25% of Nepal will be completed in this year 2017. The large scale topographical mapping of urban areas is taking place at the scale of 1:5, 000 with very slow rate and most of the new town are without maps. Re cadastral survey is progressing slowly.

4.SURVEY AND MAPPING REQUIREMENT FOR FEASIBILITY AND DPR

The hydropower project area of dam site, reservoir and power house areas are surveyed at the scale of 1:500 -1:2000 and Tunnel axis at the scale of 1:2,500-1:5,000. Bathymetric survey/ cross section survey is carried out using total station at 20-50m interval using rope across the river/stream. The accuracy of establishment of ground control points atfeasibility stage is better than 1: 10,000 and DPR stage is about 1: 100,000 and positions of details and spot heights are also more accurately surveyed at DDPR stage. Elevation control points are established by levelling. Generally detail survey is done using total station over the station established on ground control stations opposite side of bank and some time using recflectorless method. However, reflectorless gives poorer result in heighting.

Geological survey is divided into regional, specific areas and engineering geological maps. General geological maps prepared at the scale of 1:25,000 of entire area, geological maps of sites are prepared at the scale of 1:500 -1:2,000 of damsite and power house areas, and engineering geological maps prepared at the scale of 1:5,000 of the area. Sciesmic refraction survey is carried out to locate the position of sciesmic points/ phones accurately and referenced to the topographical survey. The recent sattellite imagery and stereo photography are also used for interprtation of geological features in regional scale.

Water volume is calculated from the levelling survey data at least three cross sections on straight sections of river.

Evironmental study is carried out at about1;5,000- 1:10,000 scale using existing topographical base maps and with help of recent sattellite imagery.

Existing cadastral maps and ownership data are used as available in the local offices and project area is transfered to cadastral maps for land aquisition and resettlement purposes by GIS technique.

400 KVA Transmission line survey is carried out by strip mapping of 100m either side of transmission line with establishment of positions of angle points by DGPS survey and the strip maps (at the scale 1: 5,000 and profile 1: 500 scale) is usually prepared by total station and supprted by satellite imagery. Geological and environmental feafures are also studied from satellite imagery supported with field visits.

"Guidelines for Study of Hydropwer Projects" Department of Electricity Development 2003 which provides the formats and specific details for reconnaissance, prefeasibility and feasibility studies. Spepecfication for detail project report(DPR)/ tender docunt preparation is also prepared for each specific project, are used as a guidelines.

5. METHODOLOGY OF TOPOGRAPHICAL SURVEY

Topographical base map are prepared on the basis of the points by extending 2nd or 3rd order geodetic networks to the project sites with pair of intervisible ground control points at power house, dam site and reservoir areas by DGPS method. They are further extended by precise traverses for detail mapping as well as future relocation of constructions. Detail mapping is carried out by total station observations and digital base map are produced at required detail and accuracy. Every steps of survey and sample details are checked automatically by observation procedures.

LiDAR survey are also used for multipurpose or large projects. Through, it shows the accuracy of 6-10 cm and reliability of heighting or position may required to check by ground survey methods during implementation.

Topographical surveys are carried out using differential GPS equipment and 'Total Station' and survey work includes desk study, reconnaissance survey, monumentation of control points, obeservation of control points by differential GPS and traversing including horizontal and vertical control and detail topographic survey. .

5.1 Desk Study

Prior to the field survey, desk study are carried out by using existing topographical map of the site (Scale 1:25,000 and 1:10,000) prepared during project feasibility study. Detailed information about the project area, available ground control points and topography of the area for the survey work are noted. Finally all the available layout plans and location maps prepared during the study are collected. Boundary of new survy area is marked on the maps.

5.1.1 Reconnaissance Survey

After finalizing the desk study of the project site and before the detailed survey work, a brief reconnaissance survey are carried out with signalling at necessary points around the entire project area to be mapped. All the signalling points are marked by distinguished enamel paint. The first step of the survey is to fix the control points around the project area with respect to existing control points established by Survey Department and the project during the feasibility study.

5.1,2 Monumentation of Ground Control Points

Before carrying out detailed survey at major structural locations, number of permanent ground control points are established to be connected with main traverse/ trig points. They are made conspicuous in the field with crosses chiseled on permanent boulders. They are also made noticeable in the field by marking with distinguished enamel paint. Description cards of each of the control points are also prepared accordingly.

5.1.3 Establishment of Ground Controls

Topographical base map are prepared on the basis of the points by extending 2nd or 3rd order geodetic control points to the project sites with pair of intervisible ground control points at power house, dam site and reservoir areas by using DGPS method. They are further extended by precise traverse for detail mapping as well as future relocation of constructions. Description Cards, measurement of distance of reference objects and photography of control points are completed in the field.Names of features are cllecte and verified in the field.

5.1.4 Detailed Topographical Survey and Mapping

Detail mapping is carried out by total station observations and digital base map are produced at required detail and accuracy. Basic ground models and 3 dimensional visualizations can be produced from survey information if required. Once generated the model is dimensionally accurate, and can therefore be used for area and volume calculations. Every steps of survey and sample details are checked automatically by observation procedures.

The features of terrain are surveyed by means of total station method from different traverse points. Inaccessible points like rock faces, top of cliff, landslide edge, etc. are sighted using reflector less system or from at least two known points by reading both the horizontal and vertical angles. Features such as riverbanks, high flood level, landslides, cliff, house, cultivated, lands, roads, canal, embankment, boulders, etc., are recorded. The detailed topographical survey of underground Surge tank, penstock and powerhouse structure are carried out at the scale1:500 or 1:1000 with contour interval of 1m Some common points are observed from another station to check the accuracy of detailing.

Field data are checked for completeness, consistency and contour are checked in the field. Required forms are completed while surveyors are in the field.

5.1.5 Data base Preparation and Drafting the Maps

All field data are down loaded at data base table and appropreate code, classification, area, scaling, name, administrave boundary etc are completed. Standard digital data with attribute table is prepared. Features code are symbolized, colour and tints decided and pdf map with proper sheet and colours is prepared from data base for editing and reveiw.

5.2 LiDAR Survey

It is usually done setting up GNSS receivers at two first or second order stations at an interval of 50 km. All permanent BMs of points or near to the BMs are signalized before LiDAR survey and aerial photography mission.

Aerial survey / LiDAR survey conducted using helicopter equiped with intervalometer, GNSS receiver, LiDAR, IMS and photography instruments which shown as as the following picture Fig 1.

LiDAR Survey with GPS in Nepal

LiDAR data are processed, orthophoto generated required details are vectorized and vectors maps are prepared and printed at apropreated scale and contour vertical interval.

This method is usually done larger areas more than 10 sq km. It has problem of having good visibility or cloud/ haze free situation.

LiDAR Survey are also used for multipurpose or large projects. Through, it shows the accuracy of 6-10 cm but reliability in height or position may require to be checked by ground survey methods during implementation.

5.3 Survey and mapping of transmission line

The main objective of the survey is to carry out the survey works to locate the selected angle points and prepare strip maps at the scale of 1:2000 -1:5000 and longitudinal plan and profile of the whole route alignment. The main survey works are as follows:

a. To procure high resolution satellite imagery and prepare Ortho photos

b. To conduct ground control survey of Angle Points connecting trig points and BMs, fix and monument of Angle Points by DGPS survey method

c. To prepare of Route alignment strip map (100m width)at the scale of 1:2000 - 1:5000 using total station

d. To conduct geological and socio economic survey and

6 AVAILABLE TECHNOLOGY

The technology of GNSS and total station are available and used extensively in Nepal. Digital mapping with data base is also used and needed to standarized. LiDAR Survey is also used in some projects. However, lack of required instruments and sufficient manpower at local survey companies or survey offices, this technology is not fully utilsed.

7 ACCURACY

Accuracy of ground control points at reconnaissance, prefeasibility and feasibility is better than 1:10,000 and detail project report(DPR)/ tender docunt preparation is better than 1:100,000 or 3rd order. Accuracy and density of details are also checked and be within the standards governed by the map scale although digital survey are scale free.

8 DATABASE

The data base topographical maps are prepared accordingly and data base of geological, land resources and other data are also prepared and superimposed with topographical database. Details about existing data base for urban mapping and land resouces maps were pesented in the articles as references 2 and 3. There is no clear standards or guideline for data base for study of hydropower project at DPR level is exsiting in Nepal. The following Figure 4 will show the working methodology.

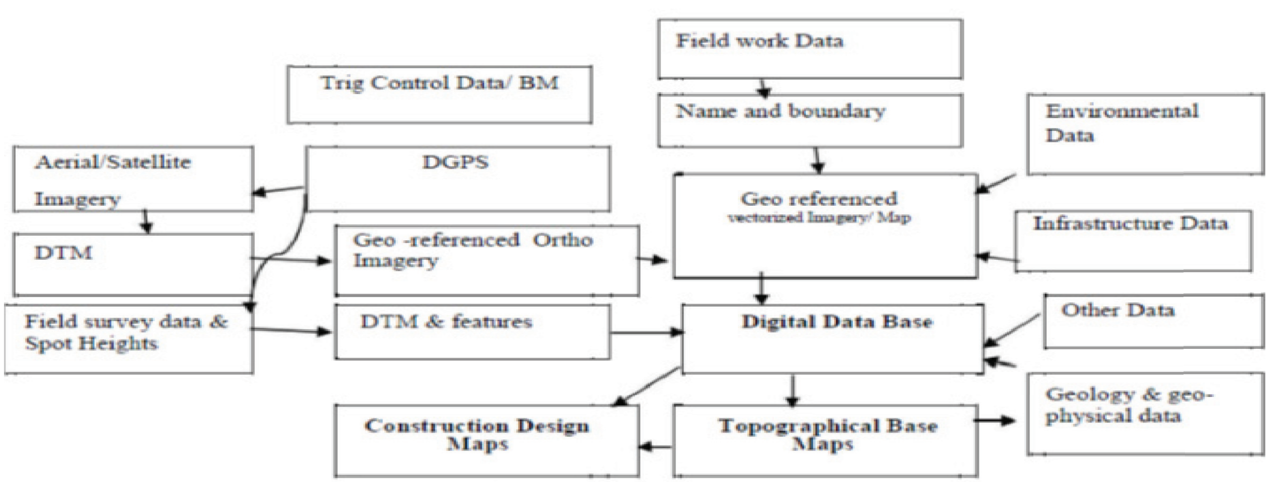

Figure 4: General Methodology

CONCLUSION AND RECCOMENDATION

Many hydropower development projects are in various stages- feasibility, DPR and construction of development in Nepal. The scale of maps, contents and standard symbols or terminology are not uniform. The soil and geological classification are based on the names of localities. It will be difficult corelate to international standards. Therefore, standard classification system of non topographical features are also needed to be developped as international standard level as well as guidelines for spatial data base and requirement studies for DPR/ tender docunt preparation are also in urgent need.

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11 ACKNOWLEDGEMENT

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Using GIS in Hotspots Analysis for Forest Fire Risk Zones Mapping in the Black Hills Region, South Dakota

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South Dakota, also known as prairie and forested ecosystem, has historically seen frequent occurrence of wildlife. The decade of the 1930s, 1939, and the year of 1974 hammered Black Hills with forest fires. The drought in 2012 invited more forest fires in Black Hills. The land cover, slope, elevation, aspects, and proximity from the settlement in the Black Hills make a perfect blend for the forest fires to occur. This study uses the historical fire data from FIRMS:

1) To identify forest fire risk zones from FIRMS fire hotspots reported between 2001 and 2015 in the Black Hills, South Dakota, and

2) To model fire hotspots through Gi(d) statistics to determine how and to what extent commonly known fire factors contribute to fire occurrences.

The study estimates that total 50 fires out of 245 fall under the very high-risk area whereas 140 fires fall under high risk area. 79.18% of the total fire risk area is high risk area. Similarly, 17.9% of the area falls under very high-risk area. Using historical fire data, a correlation between several variables and risk areas was determined. It was observed that 77.55% of historical fires occurred in very high and high-risk areas.

Introduction

As long as fuel, heat, and oxygen are supplied, there are other parameters such as weather (temperature, wind, relative humidity, precipitation), topography (elevation, altitude, slope, aspect), bio-physical features (flora and fauna, soil type and chemistry, proximity to water, population density), and socioeconomic variables (nearby population, roads, etc.) that determine the frequency, rate of spread and severity of wildland fires (Chuvieco and Salas, 1996; Chuvieco and Congalton, 1989; Sunar and Ozkan, 2001; Hernandez-Leal, Arbelo, and Gonzalez-Calvo, 2006).

South Dakota, also known as prairie and forested ecosystem, has historically seen frequent occurrence of wildlife. The decade of the 1930s saw periods of extended drought throughout the region and large fires burned in the central and northern Black Hills and across the state line in Wyoming during that time. In recent years, an increasing focus has been directed towards understanding the impact that human activities have had on the environment. Climate change is causing a fluctuation in frequencies and amount of precipitation, as a result the temperature is rising and so is the risk of forest fires (Cotter, 2009).

The Gi(d) used in this study measures concentration or the lack of weighted points within a radius of a specified distance d from an original weighted point according to Getis and Ord (1992).

The main objectives of this analysis were to:

1) identify forest fire risk zones from FIRMS fire hotspots reported between 2001 and 2015 in the Black Hills, South Dakota, and

2) model fire hotspots through Gi(d) statistics to determine how and to what extent commonly known fire factors contribute to fire occurrences.

Study Area

The Black Hills is an important ecoregion, mostly dominated by ponderosa pines. It covers an area of 210,000 hectares in South Dakota and Wyoming. The region is mostly at higher elevations (Orr, 1959). The climate is characterized as continental, having low precipitation, hot summers, and cold winters (Johnson, 1933). Mean annual temperature is 43.90 F and mean annual precipitation is 18.61 inches (Driscoll, Hamade, and Kenner, 2000). For my study, I selected the portion of Black Hills that lie in South Dakota only (Figure 1).

Data and Methodology

The data for fire is available online in Fire Information for Resource Management Systems (FIRMS) website (https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms). FIRMS distributes Near Real-Time (NRT) active fire data within 3 hours of satellite overpass from both MODerate Resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS). I chose to use MODIS data because these data were available from 2001 to 2015. FIRMS also provides users with near real-time hotspots/fire information through their Web Fire Mapper, email and cell phone text messages. FIRMS provides information on active fires using the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on board NASA's Aqua and Terra satellites (NASA/University of Maryland, 2002).

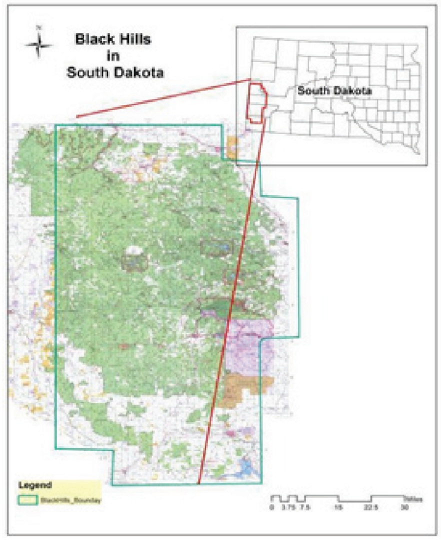


Figure 1: Study Area: Black Hills in South Dakota

The data was delivered through email and was in shapefile format. The file included the following fields: latitude and longitude (center of point location), brightness (brightness temperature measured in Kelvin), scan and track (spatial resolution of the scanned pixel), acqdate (Acquisition date), time (time of the overpass of the satellite), satellite (Terra or Aqua), and confidence (quality flag of the individual hotspot, this is an experimental field) (NASA/University of Maryland, 2002).

The data was then clipped with the South Dakota state boundary layer and Hot Spot analysis was done to see the fire concentration in South Dakota. Fire was mostly concentrated in the Black Hills region and North Central region of South Dakota (Figure 2). Using R interface, the data graphs of the fire occurrence by year for (a) South Dakota, and (b) Black Hills were produced (Figure 3).

Fire detection is based on the absolute recognition of its intensity. If a fire is weak, the detection is based on the emission of surrounding pixels (Justice, Giglio, Korontzi, Owens, Morisette, Roy, Descloitres, Alleaume, Petitcolin, and

Kaufman, 2002).
Forest Fires in the Black Hills Region The data from 2001 to
2015 shows that there were huge number of fires in 2012. The total number of fires were 245, which is 12.23% of total fire (2002) occurred in 15 years. The fires mostly occurred in the month of July. A total number of 151 fires occurred in July which is
61.63% of total fires that occurred in the year.

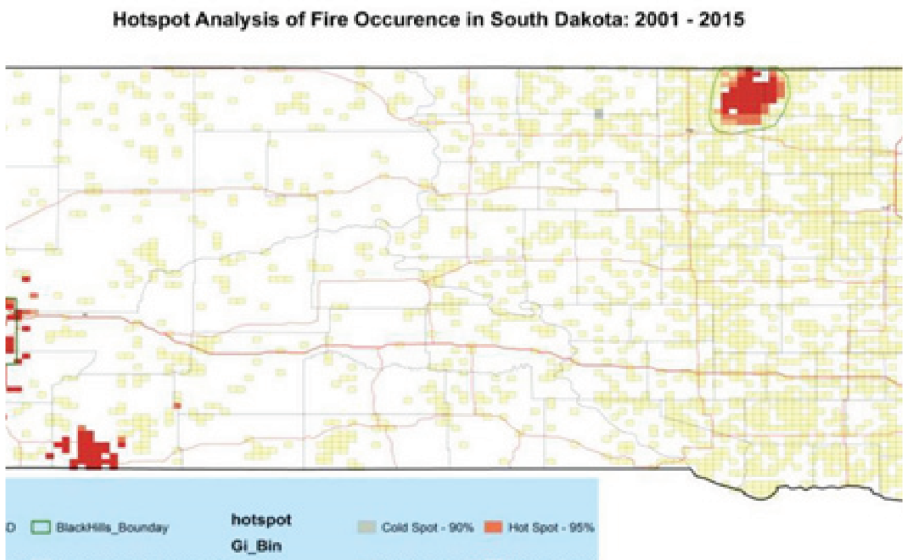


Figure 2: Hotspot Analysis of Fire Occurrence in South Dakota: 2001-2015. The fire data obtained from FIRMS were clipped with the South Dakota state boundary layer and Hot Spot analysis was done to see the fire concentration in South Dakota. Fire was mostly concentrated in the Black Hills region and North Central region of South Dakota. The Black Hills region is mostly dominated by forests while the north central region is dominated by agricultural and grass land.

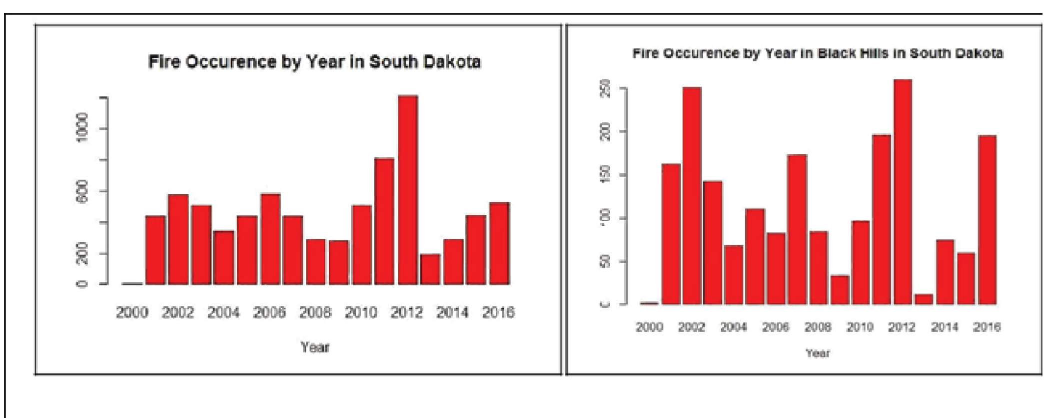


Figure 3: Fire occurrence by year (left) in South Dakota, and (right) in Black Hills region.

By the ArcGIS Kernel Density tool, a fire occurrence density map for the year 2012 in Black Hills (Figure 4) was created.

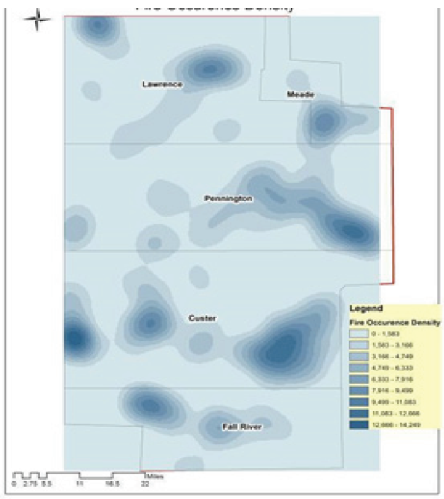


Figure 4: Fire Occurrence Density (fire/km2). The fires were mostly occurring in the Southeast and East central parts of Black Hills.

Human Factor

The two main sources of fire ignition in Black Hills are lightning and human activity (Myers, O'Brien, and Morrison, 2006). Even with lightning fires, which are highly under-reported in many areas, local authorities conclude majority of fire ignition is due to human activity. Human activity may be often difficult to understand due to the vague nature of how precisely fire ignition may begin. Lightning may Chuvieco and Congalton (1989) suggest the type and character of the vegetation is the main factor in determining the manner in which a forest fire might spread. They also suggest that the fuel available for fire is of primary importance (Chuvieco and Congalton 1989). For the purpose of land cover and vegetation, I used National Land Cover Database 2011 (NLCD 2011). The data is available online (https://www.mrlc.gov/nlcd2011.php). It is the most recent national land cover product created by the Multi-Resolution Land Characteristics (MRLC) Consortium. NLCD 2011 provides the capability to assess wall-to-wall, spatially explicit, national land cover changes and trends across the United States from 2001 to 2011. It has 16-class land cover classification scheme at a spatial resolution of 30 meters. NLCD 2011 is based primarily on a decision-tree classification of circa 2011 Landsat satellite data.

NLCD data layer has 95 different classes.

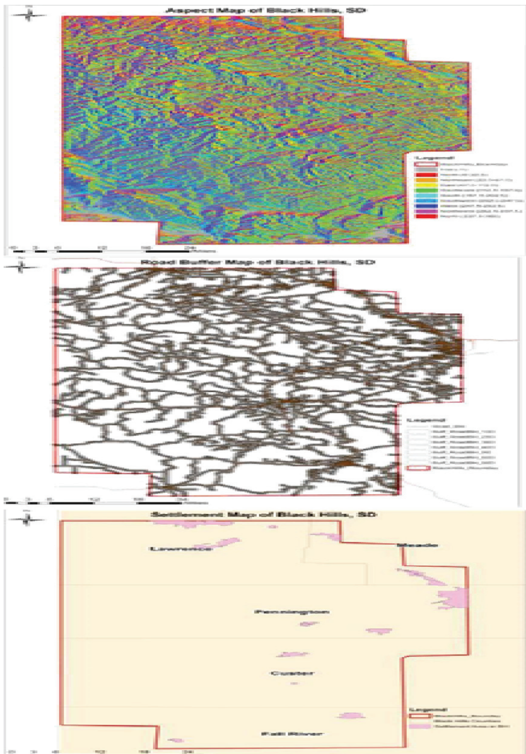
These classes were reclassified into 6 major groups:

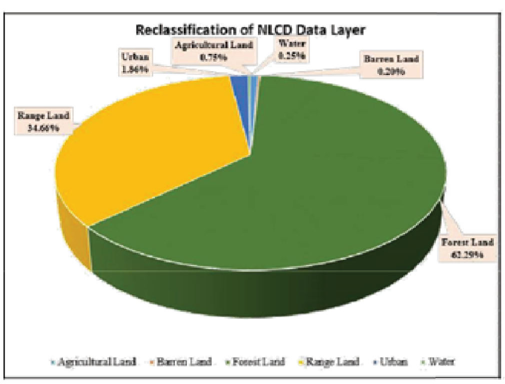
(1) Agriculture Land, (2) Barren Land, (3) Forest Land, (4) Range Land, (5) Urban or Built-up Land, and (6) Water. The reclassification of NLCD layers was done using modeling procedure in ArcGIS. A glimpse of reclassification is given in table 1.
From the resulting analysis, 62.29% of the study area was forest land, 34.66% rangeland, 0.75% agricultural land, 0.20% barren land, 1.86% urban or built up land and 0.25% water (Figure 5a). Land cover is summarized in pie chart 1.

Topographic Data

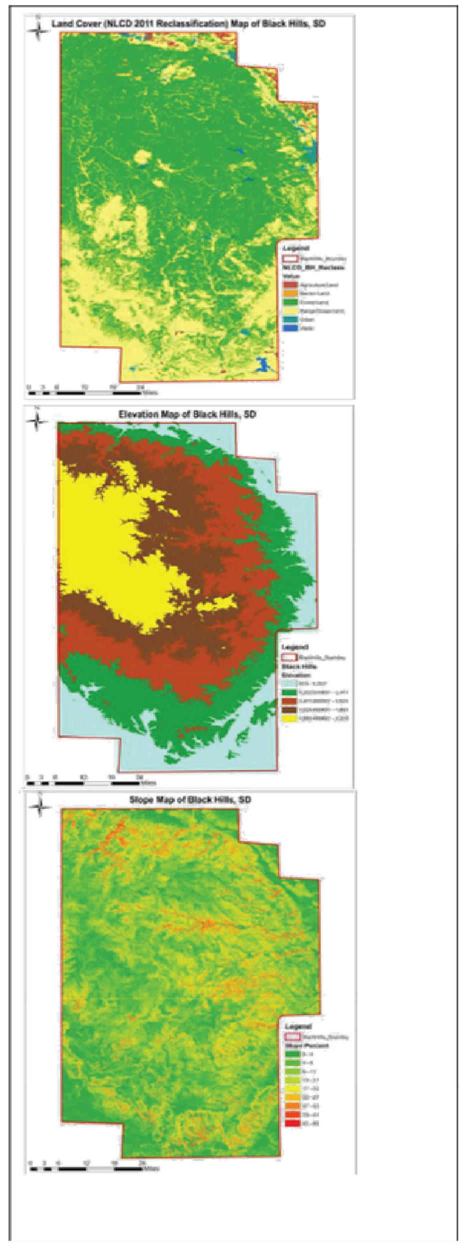
A main factor in any risk analysis is the topography with slope being a critical factor. Fire travels up slope faster than down (Chuvieco and Congalton, 1989; Jaiswal et al., 2002).

For this study, the Digital Elevation Model (DEM) data (Quad 1:24,000, topographic map sheet from USGS (30m x 30m cell size; heights in meters) was used to determine slope and aspects of the study area (Figures 5b, 5c, and 5d). Distance to Roads and Settlements Identifying distance to roads in the area can be useful in locating possible paths used for fire suppression as well as identifying risk areas where a high level of human activity might occur (Chuvieco and Congalton, 1989). For this study, multiple buffers with 7m intervals were created starting with a 50 m interval and then 100 m intervals thereafter (Figures 5e and 5f).





Pie-Chart 1: Summary of the land cover in Black Hills, SD. 62.29% of the study area was forest land, 34.66% rangeland, 0.75% agricultural land, 0.20% barren land, 1.86% urban or built up land and 0.25% water.



Fire Risk Model

Several studies have proposed the integration of variables into a single fire model (Chuvieco and Congalton, 1989; Hernandez et al., 2006; Carrão et al., 2003; and Jaiswal et al., 2002). This study integrates six layers of information: slope, vegetation, aspect, distance from roads, distance to settlements, and elevation.

Chuvieco and Congalton (1989) suggest a hierarchical scheme of fire rating (Table 2) which was followed in this study. Layers of importance from highest to lowest were as follows: land cover, vegetation, slope, aspect, proximity to roads, proximity to settlements and elevation (Chuvieco and Congalton,1989).

The fire risk model can be summarized in the following equation:

$$FH = 1 + 48LC + 30S + 10A + 5R + 5Sm + 2E$$

Where LC, S, A, R, Sm, and E are land cover, slope, aspect, roads, settlements and elevation respectively.

Fire risk modeling involved several steps. First layers were weighted depending on the risk they represented. Land cover was weighted the highest, followed by slope, aspect, distance to roads, settlements, and elevation. Every layer was assigned a coefficient starting with 0, 1, 2, etc. with 0 being the highest hazard.

Land cover was evaluated first as an estimate of fuel available for a fire. Weighting of the classes in the land cover layer were determined by the moisture; the dryer the vegetation, the higher the risk of flammability (Figure 6a).

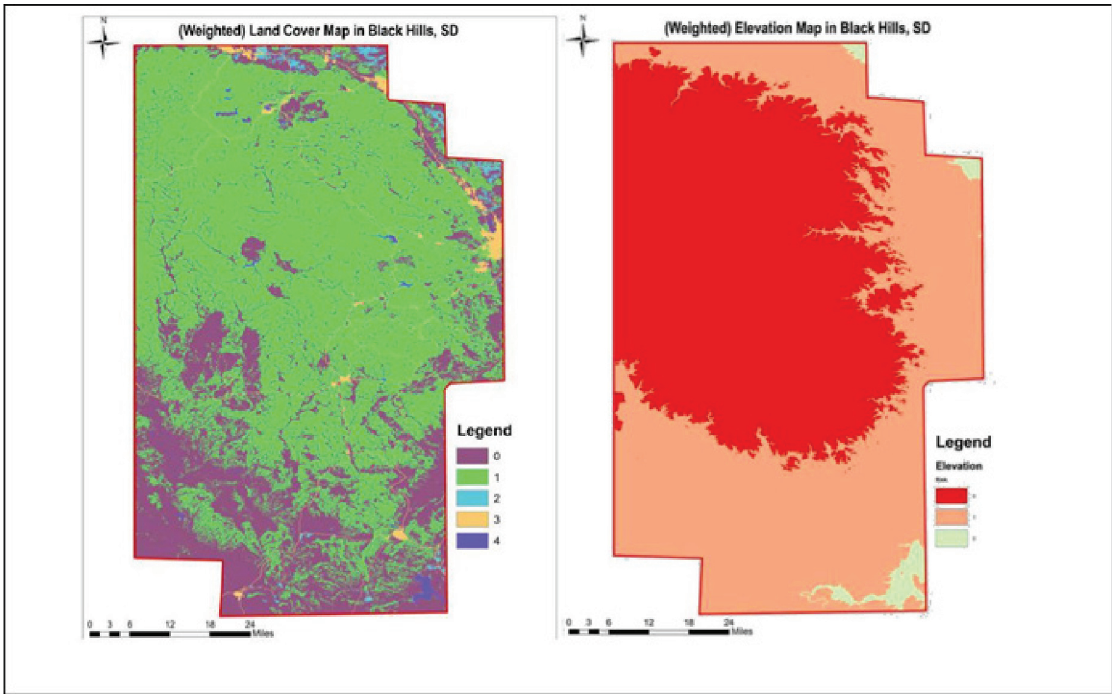
Aspect was the second factor to be evaluated. It was divided into seven categories. South and southwest aspects were given the highest weight due to a higher insolation. Southeast and the east were weighted as medium risk, while north, northeast, and northwest were weighted as low risk (Figure 6c).

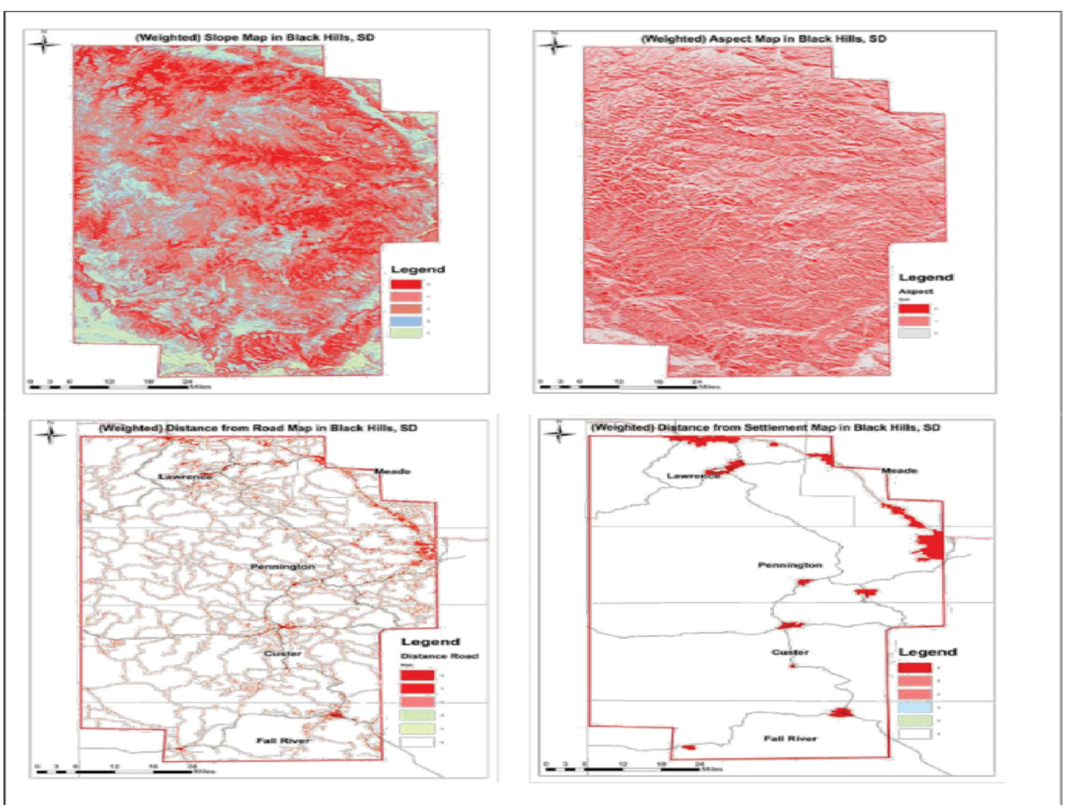
Slope was the third factor to be evaluated. Weighting was determined by the fact fire travels more rapidly in up slope. Slope layer was divided into five groups: greater than 35% (very high hazard), between 35% and 25% (high), between 25% and 10% (medium), between 10% and 5% (low), under 5% (very low) (Figure 6c).

Proximity to settlements had a similar weighting as the distance from roads. Proximity was divided into five groups. Areas less 1000 meters at very high risk, 1000 and 2000 at high, 2000 and 3000 at medium, and areas at a distance greater than 3000 meters at low risk (Figure 6f).

The distance from roads was evaluated since nearby areas have a higher risk of a fire. The buffer layer was divided into six groups. The areas within a
distance of less than 100 meters were noted at very high risk, between 100 and 200 meters was assigned high risk, between 200 and 300 meters was noted medium risk, between 300 and 400 was assigned low risk and areas with a distance greater than 400 meters were identified at very low risk (Figure 6e)
The last layer evaluated was elevation.

This layer was divided into four categories. Areas with an elevation greater than 1,500 meters were considered at very high-risk and areas less than 500 meters were considered having low risk (Figure 6b).





Classes	Coeff	Fire Rating
Land cover (weight 100)		
Rangeland (Scrub/ Shrubs)	0	Very high
Forest Land	1	High
Agricultural Land	2	Medium
Urban or Built-up Land	3	Low
Barren Land and Water	4	Very Low
Slope (weight 30)		
> 35 %	0	Very high
35 – 25 %	1	High
25 – 10 %	2	Medium
10 – 5 %	3	Low
< 5 %	4	Very Low
Elevation (weight 2)		
> 1501	0	Very high
1001 - 1500	1	High
501 - 1000	2	Medium
< 500	3	Low
Aspect (weight 10)		
South	0	High
Southwest	0	High
Southeast	1	Medium
East	1	Medium
North	2	Low
Northeast	2	Low
Northwest	2	Low
Distance from roads (weight 5)		
<50	0	Very high
50 - 100 m	1	Very High
100 – 200 m	2	High
200 – 300 m	3	Medium
300 – 400 m	4	Low
Distance to settlements (weight 5)		
<500 m	0	Very high
500 - 1000m	1	High
1000 – 2000 m	2	High
2000 – 3000 m	3	Medium
> 3000 m	4	Low

Hotspot Analysis

Another objective of this project was to determine how and to what extent commonly known fire factors contribute to fire occurrences. This was examined using the Spatial Statistics Hot Spot analysis tool from ArcGIS which uses the Getis-Ord Gi* algorithm (Figure 7).

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\left[n\sum \quad -\left(\sum \quad \right)^2\right]}} \quad (1)$$

Figure 7: Getis-Ord Gi* (ESRI, 2009)

According to Getis and Ord, the Gi * statistic is used to measure the degree of association from a concentration of weighted points (Getis, and Ord, 1992). Greater Gi* values indicate significant spatial clustering with values >2 (Potter, 2009). A total weighted field calculated from the six layers used in the fire risk model was added to the total fire risk data. This new field was used as the input for the hotspot analysis.

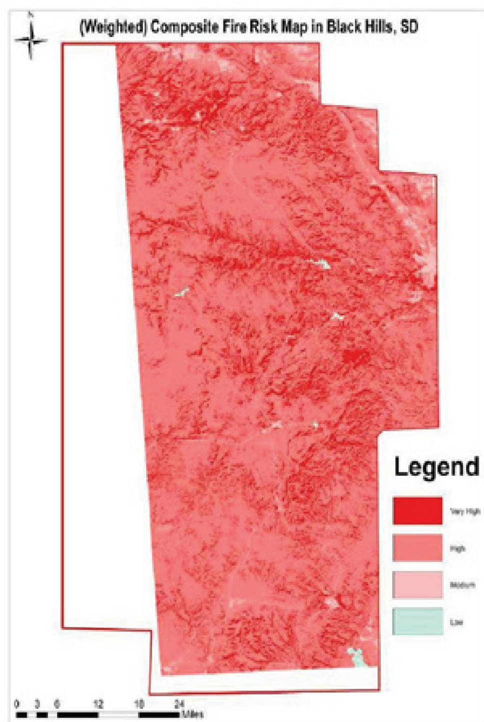
Results

Figure 8 estimates the High-risk area in Blacks Hill, SD. Total 50 fires out of 245 fall under the very high-risk area whereas 140 fires fall under high-risk area. 79.18% of the total fire risk area is high-risk area. Similarly, 17.9% of the area falls under very high-risk area (Figure 9). But, the medium and low risk area were nominal. The area included in the fire risk analysis included range land, forest land and agricultural la nd. The area that fall under very high and high-risk were mostly forest area.

Conclusion

In this study GIS was used to integrate varying layers of data for use in forest fire risk modeling. Additionally, NLCD and other remotely sensed imageries (data) were used to analyze the Forest Fire Risk Zone in Black Hills region.

Using historical fire data, a correlation between several variables and risk areas was determined. It was observed that 77.55% of historical fires occurred in very high and high-risk areas.



OBJECTID *	Value	Count	RiskArea
1	1	116732	259605.8
2	2	514919	1145152
3	3	169005	37585.78
4	4	17389	3867.218

Recommendation

It will be interesting to look at the Fore Fire Risk Zone at the North Central South Dakota where 107 fires occurred in the 2012 which is 9% of total fires that occurred in entire South Dakota. The area is agriculture and grassland dominated, therefore it could have a different result than the Black Hills region because Black Hills is forest dominated area. Using the weather parameters such as temperature, precipitation, and relative humidity could give a different result in the same study area in the same study period. Additionally, it could be interesting to look at the total area burnt versus land cover versus topography. The data used for the study is only the number of fire occurrences in the study area in 2012.

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Use of GIS and Remote Sensing in Present Land Use Classification

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Shree R S Engineering Solution Pvt. Ltd.

National Land use Survey Project/GoN initiated to prepare the VDC Level Land Resource Maps (Present Land Use Map, Soil Map, Land Capability Map, Land Use Zoning Map, VDC Profile for Land Use Zoning and Superimpose of Cadastral Layers), Land use Database and Reports to minimize the ratio amongst the different land use sectors for maintaining the balanced land use from the point of view of population, environment and sustainable development; and classify the land for agriculture, forest, pasture, settlement, urban development, industrial, Residential, and Public areas, and prepare profile for Village Development Committees/municipalities level and to superimpose cadastral map.
To accomplish the objectives, the NLUP prescribed classifications scheme for the present land use map was employed. On the basis of the classification, 11 categories land use system was instituted that are Agriculture, Residential Commercial, Industrial, Forest, Public use, Mine and Minerals, Cultural and Archaeological, Riverine and Lake Area, Excavation Area, and Others. Similarly, 6 hierarchies for agriculture, 4 hierarchies for residential, Commercial; 2 hierarchies for Industrial; 7 hierarchies for forest; 3 hierarchies for Public Use Area; 3 hierarchies Public Use Area; 5 hierarchies for Mine and Minerals Area; 2 hierarchies for Cultural and Archaeological; 2 hierarchies for Riverine and Lake Area; 3 hierarchies for Excavation Area; and 3 hierarchies for Other Lands.

1. Introduction:

Land use planning is the systematic assessment of the land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the land use options (FAO, 1993). The proper utilization of land based on the land system and type has not been practiced so effectively in Nepal. Due to modernization and the rapid building construction, either for the residential or the commercial purpose, the land is becoming a scarce resource. Being agricultural country, about 60% of the active population in Nepal is depending on the agriculture and other related activities such as forestry and pasture. The insufficient production of food has led to the increasing demand of the arable land. Except sporadic attempts for the urban areas (GoN, 2002), Nepal has not practiced land use planning for the country as a whole, although attempts were made for balanced use of country's existing natural resources in the past through different policies and national planning efforts. The Ninth and Tenth Five Year plans (2002/03 - 2006/07) of Nepal highlighted on the formulation and implementation of land use policy to discourage to use arable land for non-agricultural purposes. With the purpose of addressing the issues of food security, land degradation, forest and wild life protection, hazard migration, and physical development, the Government of Nepal felt the necessity of comprehensive local level (village or municipality level) land use planning. Therefore, National Land Use Project (NLUP) initiated its work to update existing land resources maps, to prepare land zoning data and to prepare profile of district level and to create land use data, to prepare land zoning data, to prepare profile for Village Development Committees/municipalities level and to superimpose cadastral map.

2. Present Land Use Classification

2.1 Classification System and criteria

No ideal classification of land use and land cover exists and also it is not so likely for one could ever develop. The perspective for the classification process is different and the process itself tends to be subjective, even when an objective numerical approach is used. While attempting to develop classification system for use with remote sensing techniques that provides a framework to satisfy the needs of the majority of the users, certain guidelines of criteria for evaluation must first be established. Classification systems come in two basic formats, hierarchical and non-hierarchical. Most systems are hierarchically structured because such a classification offers more consistency owing to its ability to accommodate different levels of information, starting with structured broad-level classes, which allow further systematic subdivision into more detailed sub-classes. As prescribed by National Land Use Planning specification, the classification scheme for the present land use is:

Table 2 1: Land Use Class Category

S.N.	Land Use (Level 1)
1.	Agriculture
2.	Residential
3.	Commercial
4.	Industrial
5.	Forest
6.	Public use
7.	Mine and Minerals
8.	Cultural and Archaeological
9.	Riverine and Lake Area
10.	Excavation Area
11.	Others

2.2 Methodology

For the land use classification, the primary data source is high resolution satellite image. The satellite image is initially required to be ortho-rectified. Minimum of 6 Ground Control Points are required in a tile for the purpose of ortho-rectification. The sufficient number of GCPs are required to get the geometrically correct image and to improve RMS error. The 3rd order polynomial transformation is selected during ortho-rectification. After the ortho-rectification, the land use classification is carried out based on the visual interpretation of the satellite image aided by the field observation and other reference maps. The common visual interpretation technique during the land use classification can be tone, texture, colour, pattern, form, shadow, association, etc. The technique is mostly preferred in case of classification of the high resolution satellite image, and by the experienced users, so that they can have more control on the classification purpose. With high resolution remote sensing data and ground trothing allows the analyst to extract information about cover (physical dimension) and the use (functional dimension) of the land. Interpretation keys such as tone, colour, shape, size, pattern, texture, shape, association are applied for predicting land use and land cover types while using both true and infrared colour composite images. The common image enhancement technique applied are contrast enhancement, intensity-Hue-Saturation processing, de-correlation stretching and colour composite.

It is to be noted that a wide range classification options are developed, which include spectral-based, object-oriented, and other advanced classification methods. Jensen (2005) argued that spectral-based classifications are often not capable of extracting information at high spatial resolutions. Nevertheless, it has been observed that current object-oriented classification (OOC) is still incapable of effectively utilizing the information within High Resolution (HR) satellite images (Zhang, 2008). Given such options, the visual classification approach based on experience, familiarity of the study area and skill of analyst offer advantage over classification.

2.3 Accuracy Assessment

Accuracy assessment is done with the purpose for the evaluation of the classification performance and usefulness of the image classification. This assessment helps show the degree of correctness of a map or classification in comparison to the actual ground features. After the generation of confusion matrix, the class specific producer's accuracy and user's accuracy, overall accuracy and Kappa coefficient are subsequently computed. The producer's accuracy relates to the probability that a reference sample is correctly mapped and measures the errors of omission, whereas the user's accuracy indicates the probability that a sample from land cover map actually matches what it is from the reference data and measures the error of commission.

2.4 Results (Present Land Use of Kechana VDC)

Study Area:

Southern part of Jhapa District, Kechana VDC, is flat land with tropical climate. Pathariya VDC to the north, Kishangana, Bihar India in south, east and west of the VDC are the border shared by Kechana VDC. Total area covered by this VDC is 1589.67 ha with maximum east-west extend 4.77 km and north-south extend 4.44 km. This VDC is extended from 87˚59'36.13'' to 88˚2'13.79''E to 26˚24'133.74'' S.

Land Use Pattern:

Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (Chaudhary & Jansen, 1999). A total of 7 land use classes coverage is identified on this VDC. According to the present land use classification of this VDC it is found that agriculture covers maximum area (93.458%) which is then followed by residential (1.72%), and public use (1.72%). Public land use is referred as the area covered by school, college, hostel, pilgrimage, funeral sites, well, Chautari, parks, Bus Park, airport, and also the area declared by the government as public use area. The present land use table and figures is shown below:

Table 2 2: Present Land Use of Kechana VDC

S.NO.	Land Use	Area	Percentage
1	Agricultural	1484.578	93.39
2	Residential	42.602	2.68
3	Commercial	0.102	0.01
4	Public Services	19.610	1.23
5	Others	1.060	0.07
6	Cultural and Archeological	0.010	0.00
7	Riverine and Lake area	41.711	2.62
Grand Total		**1589.672**	**100.00**

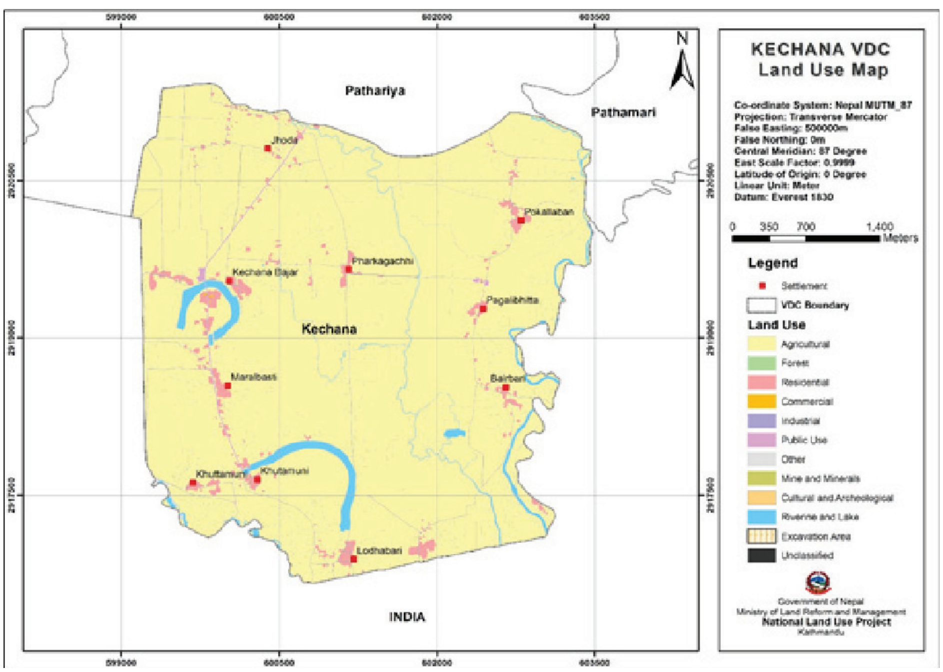

Figure 1: Present Land Use Map of Kechana VDC

Land Use GIS Database

According to NLUP specification, GIS database of present land use will be prepared. The database has the field and data type as below:

Field	Data Type	Description	Remarks
FID	Feature Id	Feature	FID
SHAPE	Geometry	Geometric Object type	SHAPE
ID	Long	Unique Object ID	ID
LEVEL 1	String	Land Use Class	LEVEL 1
LEVEL 2	String	Land Use Class	LEVEL 2
LEVEL 3	String	Land Use Class	LEVEL 3
LEVEL 4	String	Land Use Class	LEVEL 4
LEVEL 5	String	Land Use Class	LEVEL 5
LEVEL 6	String	Land Use Class	LEVEL 6
AREA	Double	Area in m2	AREA
AREA_HA	Double	Area in Hectare	AREA_HA

Table 2 3: Database for Present Land Use

2.5 Conclusion and Recommendations

The present land use has for this VDC has been prepared after the field visit of the project area with the reference of the satellite image, matching the major land usage in field as well as on image followed by visual classification of the image during the pre-field visit. The object identification during the presentation of present land use map would be much enhanced if the higher resolution panchromatic image is used together with multispectral image. The land use condition is dynamic and hence changes rapidly. Thus it is necessary to update the land use map time and again so that it will be useful and relevant for planning in various sectors like agriculture, forestry, etc. Similarly, the public awareness towards the sustainable utilization of land resource is need to be done, which can be achieved through displaying the land use maps of various time interval and explaining its impact in the present and future.

Advertorial

SURVEY DEPARTMENT

NATIONAL MAPPING ORGANIZATION

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

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

Available Maps and Data

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

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