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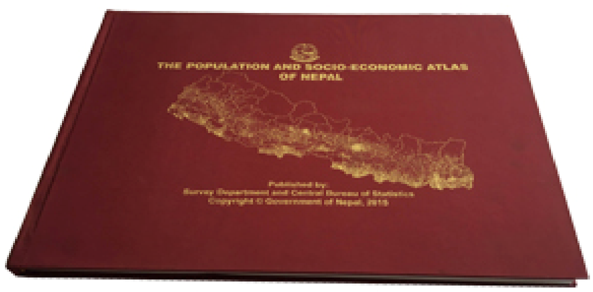

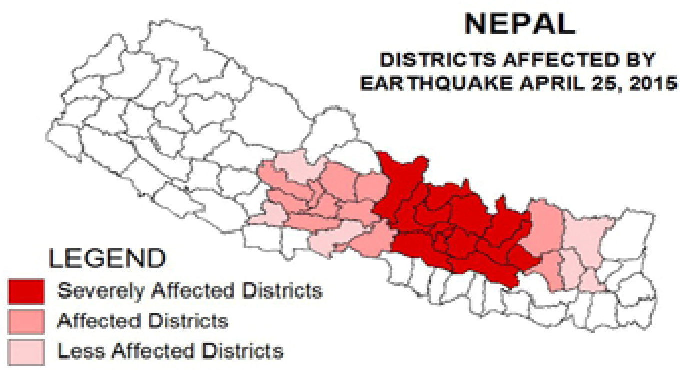

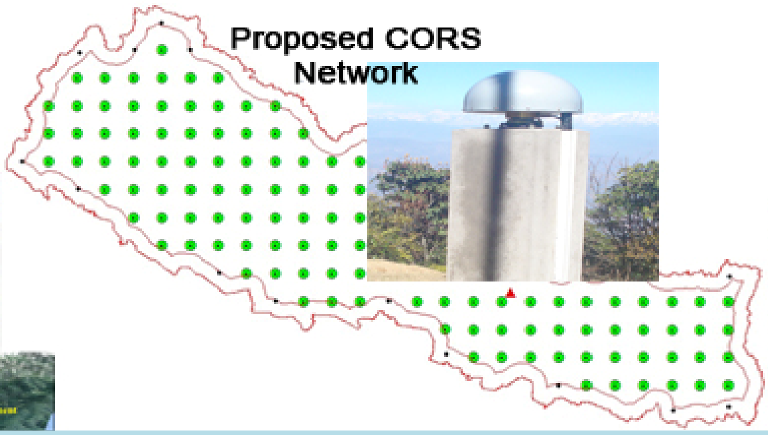

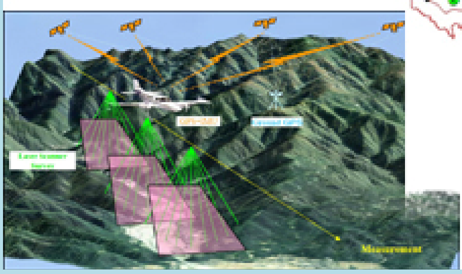

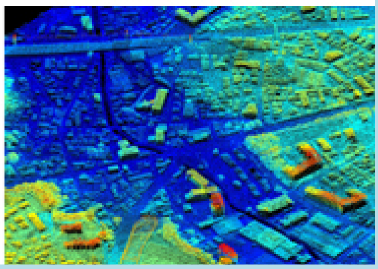

Annual Publication of Survey Department, Government of Nepal

Former Director General Mr. Madhusudan Adhikari and Chief Survey Officer Mr. Anil Marasini participating in the observation tour organized by Earth Observation of Singapore during August 10 – 13, 2015.

Participants of the
2nd meeting of Nepal-India Boundary Working Group,
Dehra Dun, India, August 24-26, 2015

Third Survey Officials' Committee (SOC) Meeting on Nepal – India Boundary, Dehra Dun, India,
October 06 - 08, 2015.

Participants of "Master in Security, Development and Peace Studies (MSDPS)" from APF at Survey Department after lectures on Border Security held at Survey Department, December 21 - 22, 2015.

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Cover Page

The Population and Socio-Economic Atlas of Nepal prepared by Survey Department and Central Bureau of Statistics; Districts affected by Earthquake of April 25, 201; Planned CORS Network.
Illustration of LiDAR Technology (Source: Geospatial Systems Pvt. Ltd.\ Nakanihon Air Service Co. Ltd.)

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Advisory Council

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Editorial

Government or public departments can't achieve their goal without a good team of competitive and ready for action professionals. A team can perform only when its members have adequate academic background, practical skill and experience in related fields. With these academic knowledge and practical skill in mind we may have/develop our future vision to further our profession.

Getting the job done is one of the most important parts of an organization. But, the documentation of what, how, when a job was done is equally important. Study of such documents helps later generation of professionals to save time and effort. In this context, Nepalese Journal on Geoinformatics is an important asset of Survey Department. It has documentation on more than hundred topics including a wide spectrum of different aspects of surveying, mapping and geoinformation.

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

At this point, I am very much thankful to the Survey Department for entrusting me with the responsibility of the Editor-in-Chief for the fifteenth issue of the journal. Following the advice and suggestions of Advisory Council, we, the members of Editorial Board have been able to bring forth the fifteenth issue of the journal.

On behalf of all the members of the Editorial Board, I would like to express sincere thanks to all contributing authors, members of Advisory Council and all others who have contributed for the publication of this issue of the journal. Last but not the least, I feel privileged and honored to work as the Editor-in-Chief.

2073 Jeth,
Kathmandu

Suresh Man Shrestha
Editor-in-Chief

Forewords

This is indeed my immense pleasure to give my preludes on the Nepalese Journal on Geoinformatics, the publication from Survey Department. Survey Department has been making this annual publication since 2002 and the current issue is the fifteenth issue of the series. The Journal is incessantly doing its best efforts to provide a common platform of sharing the professional knowledge, researches and experiences in the field of Geo-spatial Information.

It is the matter of proud to recall the history of the Department and its contribution in the nation building as the National Mapping Agency of the country. Of course, it is continuously doing its best in the field of Topographic & Cadastral mapping, Geodetic activities, Spatial Data Infrastructure (SDI) efforts and boundary mapping as well. It has the glorious history in surveying and mapping which has been passed the way of chain survey to satellite survey.

Recently we are in the phase of technological transformation and we are now trying to adopt digital technology in district level cadastral offices for implementing digital service delivery system. Boundary survey in Nepal-India International Boundary is being done rigorously with the Joint Technical Team from Nepal and India. Furthermore, as the total Geodetic Network of the country has been disturbed due to devastating Earthquake of April 2015, the Department is initiating its efforts for strengthening the Geodetic Network by establishing the Continuously Operating Reference Stations (CORS) covering the entire country. Moreover, Department is also instigating for the large scale Multi-purpose mapping and Digital terrain Model (DTM) of the country and the initial focus will be given to the 31 earthquake affected Districts. The output will be a high resolution Ortho-photo Image and DTM that will support for many applications like Cadastral, Topographic and Land-Use mapping, Disaster Management and Infrastructure Development activities. For this, Department is coordinating with the stakeholder organizations and approaching with National Reconstruction Authority (NRA). Likewise, Department activities are focused in the rehabilitation of the maps and land records destroyed at the time of conflict, surveying and mapping of the village block areas and improving the quality of service delivery from its District Level Offices. In the modern era of Geo-ICT and increasing the social need and public expectations in Geospatial-technological transformations, the Department is lacking sufficient organizational capacity in terms of technology and resources.

Finally, I would like to express my heartiest thankfulness to the Advisory Council and Editorial Board of the Journal for their outstanding efforts to bring out this issue. Similarly, I would like to thank all the authors of the paper for their valuable professional contribution by providing the article which definitely affords a lot of knowledge, experiences and information to the readers. I am expecting such kind of professional support and contributions in the upcoming issues too.

Enjoy Reading!
Thank You!!

2073 Jeth,
Kathmandu

Krishna Raj B.C
Director General,
Survey Department.

A SECURE SERVICE ORIENTED ARCHITECTURE BASED MOBILE SDI MODEL FOR MINERAL RESOURCES MANAGEMENT IN INDIA

Rabindra K. Barik, Arun B. Samaddar, Shefalika G. Samaddar

Keywords: Mineral Resources, SDI, SOA, Mobile GIS, UML

Abstract: *Economic growth rate of any country largely depends on the development of mineral sector. Then, the level of technology employed for meeting the extraction conditions must meet environmental norms. Exploration of mineral resources in India and mining is a ready application for technologies for ensuring productivity and efficiency. Use of Geographical Information System (GIS) in mineral resources management is of great help, where each stakeholder can access, use and exchange spatial and non-spatial data for social, economic and environmental activities. With development of communication and information technology, integration of heterogeneous repository of data from the different data sources can be achieved by using Spatial Data Infrastructure (SDI). At the present scenario, the dynamic updating of data, data analysis, data visualisation and data uploading are lacking in most of the information system in GIS environment. For real time integrated mineral resources information monitoring, it is essential to integrate information system with geospatial database. Visualisation of integrated mineral resources information is possible on the desktop environment with the help of GIS. But it is not sufficient for updating the data in dynamic environment. It may be possible to perform dynamic tasks like update, analysis and visualisation of mineral resources information through the mobile devices with the modern high end mobile communication infrastructure. It makes it possible and very useful to take the decision at anytime from anywhere in the world. The data repositories can also be timely updated with the help of common mobile devices from any location, of course with security measure in place. In the present work, a three tier secure framework has been proposed for the mobile based SDI Model for the better management of mineral resources information infrastructure with the use of mobile devices by the integration of geospatial database. The interaction between the various services in the proposed Model has been modeled by using Unified Modeling Language (UML) use case and activity diagrams.*

1 INTRODUCTION

Mineral Resource exploration is an important economic activity, which contributes significantly to the economy of India. The Country exports a variety of minerals which are in abundance its geographically diverse regions. On the other hand, in long run, mineral resources are limited, precious and non-renewable. Mining sector is facing an increased challenge on account of globalisation and the level of technology employed and the environmental norms, thereby necessitating new initiatives for meeting the new challenges of cost-effective extraction, which require proper management and standardisation. The standardisation and scientific management not only provide the efficient use and exploitation of mineral resources but also relates to social sustainable development (Samaddar et al., 2010). There is a need to make coordinated efforts to encourage greater investment in exploration and mining as well to integrate modern technologies like GIS, Remote Sensing and GPS to increase the productivity and efficiency of mining sector. That leads to establish a well organised Mineral Resources Information Infrastructure with the help of GIS technology in India (Paul and Das, 2006).

GIS has wider applications in decision making, storage of various kinds of data, bringing data and maps to a common scale to meet users' need, superimposing, querying and analysing the large amount of data and designing and presenting final maps and reports to administrator and planner (Broueckner and Orasa, 2008). GIS can deal with large amount of spatial data at different scales as well as non-spatial data for deriving useful information in maps/ tabular form.

With the integration of web technology with GIS, it gives rich functionalities in terms of spatial data sharing on the Web. It can provide a real time and dynamic way to represent information through maps on the Web. So there is a need to establish a well organised Spatial Data Infrastructure (SDI) which is a portal where each stakeholder can access, use and exchange spatial data for social, economic and environmental application.

Geospatial Web Service is one of the key technologies required for development and implementation of SDI. Design and implementation of SDI is used with Service Oriented Architecture (SOA) which may be used for sharing mineral resources information on the Web enabling the investors to quickly look into the problems and prospects of investment in mineral resources exploitation in India (Alesheikh et al., 2002).

With the addition of mobile communication technology, GIS has wider applications in decision making, storage of various kinds of data, bringing data and maps to a common scale for user need, superimposing, querying and analysing the large amount of data, and designing and presenting final maps and reports to the administrators and planners. GIS technology deals with the large amount of spatial data and non-spatial data for deriving useful information on maps as well as tabular forms for better understanding of development of information infrastructure required for offering web services in mining sector (Barik et al., 2009).

2 MINERAL RESOURCES INFORMATION MANAGEMENT: INDIAN SCENARIO

India is endowed with significant mineral resources. It normally produces 89 minerals out of which 4 are fuel minerals, 11 metallic, 52 non-metallic and 22 minor minerals. The entire metallic production is accounted for by iron-ore, copper-ore, Chromite and/or zinc concentrates, gold, manganese ore, Bauxite, lead concentrates, and silver. Amongst the non-metallic minerals, 92 percent of the aggregate value is shared by limestone, Magnesite, Dolomite, Barytes, Kaolin, Gypsum, Apatite & Phosphorite, Steatite and Fluorite.

The public sectors contributes over 88 percent of the total value of mineral production. Public sector enterprises like the National Mineral Development Corporation, Kudremukh Iron Ore Company, Steel Authority of India Limited and Orissa Mining Corporation dominate the iron ore sector. Two public sector enterprises - National Aluminum Company and Bharat Aluminum Company, account for over 66 percent of aluminum production in India. Hindustan Copper Limited predominates the copper ore mining sector, zinc-lead ore mining and processing is dominated by Hindustan Zinc Limited. Bharat Gold Mines, a public enterprises of the Government of India and Hutti Gold Mines Limited (a Government of Karnataka undertaking), are engaged in the mining of gold. Rajasthan State Mines and Minerals Limited and Andhra Pradesh Mining Development Corporation predominate the mining of rock Phosphate and Barytes respectively (Internet-1, 2015).

However, the information so far available from bulletins of different agencies, or at some specific websites, are not comprehensive or easily available. For exploitation of mineral resources however, it is important to have a better understanding and perception of the geographical location, production, user base, port and transport facilities, electricity, skill manpower, availability of experts and various agencies etc. This may be well achieved through a spatial information system with geographic references. Further, in the era of globalization, it is important to make this information available on the Web for ready access to the world community for FDI etc. This will also give a great scope for the expertise, especially the site specific expertise available in the Country to put forward their skills which would be required by the investors any way. This also will be a powerful tool for the policy makers and government for mineral resources management while implemented in the specific manner. The Government must frame some simple but implementable norms for that and the sectors irrespective of being government or private should come forward for a agreeable protocol for common benefit.

Thus, the role of a GIS based information system in mineral resources from the perspective of the user is an urgent need. In the present era of information age, new tools and technologies have emerged to collect, store, retrieve and analyze various types of information related to mineral deposits. Today, Two GIS packages, M.R.I.S and MINFO are used for mineral resources information management which are derived from the concept of MERIGOLD, a database on gold deposits of Australia. But both have not the capability of web enabled although it has greater efficiency in analysis WeBSAS is another WebGIS system which provides the web capability for sharing of data through web (Ayachi,2005 and Roy et al.,2001). But the WeBSAS is very difficult to implement and it does not support Open Geospatial Consortium (OGC) specification. These challenges cause barriers in extensively sharing mineral resources data and restrain the effectiveness in understanding and responding to proper management. To overcome these challenges in mining sector, mapping and sharing of mineral resources information in a secure framework based on OGC specifications under GIS environment is the need of the hour.

3 SOA BASED MOBILE SDI MODEL

SDI provides an environment within which organizations interact with technologies to foster activities for using, managing and producing geographic data. The core components of SDI can be viewed as policy, networking, standards, people and data. An integrated SDI model not only provides spatial data, value-added services for end-users, but also involves other important issues regarding interoperability, plugability, security, policies and networking. Geospatial web services are integral part for the development and implementation of SDI Model (Rajabifard et al.,2002). For implementing of any SDI model, following thin client-server architecture has been proposed in which most of the processing takes place at server side (Puri et al., 2007).

In terms of managing number of geospatial web services, SOA recognises processing load and tries to construct flexible, distributed, re-configurable and dynamic service system which can meet service requirement and information on web for the development of SDI. The component in the SOA is service and a chaining system of services through the composition of services i.e. a well defined set of ordered actions. Each service does not depend on other services as it is stateless and self contained. Figure 1 shows three major functionalities in SOA based SDI.

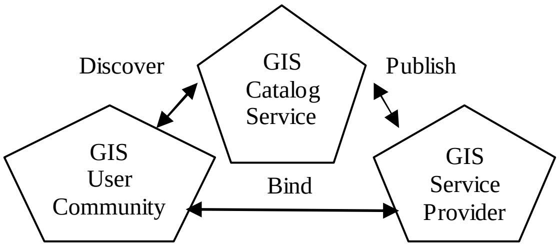

Figure 1: Three major functionalities in SOA (Xiaolin, 2005)

In development of SDI, the major focus has been on SOA based geospatial web service by using spatial data, which may be grouped into data service, processing service and catalog service. Data service is tightly coupled with specific data sets on which it operates and offers Web Coverage Service (WCS), Web Feature Service (WFS) and Web Mapping Service (WMS). In SOA based SDI, there are three types of key actors i.e. service requester or GIS user community, GIS service provider and GIS catalog service. Catalog service may also be called registry service or broker service with discover-bind-publish operation. However, the functionality remains similar in most of the applications in registry service. Catalog service helps the requestors to discover or find the appropriate services. Service providers publish all their services for consumer to use by using "publish" method (vaccari et al.,2009).

In the ubiquitous era, for geospatial web services in SDI Model to become a universal communication paradigm, mobile devices enabled with web services should be considered. Mobile GIS is an integrated technological framework for the access of geospatial data and location-based services through mobile devices in secure way, such as Pocket PCs, Personal Digital Assistants (PDA), or smart cellular phones. For mobile GIS applications, it requires an efficient interaction framework for mobile web services in SDI Model. Mobile GIS applications are also implemented in distributed environment with the help of common client-server model. Mobile Data Service (MDS) is one of architecture for implementing geospatial web services in mobile client. A light mobile GIS framework has been proposed and implemented on J2ME and mobile scalable vector graphics (SVG). The proposed framework uses the specification of mobile SVG, the specification of mobile XML and the rules for spatial data organizing (Yeon-Seok and Kyong-Ho, 2009,Li et al.,2004 and Samaddar and Barik, 2013).

4 OBJECTIVE OF THE PRESENT WORK

The main aim of the present work is to propose a three-tier secure framework for mobile based SDI Model for efficient management of mineral resources information infrastructure with the use of mobile device by integrating geospatial map data. It has defined the prototype development by using win-win spiral model. The interaction between the various services has been modeled by using Unified Modeling Language (UML) use case and activity diagrams.

5 METHODOLOGY ADOPTED

The main focus on the secure framework has been on the use of a practical approach to explore and extend the concept of SDI in mining sector. It should provide an effective and efficient means of sharing geospatial data and non-spatial data on the web using GIS in a secure way. Figure 2 shows the proposed three- tier secure SOA based SDI architecture of mineral resources in which the basic over view of service provider, service consumer and catalog service are being shown.

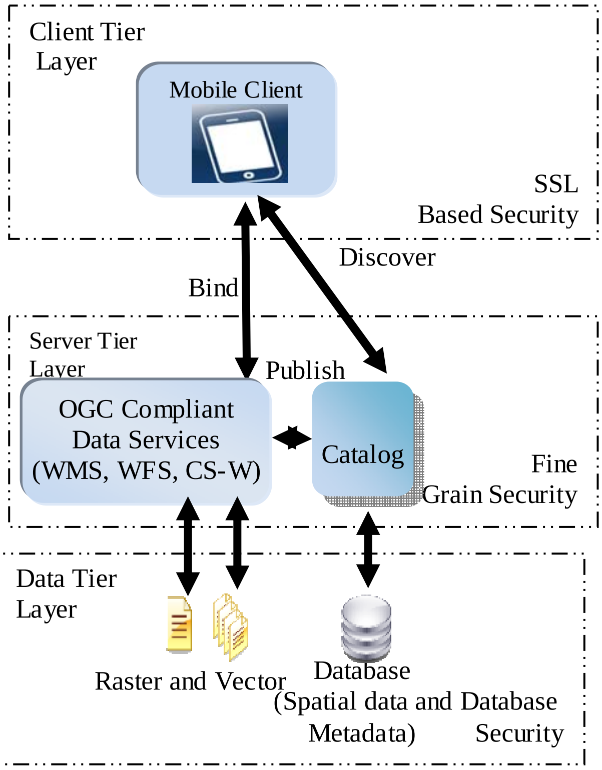

Figure 2: Proposed Secure Framework for Mobile based SDI Model

In the proposed framework, it focuses on OGC compliant web services using vector and raster data. 'Admin' is the system administrator. 'Admin' is managing the data and gives authority to the different mobile users. There are various categories of administrative services. For example, Catalog is updated by 'catalog admin'. This architecture fulfils the most sophisticated workflow for development of the mobile based SDI Model. Figure 2 shows the flow of information for the development of Mobile based SDI Model in the present work. Web plays one of the important factors for widespread information infrastructure in Mobile SDI Model development. Since, it is characterised by free flow of information in an insecure channel, and so it requires high security measures. Different methods have been used to protect the transfer of data over the Web. This includes encryption, in which data is transformed and a decryption key is generated for the receiver of the data. So for secure transaction of spatial data over the web, different security measures have been described which have been developed and implemented in different phases.

Information Security is usually seen as a combination of three core principles: Confidentiality, Integrity and Availability (CIA) (Kabbani, et al.,2010). By keeping these three core security principles, the three-tier Security architecture has been proposed for the developed Secured SDI Model. From the above figure, it is proposed to achieve the principle of CIA. Confidentiality can be achieved by the SSL Based Security Integration. Fine Grain Security is meant to focus on integrity of services where as Database Security is to focus on the availability of the data to the authenticate user.

In the proposed three-tier Security Architecture, the middle layer is technically divided into two parts: one is Applications Server and other is GIS Server. GIS Server is responsible for supplying the correct data according to the application as per the user role. Therefore, the security features between Application Server and GIS Server requires Fine Grain Security elements such as role base access control mechanism. For that easy to implement mechanisms like discretionary access control mechanism and mandatory access control mechanism may be used. Role base access control mechanism in a preventive way accesses the data tier and ultimately the data will reach the application layer passing through the security mechanism of the data tier and application layer. The user role is defined at the very beginning at the web client layer by providing authorised access after authenticated verification of the user identity.

Secure data communications can be achieved through Hypertext Transfer Protocol Secure (HTTPS) protocol. HTTPS is a combination of the Hypertext Transfer Protocol with the SSL/ TLS Protocol to provide encrypted communication and secure identification of a network web server. HTTPS connections are often used for payment transactions on the World Wide Web and for sensitive transactions in corporate information systems. The main idea of HTTPS is to create a secure channel over an insecure network. This ensures reasonable protection from eavesdroppers and man-in-the-middle attacks provided that adequate cipher suites are used and that the server certificate is verified and trusted (Nayak and Samaddar, 2010).

The proposed secured Mobile SDI Model features a role-based security system which defines fine-grained security at the service tier layer. For each layer of the service, the administrator can configure the security settings which has been authorised/denied different service access as per user role. The fine grain security has been successfully implemented in GeoCat Manager Module. In GeoCat Manager Module, Administrator has the access for giving privilege to the users according to the availability of services. It generally focuses on the security in PostgreSQL where both spatial and non-spatial data have been stored. Database security in PostgreSQL is addressed at several levels.

6 PROTOTYPE DEVELOPMENT

The prototype development of the mobile based SDI model is based on Jacobson's method of Object Oriented Software Engineering (OOSE) method that capture the actors of the system and their behavior for each of the design stages which involves the formation of models. Figure 3 shows the complete process model for development of mobile based SDI model.

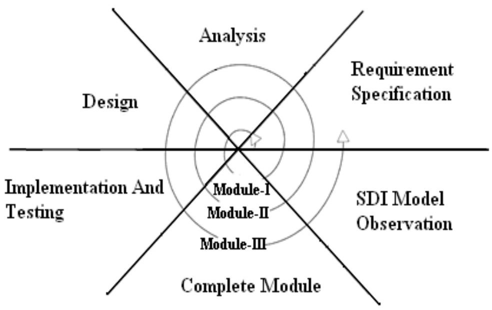

Figure 3: Process Model for mobile based SDI model – Customisation of Win-Win Spiral model

In OOSE approach, the software development process adopts the steps including requirements specification, analysis and design, implementation and testing, complete module and model observation (Mall, 2014).

Requirement Specifications

The requirements stage of application design aims to specify the behavior of the framework from the perspective of a user which has been shown in Figure 4.
A use case specifies a sequence of actions, including variants that the system can perform and yield an observable result of value to a particular actor. Figure 4 shows the Use Case Model which specifies how a user would interact with the system to identify the various systems.

In the present work, the use case model has been associated with three types of users, i.e., administrative user, general mobile user and developer. The

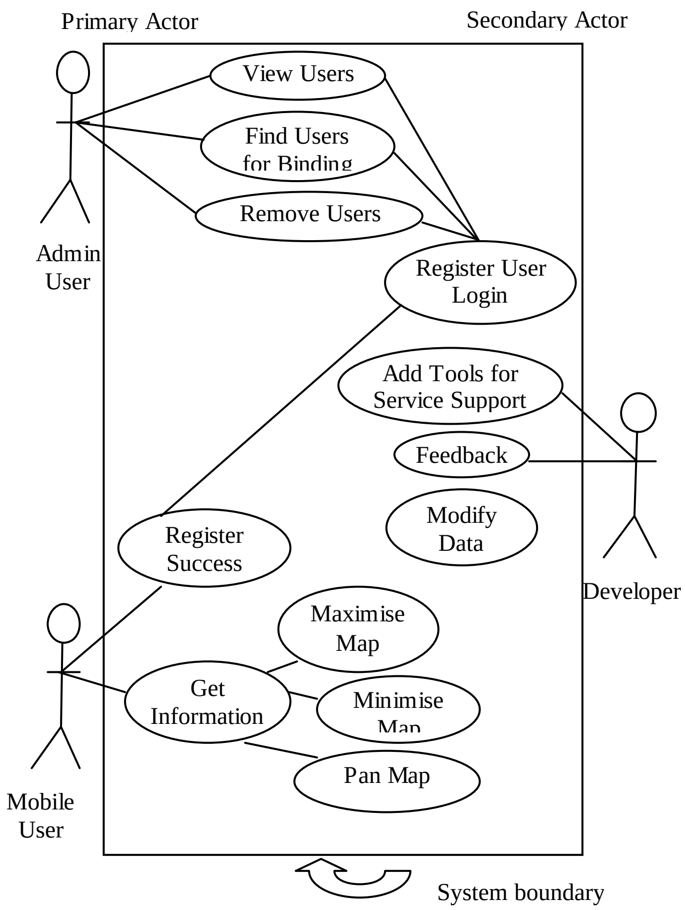

Figure 4: Prototype of Use Case Model

administrative user will have the authority to view, delete and find existing users which are associated with this system. The general mobile user has the variety of option like login, logout, register, get-information, maximise map, minimise map, pan feature, get-coordinate, upload files and download files.

Even an object diagram can have different annotations depending on guard conditions. System sequence diagrams depict the flow of actions in a sequence considering one action at a time. The domain model (complete or partial) is obtained on the basis of all the above models and that completes the modeling the static nature of the application. The dynamic nature of the application is captured through a number of modeling schemes like action diagram, collaboration diagram, state chart diagram etc.. The complete modeling of mobile based SDI model is out of scope of this paper. A number of modeling schemes are used for analysis, further refinement and subsequent design.

Analysis and Design

The underlying algorithms for formulation of prototype fall within the analysis portion of the OOSE life cycle. The thematic layers created include maps of India with state boundaries and different mineral resources information. The flow of processes in the system is captured in the form of state chart diagram that need to be translated into design element of the software. In present work, activity diagram describes the workflow behaviour of secure mobile based SDI model and are shown in Figure 5.

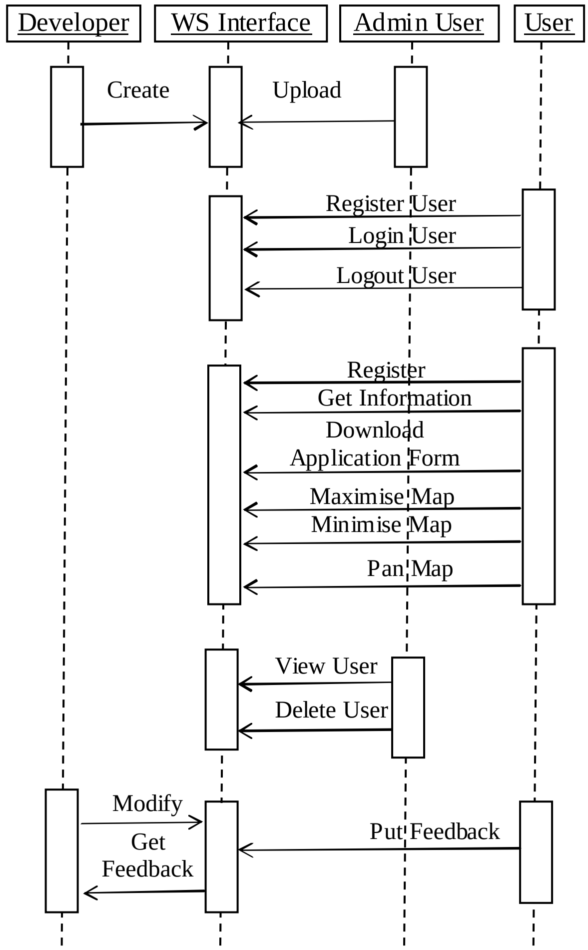

Figure 5: Activity Diagram for mobile based SDI model

A preliminary activity diagram, as a result, is obtained in Figure 5 that can be refined further depending upon the various iterations of earlier steps of design under the guidelines of OOSE.

Complete Module

The framework consists of three main modules, e.g., Module-I for registration, Module-II for mineral resources information Mapping, and Module-III for Utility Services. Module-I describes the detailed process to register the user for authentication. After registration process, user can use the framework with various operations like registering a mineral resources information. Module-II gives detailed viewing mineral resources information mapping in terms of various factors associated with availability in India. Module-III describes utility services, i.e., management of user level security aspects, and uploading/ downloading features for all operations mentioned above in the activity diagram. The mobile based SDI model framework developed has been shown using two illustrations. Figure 6 shows the mineral resources information database creation in Quantum GIS.

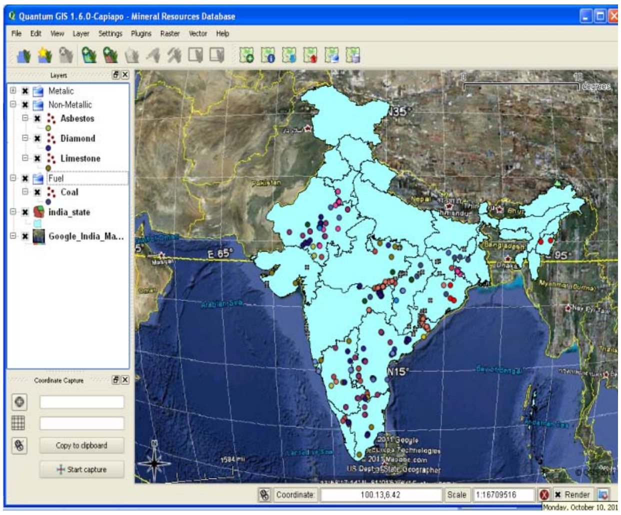

Figure 6: Mineral Resources Geospatial Database in Quantum GIS

7 CONCLUDING REMARKS

A secure framework for Mobile based SDI Model mineral resources information infrastructure has been proposed and the prototype with certain simplification of operation has been tested for its primary function i.e. mineral resources geospatial database has been created. The present research work is focused at adopting OGC standards for registering, creating, accessing, integrating, sharing and testing the mineral resources information on the Web. The proposed framework adopts a modular and flexible structure, and provides an efficient mechanism for the generation and delivery of value-added spatial information to extend the concept of secure SOA based SDI Model in the field of mining sector, particularly at national level. It has been planned to develop and implement the prototype by using Open Source GIS at a later stage contributing to Open Source Movement.

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CAPACITY BUILDING IN GEO-INFORMATION SECTOR (A CASE OF KATHMANDU UNIVERSITY)

Subash Ghimire

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Abstract: *Capacity building in Geo information is the empowerment that encompasses the ability, skills to initiate, manage, undertake, organize and evaluate Geo-information activities. The capacity building includes major elements such as education, training, research, informal approaches such as networking, refresher courses, seminar/ conference. This paper aims to highlight the role of Kathmandu University (KU) for capacity building in Geo information sector in Nepal. It is committed to develop a center of excellence in Geo- information sector by providing quality education, research, training etc. Kathmandu University, Geomatics Engineering program has collaboration with academic and nonacademic organizations to strengthen the quality of geo-information education, research and internship. KU has also planned for the capacity building of faculty and students through its faculty development plan and student exchange program with other collaborating Universities. Geo spatial lab and other important advanced survey; Geodesy, remote sensing, photogrammetry lab etc. will be developed in near future at KU premises. LMTC and KU are also jointly establishing the necessary infrastructure required for the Geomatics Engineering program in the vicinity of these two organizations.*

1 INTRODUCTION

The capacity building in Geo information sector is the empowerment which encompasses the ability, will and skills to initiate, plan, manage, undertake, organize, budget, monitor/supervise and evaluate Geo information activities. The capacity and capability building are related to the organizational and functional levels as well as to individuals, groups and institutions. The capacity building includes major elements such as Education, training, research, informal approaches like networking, refresher courses, seminar/ conference. Institutional capacity building includes networking (Collaborations), Development of infrastructure and human resources. In this context, Kathmandu University (KU) is playing an important role on capacity building in Geo information sector.

KU is an autonomous, not-for-profit, non - government institution dedicated to maintain high standards of academic excellence and is located in Dhulikhel Municipality, about 30 kilometers east of Kathmandu.

It is committed not only to develop leaders in professional areas through quality education but also to develop as a centre of excellence in education and research. KU has successful collaboration with more than fifty universities and institutions. KU offers various graduate and undergraduate courses in different discipline through its seven schools; School of Engineering, School of Management, School of Science, School of Arts, School of Medical Sciences, School of Education and School of Law. Geomatics Engineering program is under the Department of Civil and Geomatics Engineering within the umbrella of School of Engineering. On the basis of Memorandum of Understanding signed-in between School of Engineering, Kathmandu University and Land Management Training Centre (LMTC) in 2007, 2011 and 2015, KU is conducting a four year BE course.

2 GEOMATICS ENGINEERING EDUCATION

Kathmandu University, Geomatics Engineering program is successfully running following programs in its central premises at Dhulikhel, Nepal.

2.1 Diploma in Geomatics Engineering

KU has started Diploma in Geomatics Engineering (3 year's course) from 2015 in collaboration with LMTC and CTEVT and is running under the framework of MoU signed among KU, LMTC and CTEVT. The total intake of the student is 48. The students are selected based on the competitive entrance exam and interview.

2.2 Bachelor in Geomatics Engineering

The first and second memorandum of Understanding (MoU) between KU and LMTC under the framework of which the Geomatics program has been running is now completed and the new MoU has been signed on 2015. Under the previous MoU, Ministry of Land Reform and Management had already provided financial support for 7 years for four batches. In this case 75% of total fee was waived out for 24 students. In the second MoU, a 100% tuition fee is waived for two students from government employee in the engineering services under survey group category, a 50% fee is waived for eight students from four Development Regions except the central regions of Nepal and 33% of tuition fee is waived for 10 students passing the Kathmandu University Common Admission Test (KU-CAT) entrance exam on merit basis. In third MoU, 35% scholarship of total tution fee is provided to 20 students from all development regions, 4 students from each development region.

The first, second, third, fourth and fifth batch Geomatics Engineers are now in the market. The current status of the number of students with category is tabulated as follow.

Table 1: Number of students in Bachelor in Geomatics Engineering at KU

Batch	Year	Female Students	Male Students	Total Students
2015	Ist year	4	25	29
2014	2nd year	6	22	28
2013	3rd year	5	21	26
2012	4th year	0	33	33
Total enrolling students		15	101	116
2007-2011 GE Alumuni	1st - 5th batch	16	105	121

The students will carry out the internship for one and a half months in Geo information industry, engineering project works and field survey almost three and a half months during the study period. In the internship, students are sent in different organizations to carry out the real Geo information activities.

2.3 Master and PhD program in Land Administration

KU is also running two year's master degree program in Land Administration since 2013 in collaboration with LMTC. The main aim of running Master in land Administration course is to produce graduate level highly skilled and qualified professionals in the field of land Administration and to conduct and promote research and development activities in the field of land administration and management. The market study was carried out in 2010 and implementation plan was drafted in 2011 to start the master program. Land administration program at KU consists of multidisciplinary courses so that the intake will be from multidisciplinary background. The Government of Nepal has approved 100% scholarship to 10 candidates for government employee up to four batches. The financial aid is also available to selective full paying students in the form of graduate teaching assistantships as per the requirement of the Department.

The total nine (9) out of 12, Master in Land Administration students were recently graduated in 2015 and five students are enrolled in 2014 batch. The Memorandum of Understanding (MoU) between Kathmandu University, School of Engineering, Nepal and University of Twente, Faculty of Geo-Information Science and Earth Observation, the Netherlands had already been renewed to run the Land Administration program. Similarly, MoU is signed between Kathmandu University and Changan's University for strategic partnership in land Administration. KU is also running PhD course in Land Administration in collaboration with UT/ITC, the Netherlands. KU is also planning to start B. Tech. Ed. in surveying in undergraduate level in collaboration with LMTC.

3 ACADEMIC AND APPLIED RESEARCH

The following academic and applied research has been carried out by Geomatics engineering program of Kathmandu University

Developing land valuation model for land acquisition focusing on livelihood supported by KU and NAST

Estimation of above ground biomass by using UAV funded by ICIMOD

Strengthening Geospatial Infrastructure and Research Capacity at Kathmandu University funded by ICIMOD

Developing Demonstration Model to Revive Springs for Enhancing Rural Water Security funded by Oxfam.

Land Surface temperature change analysis of Kathmandu Valley using Landsat images funded by UGC.

4 TRAININGS

The various training organized by Kathmandu University for Geo information sector is discussed in following sections.

4.1 UAV Training

Geomatics Engineering Program of Kathmandu University (KU) hosted 3 day Unmanned Aerial Vehicle (UAV) training at KU, Dhulikhel from September 23 to September 25, 2015. The training was organized together with Humanitarian UAV Network (UAViators), UAV manufacturer DJI, UAV data processing Software Company Pix4D and Kathmandu Living Labs (KLL). Thirty two participants from different organizations (Kathmandu University, Land Management Training Center, Survey Department, ICIMOD, Nepal Police, Practical Action Nepal, NSET, KLL etc.) learned UAV applications, UAV flying and data analysis skills.

Six DJI Phantom 3 Advanced and 6 smatisan smart phones were handed over to Kathmandu University by UAV manufacturer company DJI. Further, UAV data processing software company Pix4D handed over Educational license of Pix4D mapper to the university. Besides, the trainer team also prepared 3D model of Dhulikhel Hospital using UAV images captured during the training. Furthermore, UAV images of Panga (one of the earthquake badly affected area), Kirtipur were captured with DJI Phantom 3 Advanced and image mosaic of Panga was prepared. Local people did participatory mapping using the UAV image mosaic.

4.2 Web and Mobile based application development training

The android application development and web map application training were organized at Kathmandu University from July 17, 2015. The training was designed for Geomatics Engineering final year students. This training is an initiative to develop the skills of trainee regarding the use of geospatial technology in android platform.

4.3 Scientific Report Writing Training

Geomatics Engineering program under DCGE with a support from International Center for Integrated Mountain Development (ICIMOD) successfully organized two day; 7-8 July, 2015 workshop on Scientific Writing and Presentation training at Kathmandu University Dhulikhel. The training meets the objective of

1. Distinguishing scientific research, their audiences and how research material might be effectively presented.

2. Preparing scientific and technical papers.

3. Accepting constructive criticism and using reviewers' comments to improve quality and clarity of written reports.

The target audience was fourth year Geomatics students who are in a process of writing their final year project report.

4.4 Training of Trainers in Land Administration

The Transparency in Land Administration Capacity Building Programme is a joint initiative of Kathmandu University and the United Nations Human Settlements Programme (UN-HABITAT) Training and Capacity Building Branch (TCBB) and ITC, the Faculty of Geo-information Science and Earth Observation of the University Of Twente.(more specifically the United Nations University School for Land Administration Studies (UNU-LAS) of ITC). This programme is implemented under the aegis of the Global Land Tool Network (GLTN). A first phase comprising the development of a toolkit and a training guide for transparency in land administration parallel to the implementation of a training programme in Africa was successfully carried out in the period 2007-2008. Only in 2010, resources became available to carry out a second phase by rolling-out the programme in Asia, more specifically in South and Southeast Asia. The countries targeted to benefit from the second phase were Bangladesh, Pakistan, Nepal, Sri Lanka (for South Asia) and Vietnam, Lao PDR, Cambodia, Philippines and Indonesia (for Southeast Asia).

The three major outputs foreseen for this second phase included: 1. Case studies; which would be front and centre in the training and vitally important to localize domestic training; Eight short and eight long case studies were envisaged for the training workshops. 2. Expert Group Meeting; which would serve to understand land issues in the South and Southeast Asian region and tailor the Training of Trainers (ToT) training accordingly; identify areas of focus, build partnerships; and create local ownership; The EGM targeted fifteen (15) participants with knowledge of the state of land and governance in their respective countries. 3. Training events; Two (2) ToT workshops would serve to expose participants from South and Southeast Asia to land sector specific transparency principles, concepts and tools, including training delivery methods so that participants would be equipped to impart knowledge and skills to others in their respective countries; The workshops each targeted fifteen (15) trainers, formally or informally engaged in building capacities of people involved in land administration in their home countries. The second phase was implemented by the original partners of Phase 1 UN-HABITAT/TCBB and ITC/UNULAS expanded with three regional partners:

Faculty of Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia

School of Engineering, Kathmandu University, Dhulikhel/Kathmandu, Nepal

Faculty of Geography, Hanoi University of Science / Vietnam National University, Hanoi, Vietnam.

Adopting Geo ICT in Land Administration

International Institute for Geo-Information Science and Earth Observation (ITC), The Netherlands and School of Engineering, Kathmandu University (in collaboration with Land Management Training Center LMTC) organized short course on "Adopting Geo-ICT for land Administration" in Kathmandu University, Nepal on 15 – 19 June 2009. The resource persons from ITC and Nepal delivered lectures in the emerging areas such as:

Latest Geo-Information Technologies

Land administration: policy targets and Geo-ICT
Sensors and Applications to Land administration
Land Information Systems: Development and experiences

Transparency in Land Administration

Research on transparency in Land Acquisition
Strategic planning for adopting Geo-ICT for Land administration

The courses were attended by participants from Nepal, Bhutan, Bangladesh, India, Sri Lanka, and Iran.

4.5 QGIS Training

The Geomatics Engineering Society, Departmental club of Geomatics Engineering program successfully organized a week long QGIS Training followed by JOSM training for various departmental students of KU from December 23, 2015 onwards at Kathmandu University, Department of Civil and Geomatics Engineering. The total participants were thirty. The resource people for the training were from Kathmandu University and Land Management Training center.

5 REFRESHER COURSE

This 11-day Regional Refresher Course 2012 on "Building Flood Disaster Resilience of Cities-Meeting Internal and External Challenges of the Future" was organized jointly by the Department of Civil and Geomatics Engineering of School of Engineering, Kathmandu University Nepal and UNESCO-IHE Institute for Water Education in Delft, the Netherlands. The course began on 1st October and ends on 11th October 2012. Around 22 alumni were participating in this Refresher Course and 10 national and international experts were sharing knowledge with them.

The overall aim of the course was to strengthen knowledge and capacity of the alumni of UNESCO-IHE, working in the Asian region for the improved management of increased urban flood risk due to external and internal threats.

6 CONFERENCE/SEMINAR

Kathmandu University (KU) in collaboration with Survey Department (SD), Land Management Training Center (LMTC), University of Southern Queensland, Australia, and Global Spatial Data Infrastructure (GSDI) organized a pre-conference event, "Sharing SDI Research on Disaster Risk Reduction" at the central premises on 24 November 2015. Various national and international dignitaries presented on Geo-spatial Technologies and People: Respond and Recover Challenges and Opportunities in utilizing SDI and Crowd, Digital Innovation for Social Good, Next Generation of Disaster Management and UAV technology for Geospatial Data acquisition. The participants were young surveyors, Kathmandu University students and faculties and LMTC staffs and students.

7 AWARENESS RISING ACTIVITIES

Geomatics Engineering Society (GES), Departmental club of Geomatics Engineering program is celebrating GIS Day events every year at KU organizing various activities such as UAV demonstration, presentations, exhibitions, publication of Journal etc. Mostly Awareness rising in Geo information sector activities will be displayed in the event. The various organizations actively participated in the event. GES also uses its social networking for promoting Geo information activities at KU.

8 BUILDING INSITUTIONAL CAPACITY

Kathmandu University, Geomatics program has Collaboration with academic and nonacademic organizations to strengthen the quality of geo-information education, research and internship. Geo spatial lab and other important survey, Geodesy, remote sensing, photogrammetry lab etc. will be established in near future. LMTC and KU jointly establishing the necessary infrastructure required for the Geomatics Engineering program in the vicinity of these two organizations. KU Geomatics program is also supporting faculties to explore the academic activities through faculty development plan and encourages participating in various activities such as participating and presenting in seminar, workshop, training, and refresher course etc. KU is also organizing various guest lectures and interactions programs with national and international experts for sharing the knowledge and expertise in Geo information sector. KU in collaboration with University of Tokyo is planning to establish the Continuous Operating Reference System (CORS) at KU, Dhulikhel.

9 FACULTY/STUDENT EXCHANGE

KU has also planned for the capacity building of faculty and students through its faculty development plan and student exchange program with other collaborating Universities. Some of our undergraduate Geomatics Engineering students and Master in Land Administration students carried out their final semester project, internship and research in foreign Universities having EMMA fellowship and exchange program.

10 CONCLUSION

Geomatics Engineering Program, under the Department of Civil and Geomatics Engineering, is the endorsement of mutual understanding between LMTC, Government of Nepal and KU. Till now 121 Bachelor in Geomatics Engineering and 9 Master in land Administration students are graduated including 5th batch of Undergraduate program and first batch of Master in Land Administration, out of which around 50 of our undergraduate students after graduation are working in Government of Nepal service, few in NGO/INGOs, few study abroad and few are in private consultancies and firms. Physical infrastructures and technical facilities are shared between KU and LMTC. KU is playing a very important and pioneer role for capacity building in Geo information sector in Nepal.

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WCS Summit
Date - 19th April to 23th April 2015
Venue - Istanbul, Turkey
Participants - Director General Mr. Madhusudan Adhikari

Observation Tour
Date - 10th August to 13th August, 2015
Venue - Earth Observatory of Singapore, Singapore
Participants - Director General Mr. Madhusudan Adhikari and Chief Survey Officer Mr. Anil Marasini

E-governance for effective Land Administration Services
Date - 16th August – 29th August, 2015
Venue - Ulaanbaatar, Mongolia
Participants - Deputy Director General Mr. Ganesh Prasad Bhatta and Chief Survey Officer Mr. Susheel Dongol

Eighth GEOSS Asia Pacific Symposium
Date - 9th September to 13th September 2015
Venue - China
Participants - Director General Mr. Madhusudan Adhikari and Survey Officer Ms. Shanti Basnet

Twentieth United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP) and Fourth Regional Committee of United Nations Global Geospatial Information Management for Asia and the Pacific (UNGGIM-AP) Plenary Meeting
Date - 5th October to 10th October, 2015
Venue - Jeju Island, South Korea
Participants - Director General Mr. Madhusudan Adhikari

First Steering Committee (FST) Meeting of the Sentinel Asia Step 3
Date - 13 - 15 October 2015
Venue - Bangkok, Thailand
Participant – Mr. Suresh Man Shrestha, Chief Survey Officer

2015 Seminar on Land Use and Management for Nepal
Date - 18th November to 8th December, 2015
Venue - Beijing, China
Participants - Chief Survey Officer Mr. Anil Marasini along with Joint Secretary Mr. Kapil Dangol and others

APRSAF Conference
Date - 30th November to 5th December 2015
Venue - Indonesia
Participants - Director General Mr. Madhusudan Adhikari

Training on GNSS and Airborne LIDAR Data Processing
Date - 18th January to 12th February 2016
Venue - Earth Observatory of Singapore, Singapore
Participants - Chief Survey Officer Mr. Kamal Ghimire and Survey Officer Mr. Prashant Ghimire

Training Seminar on Geographic Information System and Land Management
Date – 02nd March – 15th March, 2016
Venue – ICLPST, Taiwan
Participants - Survey Officer Mr. Ram Kumar Sapkota

COMMUNITY LAND GOVERNANCE AND ITS CONFLICTING THEORIES

Sanjaya Manandhar & Dr. Purna Bahadur Nepali

1 BACKGROUND

Land is a scarce resources, that's why it is directly tied into economic, political and social power in an agrarian society cause of inequitable and skewed distribution of land, Land governance is complex part of land administration having different land governance challenges. There are 1.6 billion skimpy people living in forested lands worldwide, nearly 80 percent of which is considered public/ state and common land (Franco, 2008). Access to land, right over it and ownership are key aspects for economic and social development. Community land governance is important issues to every national land administration.

We can review, Nepal's community land, the exact data on the extent of community land in Nepal is yet unknown. However, this land is categorized according to different names, including: Community Forest Users Groups (CFUGs), public land, pasture land, religious places, and others. Land statistics reveal that agricultural land, forest land, grazing land and water bodies occupy 26.8%, 39.6 %, 11.9%, and 18.5% of the total land respectively (Wily, 2008). By ownership, state land (including government land and public land) makes up 73% of the total area of Nepal, including forests, pastures, and riverbanks (approximately 10.5 million hectares). In contrast, private ownership accounts for 26.9% of the land in Nepal, including cultivated and uncultivated land (4.1 million hectares). Various studies show that much of the public land is centralized in the Terai region (Jamarkattel and Baral, 2008; Kunwar et al., 2008; Acharya, 2008; Deuja, 2007).

In Nepal, local communities use most of the rural land and natural resources according to customary practices. These communities not only use their local land and resources to meet their food and livelihoods needs, but also manage these lands in such a way as to best conserve, manage and protect these resources. Nepal's long history of community forestry (also known as participatory natural resource management) showcases the success of local communities both protecting and using forest resources sustainably for their livelihoods.

However, the property rights regime undergirding community forestry in Nepal is burdened by tenure insecurity, as government owns those forest lands: a given community's rights to its forest are only usufruct rights. There is thus constant contestation and confrontation between legal systems and in daily practices concerning who owns community lands and forest resources. Meanwhile, an unintended consequence of the success of community forestry efforts – supported by a heavy flow of foreign aid – has been afforestation on public (community) lands. Ad hoc and uncoordinated government interventions have led to a problem of tenure security and tree tenure security on this public land. This tenure insecurity has been exacerbated by the fact that the institutional arrangements, governing systems and state agencies in the land sector are not as strong and systematic as in the community forestry sector. Forest right activists and land right activists were thus demanding constitutional guarantees of community land tenure security during constitution making process. They are arguing that community land rights should be its own separate category of land classifications, alongside state (public) lands and private lands.

Public land has a high potential for livelihood improvement of poor and land-poor peoples in Nepal, despite higher risks associated with insecure tenure. The experiences of some Village Development Committees in Terai District demonstrate that effective management of underutilized public land provides an important asset for communities, not only to generate forest resources and supplement forest products but more importantly also to reduce vulnerability and generate livelihood opportunities for the landless and the land poor. (Kunwar et al., 2008 and Jamarkattel & Baral, 2008)

Most legal documents pertaining to land, such as the New Constitution 2007, the Lands Act of 1964, the Land Use Policy of 2012, the Agriculture Development Strategy (ADS) policy, and the Draft National Land Policy focus mostly on tenures and tenancy of agricultural land. These legal documents focus less concerned about public land management, community land tenure security, and the allocation of public resources for the support of local peoples' livelihoods (especially the livelihoods of poor, marginalized and Indigenous Peoples). Despite various legal provisions that address these issues, these legal frameworks establish ambiguity and inconsistency concerning matters such as jurisdiction and enactment/initiation of implementation. Moreover, there are no explicit interventions in these legal instruments that secure community land rights.

Issues of inclusion and participation in community forest management in Nepal are usually determined by the rules, norms and perceptions of the communities with management responsibility. These factors tend to impact the inclusion of disadvantaged social groups, women, and poor households, who often do not benefit from community forest management as much as more prosperous households do. (Agrawal, 2001). For example, in many regions of Nepal, community forest user groups are usually led by men and so called "high caste" people, with and women and Dalit are in subordinate positions. Similarly, the Local Self Governance Act of 1999 has recognized public land encroachment and inequitable distribution of community forest resources as probable causes of community land conflict. Multi-national companies' recent acquisition by of land held by indigenous communities has also resulted in land conflicts at community level.

In a given context, this article attempts to understand the community land governance with respect to conflicting theories to suggest an informed and pragmatic community land governance.

2 LAND GOVERNANCE

Land governance means implementation of laws, policies to manage land, property and natural resources. Land governance is the process by which decisions are made regarding the access to and use of land, the manner in which those decisions are implemented and the way that conflicting interests in land are reconciled (GLTN).

Weak governance in managing common property assets shows massive significances on all sectors i.e. economic change, poverty mitigation, the environment, political legitimacy, peace and security, and development cooperation. Public land or management of common property is a critical factor for safeguarding good governance in the land administration of a country. Public property assets are frequently misused, and nearly all countries underutilize these assets (Zimmermann, 2008).

3 COMMUNITY LAND RIGHTS

Community land refers to land that has long been owned, managed, held, and/or used by local people. Community land may be divided into parcels for individual or family use, but it remains in the 'ownership' of the larger community. Other community land is held in common for shared use. Community land and resources may include farm land, forests, range lands, fishing areas, watering points, wildlife habitats, and sacred areas.

The lack of clarity and recognition of community land and resource rights across the developing world has become a global crisis undermining progress on social and economic development, human rights, peace, food security, environmental conservation, and our ability to confront and adapt to climate change. Ownership of roughly one-half of rural, forest and dry land areas of the developing world is contested, directly affecting the lives and livelihoods of over two billion people. These lands, which contain the soil, water, carbon, and mineral resources that the future of all humanity depends upon, are the primary targets of rapidly expanding investments in industrial agribusiness, mining, oil and gas, and hydro-electric production.

4 CUSTOMARY LAW AND COMMUNITY LAND

Customary tenure refers to the traditional institutions and rules that communities around the world have created to administer land and natural resources. These practices are interwoven with traditional community governance and social systems, which give them great resilience and flexibility. In most African countries, the majority of the population lives in rural areas, and holds land based on undocumented customary arrangements. Customary systems can also hold sway in the rapidly growing peri-urban areas that fringe Africa's cities and towns. They often provide the only means for local people to assert their rights.

But customary practices over land are not perfect. In some cases, they sustain inequitable or discriminatory practices. Conflicting statutory law or corrupt customary leaders can weaken customary systems. Customary practices often favor men, and thus reinforce women's inequality and poverty. Such shortcomings can and must be addressed if customary systems are to effectively promote local people's rights to land and resources. In agrarian cultures, the social owner of common land is consistently a community. It is a fact that, generally, the larger a river, the less localized the claim upon it. As a rule, forest, pasture, marshland, and rangeland falling within the area of a particular group, village, or village group, are considered the assets of that community (Alden, 2011). In agrarian societies, the social owner of common land is evenly a community. What institutes this community is much more various: it may alter by country, status quo, and the nature of resources involved.

5 CONFLICTING THEORIES ON COMMON

The management of community land is commonly problematic, with, for example, considered, rational, equitable and transparently implemented policies lacking, frequent corruption in the administration of such assets and lack of adequate capacities to manage such lands effectively. These problems are globally widespread and are present in both developing economies and more developed economies (Törhönen, 2009). There is typically ambiguity in authoritative roles and responsibilities, a lack of accountability or methodology in the systems of allocation, appropriation, disposal or use of public/common land, and a lack of information on state assets (Zimmermann, 2008). There are different concept existed regarding management of common land property i.e. Tragedy of commons, HRS, Marxism theory and Governing the commons.

6 TRAGEDY OF COMMONS

The Hardin's concept about 'Tragedy of Commons' is more relevant with community land management. "There appears, then, to be some truth in the conservative dictum that everybody's property is nobody's property. Wealth that is free for all is valued by none because he who is foolhardy enough to wait for its proper time of us will only find that it has been taken by another. The blade of grass that the manorial cowherd leaves behind is valueless to him, for tomorrow it may be eaten by another's animal; the oil left under the earth is valueless to the driller, for another may legally take it; the fish in the sea are valueless to the fisherman, because there is no assurance that they will be there for him tomorrow if they are left behind today" (Gordon', 1954). Table 2 shows about Tuna catches yearly by Million Ton-MT, which shows yearly increments from 1985 to 2005. Common property or natural resources are free goods for the individual and scarce goods for society. Under unregulated private exploitation, they can yield no rent; that can be accomplished only by methods which make them private property or public (government) property, in either case subject to a unified directing power. Ten Real-Life Examples of the Tragedy of the Commons that Alecia M. Spooner mentioned in study Environmental Science for Dummies are Grand Banks fisheries, Bluefin Tuna, Passenger pigeons, Ocean garbage gyres, Earth's atmosphere, Gulf of Mexico dead zone, Traffic congestion, Groundwater in Los Angeles, Unregulated logging and Population growth

7 CHINA'S HOUSE-HOLD RESPONSIBILITY SYSTEM-HRS

China's land reform since the 1970s as three major stages as first; emphasis on 'land to the tiller', second as land reform launched in the 1950s, was aimed to avert land amalgamation derived from enlarged inequality in order to ensure the sustainability of the 'land to the tiller' principle and practice and third stage as land reform, characterized by the introduction of the Household Responsibility System-HRS, in the late 1970s, was a tactical more towards more incentive based land management structures (Zhao, 2013).

Land tenure is about more than simple property rights. The broader dynamics of governance and politics in which struggles over land control are embedded. The recent land reform policies, with collective ownership and individual use rights, have caused social fragmentation and a weakening collective power of the poor, and have led to unsustainable natural resource use and farming practices. The current policies have paradoxical results. HRS has put increasing emphasis

Tuna catches by species (1000MT)

Year/Type	1985	1990	1995	2000	2005
Skipjack	914	1290	1645	1957	2305
Yellowfin	725	1027	1072	1185	1296
Bigeye	258	306	386	437	404
Albcore	193	232	195	215	236
Bluefin	73	49	70	68	43
Total	2163	2904	3368	3862	4284

Table 2:Review of Global Tuna Trade and Major Markets Source: David James Consultant FAO and Helga Josupeit, Fish Utilization and Marketing Service FAO, 2007

on individual property rights to land, limiting people's ability. The HRS reform, as well as the other reforms that accompanied it, has had a profound positive influence on China's growth and the livelihoods of its people (Li, 2010).

It demonstrates the linkages between land tenure and wider concerns over poverty, inequality, environmental degradation, political stability, and social cohesion and develops a holistic understanding of land tenure systems in China today, their history, problems, and potential to contribute to poverty alleviation. It also provides a lens into a multi-layered crisis faced by China's peasant households. Zhao shows how the confluence of policy, growing markets, and lack of representation, illegal expropriations and distant opportunities shape peasant attachment to and departures from the land.

8 MARXISM AND LAND GOVERNANCE CONCEPT

Marx shows the relation of property ownership with the social power. He debates on the equitable access of land on social status and production level. In the world of capitalism, for example, the nuclear cell of the capitalist system, the factory, is the prime locus of antagonism between classes--between exploiters and exploited, between buyers and sellers of labor power rather than of functional collaboration. The Marx class theory debates on ownership of land on a society as perspective of access on property, with regarding the productivity factor (Duggett, 2008). Access on land and the tenure security is major factor for productivity and social sustainability. Society grants the holders of social positions power to exercise coercive control over others. And property ownership, the legitimate right to coercively exclude others from one's property, is such power.

Marx's analysis continually centres on how the relationships between men are shaped by their relative positions in regard to the means of production, that is, by their differential access to scarce resources and scarce power. He notes that unequal access need not at all times and under all conditions lead to active class struggle. But he considered it axiomatic that the potential for class conflict is inherent in every differentiated society, since such a society systematically generates conflicts of interest between persons and groups differentially located within the social structure, and, more particularly, in relation to the means of production. Marx was concerned with the ways in which specific positions in the social structure tended to shape the social experiences of their incumbents and to predispose them to actions oriented to improve their collective fate. Figure 1 shows the dependency and use of common grazing land in Ugandan experience, which clearly proofs that the community are using as fuel, water, materials, hunting and different use of grazing land.

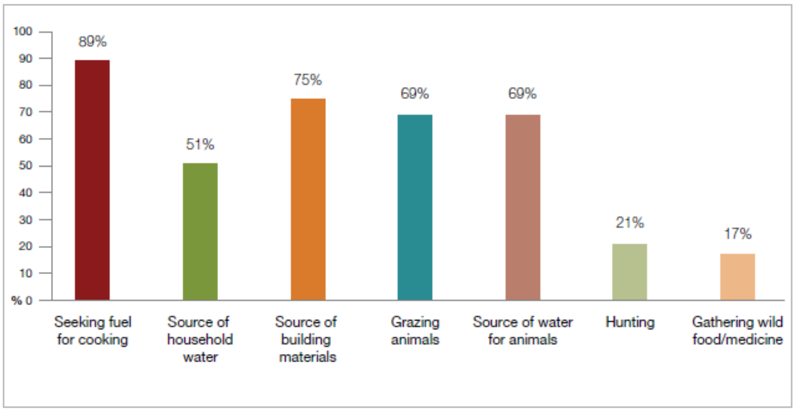

Figure 1: Ugandan respondents' use of common grazing lands (Rachael Knight J. A., 2013)

9 GOVERNING THE COMMONS

Ostrom's Governing the commons- concept is the evolution of institutions for collective action, try to answer popular theory about the "Tragedy of the Commons", which has been interpreted to mean that private property is the only means of protecting finite resources from ruin or depletion. She has documented in many places around the world how communities devise ways to govern the commons to assure its survival for their needs and future generations. Box-1 shows the successful example of forest management of West Bengal, India, which is hold by about 618 families with common tenure. This experience shows that, they shares different uses and generation of income from specified common resource.

A classic example of Ostrom, this was her field research in a Swiss village where farmers tend private plots for crops but share a communal meadow to graze their cows. While this would appear a perfect model to prove the tragedy-of-the-commons theory, Ostrom discovered that in reality there were no problems with overgrazing. That is because of a common agreement

Box-1: The Joint Forest Management-JFM in West Bengal has its origin in the success achieved in rejuvenating a patch of 17 hectares of degraded forests under a pilot project implemented during 1972 near Arabari in Midnapore district. About 618 families living in 11 villages lying in the fringe voluntarily protected these forests when in return they were assured provision of fuelwood and fodder from the regenerated forest and employment in forestry activities. In 1987 these villagers were also declared as beneficiaries for these rejuvenated forests and granted 25 per cent share from the revenue earned from final harvest. (Sarker, 2006)

Box-1: Joint Forest Management in West Bengl

among villagers that one is allowed to graze more cows on the meadow than they can care for over the winter. Ostrom has documented similar effective examples of “governing the commons” in her research in Kenya, Guatemala, Nepal, Turkey, and Los Angeles. A large study conducted by the World Wildlife Fund- WWF included over 200 protected areas in 27 countries. The WWF found that many protected areas lacked key financial and human resources, a sound legal basis, and did not have effective control over their boundaries (Ostrom, 2010). Box-2 shows Liberian experience on forest management and conservation with different laws, rules and restrictions. It aims to show different land patterns and use categories.

10 LEGAL PLURALISM AND COMMON

Legal pluralism is everywhere. There is, in every social arena one examines, a seeming multiplicity of legal orders, from the lowest local level to the most expansive global level. There are village, to town, or municipal laws of various types; there are state, district or regional laws of various types; there are national, transnational and international laws of various types. In addition to these familiar bodies of law, in many societies there are more exotic forms of law, like customary law, indigenous law, religious law, or law connected to distinct ethnic or cultural groups within a society

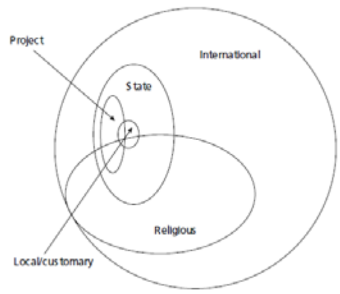

Figure 2: Legal Pluralism and Dynamic Property Rights (Pradhan, 2002)

(TAMANAHA, 2008). Most of common land are underutilized due to unclear policy and legal way-out. Figure 2 shows the complexity in property rights in different national and social attachments. Majorly there exists property right dynamics in common land with cause of legal pluralism.

11 CONCLUSION

Box-2: Examples of by-laws and rules agreed in natural resource management plans in Liberia in case of Forest conservation

• “No one is allowed to cut down the community hard forest for farming: no farming in the community reserve forest, so as to avoid deforestation, farming is allowed in the secondary forest, low land, or swamp. Anyone caught in such practices will pay that amount of ten thousand Liberian dollars (LD$10,000).”

• “No one is allowed to make farm from Camp One to Zuah Mountain – that is the reserve forest for Bar clan. Violators’ farms will be taken from them.”

Reserve Areas

• “The community shall have reserve areas, such as creeks, rivers, Zoe Bush and forest. Some of the reserves areas identif[ied] are; the Wrunee creek located in Blatoe – no one should set net, fishing and set basket on it. The reserve forest is located between Blatoe and Normah

– no hunting, farming, logging and pit sawing is allowed. The mountain is reserve[d] for minerals and a place near sand beach.”

Box-2: Examples of by-laws and rules agreed in natural resource management plans in Liberia (Rachael Knight, 2013)

The existence of common property regimes in many parts of the world reflects the importance of social relations as complex dimensions of land tenure. The equitable access on land for all social group is crucial for social agreement, which can fulfil by management of common land. So, the theoretical approach are more conflicting to use and management of common property and resource. Some of theories criticizes of common property tenure, which supports to resource degradation and depletion. In other hand some theories advocates that common property tenure will be the better way of optimal use of common resource. So, the important part to making decision about management of common property is to identifying social structure, tenure conception which can directly move individual and social groups toward mass development. For better management of common land, it should be focussed on suitable use, right and ownership of common land, which can lead to common access, security of ownership for social users. Conceptual theoretical analysis, empirical international evidences and country context study about social pattern and tenure structure is more important factors to manage community resource. Surely, it will support to social, economic and environmental development of country when there is taken following considerations also.

Landscape of stakeholder is dynamic and diverse. So, following state-society analytic perspective, strengths of state and societal actors can complement and contribute each other to precede common land reform processes.

Land issue is not only technical, but also political issue i.e. political engagement (leadership, support etc.) in land issue. But, it is missing in current land and agricultural related affairs.

Land research and land reform should have mutual and symbiotic relationship. Importantly, conceptual research is needed to guide the land right movement in track.

12 KEY POLICY MESSAGE AND RECOMMENDATION

Special precautions measures during community land distribution reform should be taken into consideration to avoid the inconsistencies, irregularities, and lapses for benefit of all sections of land reform beneficiaries. (Tactical politics: Rewarding the supporter and punishing the opponents)

Differentiated land policies should be in place to understand and address the substantive issues of all sections of subaltern groups ('One size fits for all' does not work' for existing social diversity).

Enhancing access to land and land based natural resources (public land, forest, water etc.) is an alternative way to secure the livelihood of poor people (pro-poor livelihood intervention).

Land research should be institutionalized in state's machinery and university system to shape land right movement (for informed choice) as well as for informed policy reform in Nepal.

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PRICE OF MAPS

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

PRICE OF CO-ORDINATES OF CONTROL POINTS

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

COMPARISON OF DIFFERENT RESOLUTION SATELLITE IMAGERIES FOR FOREST CARBON QUANTIFICATION

H. L. Shrestha

Keywords: Forest carbon, satellite imageries, image processing, Crown projection areas (CPA), NDVI

Abstract: *The current trend of the monitoring of the forest involves the measurement of aboveground forest biomass carbon using the multisource forest inventory techniques. The multisource forest inventory techniques involve the multiple data inputs such as GIS, Remote sensing, GPS, field measurement and existing information. The remote sensing data are useful for the quantification of aboveground forest carbon using the spectral and spatial characteristics of the data. The application of remote sensing data for the forest carbon quantification may enhance the efficiency in terms of resource allocation, time spent and interoperability and ultimately support the efficient National Forest Monitoring System as a basis for the REDD (+) implementation in future.*

The study tried to compare the methods and results from the multi-spatial resolution satellite imageries for the quantification of forest biomass carbon i.e. Landsat TM(30m), RapidEye (5/6.5m) and WorldView PAN (0.5m). The medium resolution imageries like Landsat and RapidEye images have scope to process at the plot level where as WorldView PAN has scope to process upto the tree by tree level. Thus the methods of operation involves mainly two stream i.e. NDVI extraction for the plot average for Landsat and RapidEye data and CPA analysis for the individual tree for WorldView data.

The result shows the higher R2 (0.6) relation in CPA method rather than the NDVI relation with the total forest carbon if we see the linear relations. While we see the polynomial relation, we get the R2 value of 0.77 from the NDVI value of RapidEye which support conclude the use of WorldView PAN image and RapidEye image for the quantification of forest carbon.

1 INTRODUCTION

1.1 Background

Forest has greater role in the mitigation of climate change impacts (Stern, 2009) which ultimately contributes more than 18% GHG emission to the atmosphere due to the deforestation and forest degradation. The forest has dual role in carbon flux from the biomass either sink or source of emission of carbon (Shrestha et al., 2012).

Biomass estimation has opportunity to mingle with the remote sensing data provided the capability of spectral and spatial characteristics of the satellite images. The spatial characteristics termed as resolution matters for the resolving capacity of the images to quantify for the precisely upto the pixel sizes. High resolution imageries are useful upto the tree level identification and scope to quantify precise quantification of forest carbon (Bhattarai et al., 2012).

However, the technology has capability to into deeper to the extent of half a meter resolution and products are available at coarser resolution with 250m MODIS data. If we go to the high resolution, there is opportunity to go to the depth of detail quantification, still we may have burden of huge resolution data processing sometime they are more than the output expected.

The spectral characteristics on the other hand support to interpret the earth feature specifically trees and shrubs while quantifying while they are higher spectral characteristics. If the spatial domain is lower than the high spectral characteristics are not convincingly support for the interpretation (Blaschke et al., 2000).

There is the need of comparative study on the capability of different spectral and spatial characteristics of satellite imageries which optimally can be applied for the quantification of forest carbon in Nepal, however the general estimates can be prepared using the FAO statistics (Oli and Shrestha, 2009).

The study area is of the Pine plantation at Mid-hill of Nepal extended at the 7 hectare of areal coverage.

The study carries the comparison of WorldView PAN, RapidEye images and Landsat imageries to get the precise measurement of aboveground forest carbon.

Methodology adopted for the study are different as per the inputs as required by the characteristics of the images. WorldView images were processed using the Spatial and spectral characteristics. Individual trees were delineated using the image segmentation techniques and linked with the biomass estimated from the field measurement. The field measured tree based carbon measurement were later correlated with the CPA estimated using the segmentation techniques more specifically with the approach of local maxima and minima (Blaschke et al., 2000).

RapidEye images and landsat images are more processed to develop the NDVI images from the spectral characteristics of the image as both of the images are having lower resolution respectively of 5m and 30m. The field plots laid in the ground were of 500 sqm during the field crusing having 12.6m radius. Thus, single plot in the ground covers 20 numbers of RapidEye pixels where as the plot hardly covers the single pixel of Landsat pixel.

1.2 Objective

The main objective of this study is to compare the methods and results of different resolution satellite data for the estimation of forest carbon and biomass.

1.3 Study sites

The study site is the plantation of Pinus roxburghii (Chir Pine) of almost 25 years old with the areal coverage of 7 hectares. The study site lies in the 84°42'25.70"E - 84°42'47.52"E longitude and 28° 0'36.62"N - 28° 0'50.86"N Latitude.

Figure 1. Study location

2 MATERIALS AND METHODS

2.1 Materials

Satellite imageries from the different spatial resolution and spectral characteristics (see Table 1) for the study.

Image	Spatial resolution	Bands
Landsat	30m	7 (MSS)
RapidEye	5m (6.5m)	4 (MSS)
WorldView	0.6m	1 (PAN)

Table 3 Satellite images used for the study

2.2 Methods

The overall method of the data analysis comprises image analysis, field measurement and relate between image indices and carbon information.

2.2.1 *Image analysis: Object based image analysis and NDVI image indices*

High resolution satellite image of WorldView image of 0.5m resolution was processed using OBIA techniques (Mallinis et al., 2008) for getting the tree delineation and crown projected area (CPA) of individual trees.

RapidEye image of 5m resolution and Landsat image of 30m resolution were processed to get the NDVI value for the entire area of study.

2.2.2 *Field measurement and carbon quantification: Tree based and area based*

The field measurement was carried by using the 12.56m radius plots to maintain 500m area for circular sample plot (Brown et al., 1989). The trees more than 10 cm DBH were measured with individual tree identification in printed satellite image map. The heights of individual trees were also measured using Vertex.

The biomass carbon was quantified using species specific allometric equation for Chirpine for individual tree first and then those were calculated for the plot average and density of biomass carbon in the forest (Chave et al., 2005; Ogawa et al., 2005).

2.2.3 *Allometric relation: Tree based correlation with CPA and area based correlation with NDVI values*

The individual tree biomass carbon and the CPA were regressed to find the best fit equation in case of WorldView data.

The plotwise average tree biomass carbon and the NDVI values extracted using the circular plot of 12.56 were regressed to find the best fit equation in the case of RapidEye and Landsat images.

2.2.4 *Apply best fit regression relation to the entire study area for the estimation of carbon stock in the stand.*

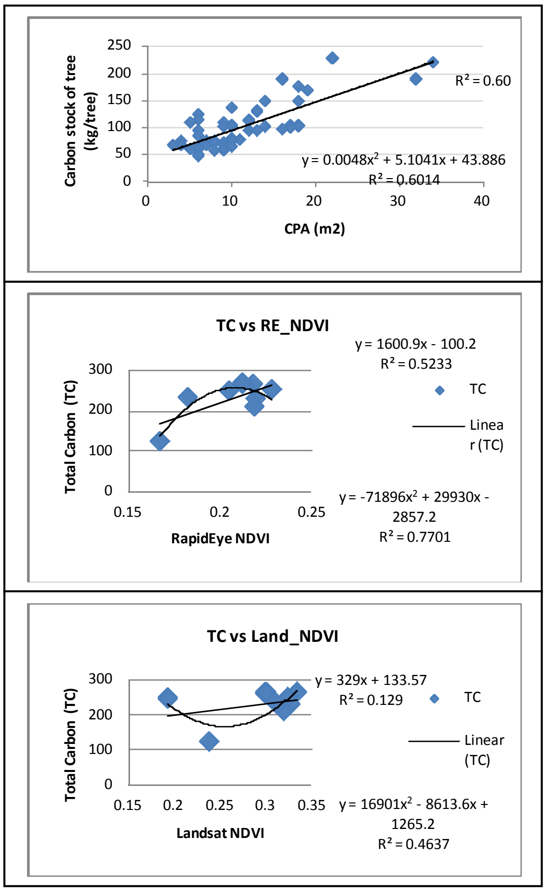
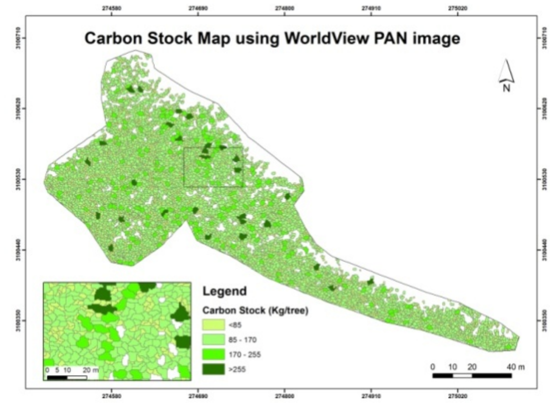
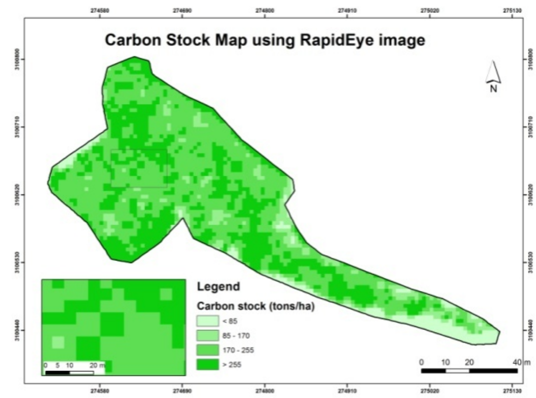


Table 4 Comparison of R2 relating WorldView, RapidEye and Landsat data with total forest carbon

3 RESULTS AND DISCUSSION

The result shows the wall to wall map using the best fit regression equation using CPA in case of WorldView and NDVI in case of RapidEye image.





The relation of between total carbon is regressed with the parameter used and found that CPA method has higher R2 value (0.6) while we are looking linear relation. If we see the Polynomial relation there, NDVI of RapidEye is giving the best result with the R2 value of 0.77.

4 CONCLUSION

In conclusion, the result derived from the study gives the freedom to conclude that the RapidEye image and WorldView images can give the better estimates of forest biomass carbon as compare to the Landsat images.

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DATA ACQUISITION FOR SEARCH, RESCUE AND RELIEF OPERATION IN AFFECTED AREAS CAUSED BY NATURAL DISASTER

Rabin K. Sharma

***Abstract**: Nepal is vulnerable to number of disaster and consequently has to bear loss of properties and infrastructures as well as human and cattle lives. In such circumstances, responsible authority should response for search, rescue and relief operation for the affected people due to disaster. In order to perform this job, they need spatial data of the affected areas and social data and information related to the disaster. There are several options for acquisition of such data and this paper tries to recommend for adopting a suitable mechanism.*

Introduction

Every part of the world would experiences disaster either due to natural phenomenon or due to human negligence. Bigger the magnitude of the disaster, bigger will be the amount of destruction. When there is loss or damage of the properties, infrastructures and lives then responsible authority should assess the damage and should act promptly to support the affected people and should prepare plan to stabilize the situation caused by the disaster. Basis to prepare the plan is the data and information collected aftermath of the disaster. There are several methods for collection and should choose the appropriate mechanism so that the necessary data and information should be collected in a short span of time, should obtain reliable data and information and the procedure should be economical. Based on the data and information collected, the responsible organization should response for the search, rescue and relief operation.

1 DIFFERENT TYPES OF NATURAL DISASTER IN NEPAL

Disaster never comes by giving information, in other words, occurrence of disaster cannot be predicted in advance, it occur all of a sudden. So the people will hardly get time to take precautionary measures for their safety. There are different types of natural disaster such as flood, landslides, Glacial Lake Outburst Flood (GLOF), avalanche, earthquake, volcanic eruption, tsunami, cyclone, tornado, et cetera. Whatever type of disaster it is, it destroys the infrastructures standing in nearby of its affected areas, takes lives of human and animals or could be injured. Amount of losses and destruction entirely depends upon the size or intensity of the disaster. Bigger the size of disaster more will be the destruction. However, amount of destruction could be minimized by creating awareness to the people, adopting strictly proper policy, rules and regulations with respect to disaster and materializing the precautionary measures such as following land use policy, performing geological study before construction of any infrastructure; identifying vulnerable places before settlements, et cetera.

Nepal is most vulnerable to different types of disaster except those related with volcano and sea because there are no volcanoes and sea in the country. In other words, there will be no volcanic eruption, should not face sea tsunami and sea cyclone. In the past, Nepal experienced several natural disasters such as flood, landslides, earthquakes, avalanches, et cetera causing destruction of agricultural field, swept away houses, loss of human and cattle, damaged infrastructures, et cetera.

It is worthwhile to give an example of a disaster related with earthquake. The experts said that Nepal is one of the earthquake prone zones of the world and ranked eleventh place in the list. So, if the past history is recalled, Nepal witnessed number of earthquakes of magnitude ranging from less than four to more than eight in the Richter scale. Earthquake caused in Nepal is due to release of energy accumulated in the process of pushing the Tibetan tectonic plate of Eurasian tectonic plate upward by the Indian tectonic plate when it is not in state to hold such energy, due to which every year, the mass of land moved northward by approximately 4 cm. Based on the past record of earthquakes in Nepal, the experts also predicted that every 70 to 100 years of time interval Nepal may experience bigger earthquake. For example, in 1934 AD, there was a huge earthquake measuring 8.4 Richter scale in Nepal due to which 8,519 people were killed and 2,074,000 structures have been destroyed in the country. After 82 years from 1934 AD, once again, on 25th April 2015, a massive earthquake measuring 7.6 Richter scale in magnitude hit the country. In this earthquake also Nepal lost large number of lives and faced huge destruction of infrastructures. According to the statistics, 8,835 people were killed and 133 cultural heritages structures and 591,648 houses were completely destroyed as well as 608 heritages structures and 276,395 houses were partially damaged.

The amount of destruction could have been minimized if the resonsible organizations have develop the definite policy to create awareness to the people, adopt building codes, took precautionary measures, et cetera. By experiencing this devastating earthquake, Nepalese people should learn lessons to prevent huge destruction due to natural disaster in future.

2 DATA NEEDED TO SEARCH, RESCUE AND RELIEF OPERATION

As mentioned above, when any type of disaster occurs in an area, there could be damage and the scale of the damage depends upon the intensity of the disaster. Destruction may affect in different sectors and several nature such as people living in the affected area may be injured or may lost lives of people, their shelters may be destroyed, stored food stuff may be mixed with the debris, infrastructures like road, bridge, canals, et cetera may be destroyed, cultural heritage structures such as temple, stupa, palace, et cetera may be damaged, and so on. When the people are affected by the disaster, they need shelter, food, water, medicine, et cetera. Government should take responsibility to provide relief materials to affected people. Besides that, the local or any people could support such people by providing any materials they need, that will relieve partially to live their daily life in such a harsh situation

The first thing is to prepare a plan for search and rescue operation. Because the responsibilities of the government are to search the persons who are affected by the disaster and who need help, to rescue the persons who are trapped and some may need to provide medical treatment and sometimes it is necessary to lift some of them by ambulance or helicopter to take to hospital who are seriously injured. Therefore, the responsible authority should have to manage a temporary medical camp(s) equipped with the necessary medicines, equipment and medical persons near the affected areas.

Next phase is to manage and supply relief materials to the affected persons and families. The relief materials could be tent, drinking water, food stuffs, medical kits, et cetera. In order to distribute the relief materials, some basis is necessary which can be regulated by local authority, volunteers, community organizations, Non-governmental organizations (NGO), International non-governmental organizations (INGO), et cetera. The plan is to be prepared based on the data collected from several sources in which delineation of affected area to be identified.

Based on the information mentioned above, data needed for the relief operation can be grouped into spatial and social data. Spatial data is the map of the area affected by the disaster. Social data consists of several information namely amount of destruction in physical infrastructures, number of family/persons affected and number of loss of human and animals, et cetera. Then the responsible authorities will distribute the relief materials based on the data provided to them.

3 TOOLS FOR SPATIAL DATA ACQUISITION OF AFFECTED AREAS

There are several tools for the data acquisition needed for the assessment of destruction caused by natural disaster ranging from traditional methods to modern methods. Selection of the method should be effective, fast, reliable and economical. Traditional methods needs lot of planning, time consuming and consequently become expensive. For example: data can be collected by physically visiting the affected areas. But, it is not simple to identify the affected areas. Secondly, access to the areas could be difficult due to damaged caused by the disaster so it will take longer time and need to bear a large sum of budget to acquired expected data. Aerial photography could be another alternate. But in the context of Nepal, this method is also not recommended because there are no organizations who could took aerial photography immediately, because the aerial photography materials needed to take aerial photography will not be in stock and it takes times to order from abroad and to receive, no special aircraft is available which can be used to take aerial photography and finally, it takes quite a long time to get permission from the concerned organizations for taking aerial photography. For instance, Mapping Committee, Civil Aviation, Ministry of Home and Ministry of Defence must grant permission to commence the aerial photography mission and the process for taking such permission cannot be completed in short span of time. Furthermore, weather condition needed to be favourable. Therefore, this method is not suitable for data collection for the purpose.

By no means, it is better to apply modern technology namely remote sensing technology. In order to apply this tool, it is necessary to acquired satellite image data after the occurrence of disaster. There are few options in this method. Firstly, there are number of international organizations who could supply remote sensing data on demand to the organization free of cost. One of such organizations is Sentinel Asia of Asia and the Pacific Region. Data provided by these organizations may be appropriate or may not be sufficient to assess the destruction mainly due to the resolution of the data. However, for immediate response to prepare the base for the assessment of the destruction caused by the natural disaster, these data could be useful. For example: in 2005 AD, when there was disaster caused by flood in Koshi area, Survey Department requested Sentinel Asia for the satellite data of the affected area. In quick response, Sentinel Asia provided the data to Survey Department and the department prepared a map of the affected area using the data and circulated the map to the concerned organization. This mission was one of the most commendable works of the department. Other option is to place order the appropriate satellite data from well known data providers. After receiving the data, an appropriate map could be prepared for the assessment of the destruction.

One of the recent technologies is Light Detecting and Ranging (LiDAR) technology which is gaining its popularity for the data acquisition due its simplicity and reliability. The system can be operated with rotary platform like Helicopter or fixed wing platform like aircraft. This method could be useful for mapping the affected areas for detailed assessment.

One of the most effective and popular methods to acquire the data is using Unmanned Aerial Vehicle (UAV); also termed as Drone. This is very easy to handle and can be used in inaccessible areas as well and can be launched immediately in the disaster affected areas. For instance, International Centre for Integrated Mountain Development (ICIMOD) had used Drone to acquire data in Sankhu, of Kathmandu after the destruction due to massive Earthquake of April 2015 and prepare a map of the affected area and shared the data and map with the concerned organization such as Ministry of Home Affairs. The map helped a lot to the Ministry for their search, rescue and relief operation in the area.

Among these several methods of data acquisition, the technology using Drone seems to be the most appropriate tool for immediate response in the case of severe disaster.

4 SOCIAL DATA COLLECTION MECHANISM

Social data for the relief operation can be collected with several mechanisms. One the most appropriate means to collect data is from the local authority. In the present context of Nepal, due to non availability of elected officials in the local authority, these organizations are not effective. Because they do not have authority to take decisions, do not have local information such as number of houses and the families dwelling in their area, do not have sufficient budget to procure relief materials, et cetera. In such circumstances, government has to collect data by mobilizing the persons from the central organizations which could be a weak part of the mission for the search, rescue and relief operation. Other option is to give authority to community organizations such as local social clubs, Nepal Red Cross Society, teaching institutions, et cetera who will mobilize a youth team who are eager to volunteer the very noble work. From the past experiences, this mechanism seems to be more effective means.

5 CONCLUSION

Disasters cannot be prevented and every disaster creates damages in different sectors. The amount of damage is depends upon the intensity of the disaster and application of precautionary measures before disaster occur. After occurrence of a disaster, responsible authority must take prompt action for search, rescue and relief operation at the areas affected by the disaster for which a plan is to be developed. In order to prepare a plan, spatial data and social information are the prime source of basis. There are several mechanisms for collection of those data and information. The most effected means to collect spatial data is the modern technology of remote sensing using unmanned aerial vehicle also termed as Drone and one of the effective options to gather social data and information is to delegate the authority to local organizations.

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EXPLORING SPATIAL DATA SHARING FACTORS AND STRATEGIES FOR CATCHMENT MANAGEMENT AUTHORITIES IN AUSTRALIA

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Keywords: Spatial Data Infrastructure (SDI), Spatial Data Sharing, Catchment Management, Natural Resource Management, Data Sharing Factors

Abstract: *Spatial information plays a significant role in addressing many decision making process including the catchment decisions. Spatial data sharing is recognized as one of the important components in spatial data infrastructure design and development. This research develops spatial data sharing strategies for the implementation of improved spatial data sharing arrangements between catchment management authorities (CMAs) and state government organizations in Australia. A mixed method research approach was utilized to collect both quantitative and qualitative data from 56 CMAs and the embedded design framework was used for the synthesis and interpretation of the results. The national survey data and case study data were collected and analyzed sequentially using the mixed method design framework. Within, the case study, social network analysis was introduced for analyzing data sharing and provides a new perspective on assessing spatial data sharing relationship. The supplemental case study analysis embedded within a larger national survey provided a supportive role and enhanced the findings from the national survey. The key factors which influence spatial data sharing between state government organizations and CMAs were identified and classified into six major classes as governance, economic, policy, legal, cultural and technical. The non-technical factors (governance, policy, economic, legal and cultural) were found to be more significant in comparison with the technical factor. Based on these findings, fourteen data sharing strategies were developed. The study suggests that the adoption and implementation of these strategies can assist in overcoming the spatial data sharing issues and hence will contribute to improved spatial data sharing arrangements between regional CMAs and state government organizations in Australia.*

1 INTRODUCTION

Spatial Data Infrastructure (SDI) is about the facilitation and coordination of the exchange and sharing of spatial data between stakeholders within the spatial community (Feeney et al, 2001; McDougall, 2006). There are many frameworks developed for sharing spatial data (Kevany, 1995; McDougall, 2006; Omran, 2007; Onsrud and Rushton, 1995; Warnest, 2005; Wehn de Montalvo, 2003). However, the frameworks are mainly based on the spatial data provider's point of view and do not recognize the power of users. Readily accessible and available spatial technologies like Google Earth, hand-held navigation systems (including smart phones, GPS, etc), Web 2.0/3.0 technology and social media has created the opportunity for users to contribute towards SDI development. Therefore, it is important to examine the spatial data sharing issues and to formulate roadmaps from the community's perspectives.

Mixed methods strategies are less well known than either the qualitative or quantitative approaches. However, in recent times there has been a growing recognition of collecting and analyzing both qualitative and quantitative data in a research study and mixing them. It has been argued that the overall strength of mixed method in a study is greater than either qualitative or quantitative research (Creswell and Plano Clark, 2007). Blending both qualitative and quantitative research methods can create an optimal design although both single methodology approaches (qualitative only and quantitative only) have strengths and weaknesses. The combination of methodologies can focus on their relevant strengths. Different scholars have used different terms (e g integrative, combined, blended, mixed methods, multi-method, multi-strategy) to identify studies that attempt such mixing (Collins et al, 2007; Creswell and Plano Clark, 2007; Tashakkori and Teddlie, 2007). However, the term mixed methods seems to be accepted by most scholars. It has also been argued that qualitative method often needs to be supplemented with quantitative methods, and vice versa (Baran, 2010), and go hand in hand.

This paper utilize mixed method research and identify key factors that influence spatial data sharing between state government organizations and catchment management authorities (CMAs). It has explored the spatial data sharing factors and developed strategies from the community's perspectives to improve spatial data sharing arrangements between CMAs and state government organizations in Australia.

2 RELATED WORK

One of the key motivations for spatial data infrastructure (SDI) development is to provide ready access to spatial data to support decision-making (McDougall, 2006).Various frameworks and models on data sharing are found in the literature. Among them are a generic model of the Mapping Science Committee of the National Research Council (National Research Council, 1993), taxonomy for research into spatial data sharing (Calkins and Weatherbe, 1995), antecedents and consequences of information sharing (Pinto and Onsrud, 1995), factors relevant to GIS data sharing (Kevany, 1995), a typology of six determinants of inter-organizational relationships (Oliver, 1990), typology based on inter-organizational relations and dynamics (Azad and Wiggins, 1995), an organizational data sharing framework (Nedovic-Budic and Pinto, 1999) a model of willingness based on theory of planned behaviour (Wehn de Montalvo, 2003), interaction between organizational behaviour of spatial data sharing and social and cultural aspects (Omran, 2007), a collaboration model for national spatial data infrastructure (Warnest, 2005), local government data sharing (Harvey and Tulloch, 2006; Tulloch and Harvey, 2008), the local-state data sharing partnership model (McDougall, 2006) and geospatial one-stop (Goodchild et al, 2007). McDougall (2006) examined the empirical research on spatial data sharing and SDI and summarized the spatial data sharing models/frameworks into characteristics, strengths and limitations. Most of these frameworks were based on the authors' experiences and have not been proven empirically except for Nedovic-Budic and Pinto's (1999), Wehn de Montalvo's (2003) Harvey and Tulloch's (2006) and McDougall's (2006).

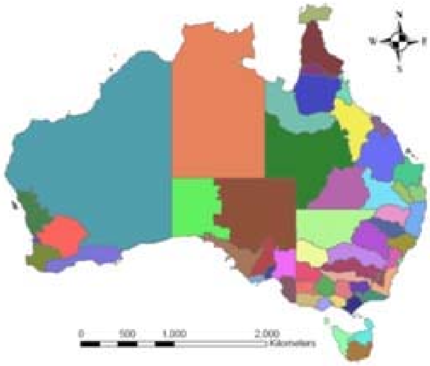
The use of qualitative and quantitative research in land administration and SDI related research is not a new approach. The case study research framework design is the most common research approach on SDI related research. Cagdas and Stubkjar (2009) analyzed ten doctoral dissertations on cadastral development from the methodological point of view and found that case study research was favoured in all the reviewed research. Several doctoral dissertations related to the SDI field (Chan, 1998; Davies, 2003; McDougall, 2006; Mohammadi, 2008; Rajabifard, 2002; Warnest, 2005) used both qualitative and quantitative strands in their studies. However, except for McDougall, all others did not use a mixed method design framework when combined with both qualitative and quantitative strands. Smith et al (2003) utilized the mixed method approach to GIS analysis. They asserted that a mixed-method would provide a more comprehensive analysis of the use of GIS within the National Health Service (NHS). Further, they argued that combining survey results and interview data within mixed method design framework enhanced the research findings. Another significant use of the mixed-method in GIS research was by Nedovic-Budic (Unpublished) who explored the utility of mixed method research in GIS (cited in McDougall, 2006). Wehn de Montalvo (2003) also used the mixed-method in her study, however her design frameworks were based on theoretical grounding (theory of planned behaviour) rather than on a mixed method design framework as suggested by mixed methods researchers (Creswell and Plano Clark, 2011; Tashakkori and Teddlie, 2003; Tashakkori and Teddlie, 2009). McDougall (2006) utilized the mixed method design framework during his SDI research and advocated it as the best of both qualitative and quantitative worlds. His study provided a very structured approach to combine both qualitative and quantitative data. The structure of this study utilizes the embedded research design framework as suggested by Creswell and Plano Clark (2011).

3 METHODOLOGY

In this section, the study area and the research method has been discussed. The institutional arrangements of CMAs (regional NRM bodies) and the framework of embedded mixed method design framework are explored in sections 3.1 and 3.2.

3.1 Study Area Description

Catchment management authorities (CMAs) have been established to address complex catchment management/natural resource management issues that involve many community groups and government agencies. All states/territories have some form of catchment management authorities or natural resource management groups under their jurisdiction and there are 56 CMAs (also called regional NRM bodies) which are responsible for catchment management in Australia. The CMAs vary in their name, corporate structure, catchment management philosophy, and relationship to the state government organization. They are termed catchment management authorities in New South Wales and Victoria, catchment councils in Western Australia, NRM boards in South Australia, regional NRM groups in Queensland and Regional committees in Tasmania. CMAs comprise representatives of the major sectors of the community and government which are involved in, or influenced by, the management of land and water resources in the catchment. Their major role is to provide a forum for community input and discussion, prioritize the issues, and develop and promote the adoption of catchment management strategies. Figure 1 shows the location of case study area and boundary of 56 CMAs (NRM regions).



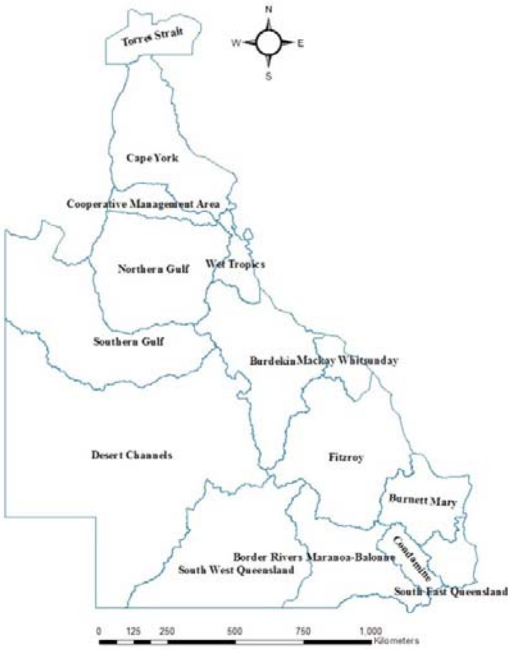


Figure 1: Location map of study areas

3.2 Research Method

It has been argued by a number of researchers that the selection and use of appropriate data collection and analysis techniques are very important to the success of research (de Vaus, 2001; Marshall, 2006; Yin, 2009). The use of qualitative and quantitative strands in SDI related research is a most common approach. However, in recent times, there has been a growing recognition of collecting and analyzing both qualitative and quantitative data in a research study and mixing them. It has been suggested that the overall strength of mixed method in a study is greater than either qualitative or qualitative research (Creswell and Plano Clark, 2007). This study has utilized the mixed method approach and followed the embedded design framework suggested by Creswell and Plano Clark (2011) (Figure 2). The survey and case study data were collected and analyzed sequentially (i.e. in two phases) with the outputs from the two methods integrated. The case study component was the supplementary component of the survey design and different research questions were addressed in the survey and case study design to achieve the main aim of this research. After the integration, the common findings were interpreted. The quality of the output was examined through the validity of the findings.

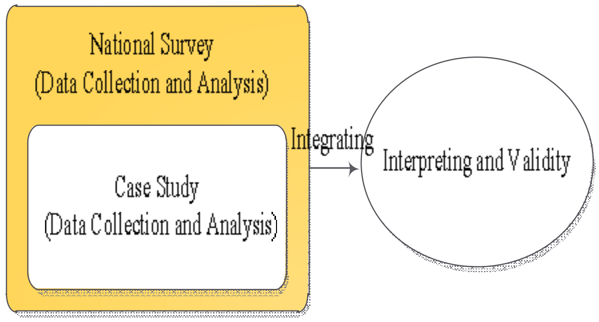


Figure 2: Mixed method: the embedded design

The survey was conducted with all 56 CMAs responsible for catchment management in Australia. The majority of questions were closed and categorical type and were measured on a five point Likert scale. The survey was undertaken from June 2010 to September 2010. A total of 56 valid responses were received to the on-line questionnaire giving an overall response rate of 100%. The online questionnaire was designed such that the data from questionnaire was automatically collected into an Excel spread sheet via a web server. This eliminated the possibility of errors in coding and transaction and accelerated transferring data into the data analysis software. The raw data were reviewed and cleaned up before inputting into the statistical software. The statistical analysis was performed using SPSS statistics package.

The Knowledge and Information Network (KIN) project was selected as a representative or typical case to investigate spatial data sharing process for catchment management. The main stakeholders of KIN project were Queensland Regional Groups Collective (RGC), 14 regional NRM bodies and Department of Natural Resources and Mines (DNRM). RGC is the lead body for regional NRM bodies in Queensland and represents the interests with the 14 regional natural resource management (NRM) bodies in the state. Regional NRM bodies are responsible to develop regional NRM plans and deliver sustainable catchment outcomes at grass-root level. DERM was the state agency responsible for funding support and overall coordination. Semi-structured interviews were conducted with all 14 regional NRM bodies, state government representatives and Queensland Regional NRM Groups Collective (RGC) which provided an in-depth understanding about NRM KIN project and its working principles. Both telephone and face-to-face interview methods were used. A brief questionnaire was conducted targeting 18 stakeholders; 14 from regional NRM bodies, two from state government organizations and two from the RGC. It consists of six categories of organizations/professionals including DERM, RGC, regional NRM bodies, Landcare groups, landholders/farmers, and knowledge coordinators. The questionnaire was distributed to a non-random and purposive sample of representatives from project stakeholders to quantify the frequency of interaction, exchange of spatial information, and role of organization in achieving the KIN goal. The data collected through the questionnaire was analyzed using social network analysis software (UCINET and NetDraw). The primary reason for undertaking the social network analysis was to measure the relationships between the KIN project stakeholders.

Using the mixed method design framework as suggested by Creswell and Plano Clark (2011), the key factors which influence spatial information sharing between state government organizations and regional NRM bodies/catchment management authorities were identified and classified into six major classes as governance, economic, policy, legal, cultural and technical. Based on these findings, fourteen data sharing strategies were developed.

4 RESULTS

4.1 Results from Survey: Descriptive Statistics

4.1.1 *Spatial Capacity of CMAs and GIS Activities*

The majority (approximately 70%) of CMAs identified themselves as being both a user and provider of spatial information and the rest as being a user (Figure 3). This response demonstrates that the regional NRM bodies not only use spatial information but also produce spatial information. This provides a strong base for developing spatial data infrastructure (SDI) in the catchment management sector.

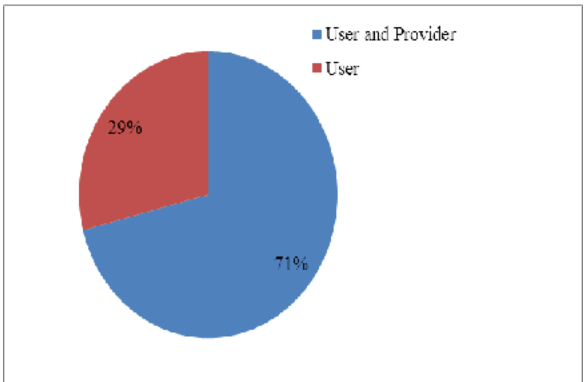


Figure 3: Breakdown of user/provider of spatial information

With respect to the use of spatial information by CMAs staff, 40 out of 56 CMAs indicated that over 40% of their staff use spatial information. In contrast, only 7 out of 56 CMAs indicated that less than 20% of their staff utilize spatial information. This result indicates that there is a strong spatial information awareness and use among regional NRM staff.

The GIS activities are also not new for regional NRM bodies. 26 out of 56 CMAs have been using GIS/spatial information for five or more years and only three NRM bodies have been using spatial information for less than two years. This illustrates that the majority of CMAs in Australia are quite mature with respect to using spatial information as part of their catchment decision-making processes.

4.1.2 *Importance of Spatial Data for Catchment Management*

When asked to identify the role that spatial information can play in addressing the catchment management issues, it was interesting to observe that approximately 60% of the CMAs responded that spatial information can play a very significant role, with the remaining 40% of the organizations responding that it can play a significant role. Not a single organization responded that it was not aware of the role of spatial information in addressing catchment management issues. This response indicates the importance of spatial information in supporting the development of SDI at the regional level (catchment level).

4.1.3 *Information Flow and Data Access*

It examined the effectiveness of access to spatial data from data providers. Approximately half (48%) of the CMAs indicated that access was neither easy or difficult, 18% indicated that it was easily accessible and 11% indicated that it was very accessible. A minority (23%) of CMAs indicated that it was difficult. In regards to the effectiveness of access to spatial data from spatial data providers, the response did not indicate any strong trends or issues for regional NRM bodies in accessing spatial information from spatial data providers.

The majority of organizations (77%) indicated that they also supplied spatial information. The main users of spatial information that was generated or value-added by CMAs were the community organizations such as Landcare, Watercare, Birdwatch, landowners and indigenous groups. Government organizations, the private sector and academic research institutions utilized spatial information managed by CMAs less frequently. It was also evident that there is a two-way information flow between CMAs and government organizations. As a result of this mutual interest, government organizations are interested in collaborating and networking with CMAs via data sharing agreements.

4.1.4 *Spatial Information Sharing Factors*

Spatial information sharing factors were identified and their importance in facilitating information sharing with other organizations was examined. Having a formal agreement, organizational attitude to sharing, individual attitude, ability and willingness to share, and leadership were found most important.

The collaborative arrangements of CMAs with other organizations with respect to the exchange of resources, skills and technology were examined. The majority (83%) of the CMAs advised that they have a collaborative arrangement with other organizations. After investigation, it was found that data sharing and spatial information management were the main areas of collaboration.

Table 1 lists the spatial information sharing factors and their importance as rated by regional NRM bodies.

Table 1: Spatial information sharing factors and their importance

Spatial Information Sharing Factors	Importance
Formal agreement	Very High
Organizational attitude to sharing	Very high
Individual attitude, ability and willingness	Very High
Leadership	Very High
Networking and contacts	High
IT system and technical tools	High

4.2 Results from Case Study: Social Network Analysis

The primary reason for undertaking the social network analysis was to measure the relationships between the KIN project stakeholders. This research measured three types of relationships namely: transactional relations, communication relations and authority-power relations. The reasons for measuring relationships were to quantify the frequency of interaction, exchange of spatial information and the role of organization in achieving the KIN goal.

The organizations were differentiated in the diagram by different node colours, node position, and node size and line width to show the interaction between organizations in network. The results from social network analysis of the KIN project are described in the following sections.

4.2.1 *The Frequency of Interaction*

The frequency of interaction was used to measure the communication relationship between catchment communities and state government organizations. The organizations were asked to rate the frequency of interaction with other organizations and their responses were measured on a five point Likert scale (from very frequently to rarely).

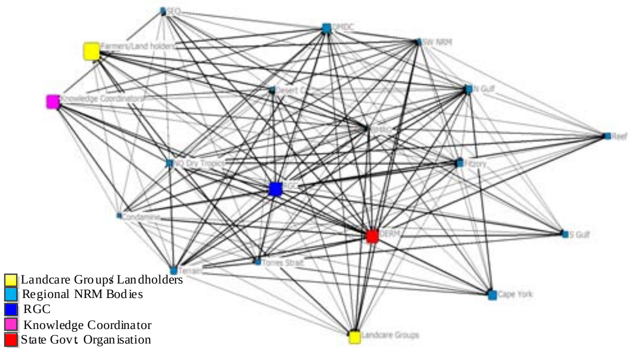


Figure 4: Frequency of interaction

Figure 4 shows the frequency of interaction between CMAs and other organizations. Five types of organizations directly or indirectly contributed to the KIN project. The different colour nodes represent the organization type. The size of the node represents the value of InDegree centrality and the rate of frequency of interaction with other organizations. The thickness of lines depicts the frequency of communication. The larger the node size, the greater the frequency of interaction and the value of InDegree centrality. The network position shows the importance of each organization with respect to the communication.

It was observed that regional NRM bodies/CMAs had frequent interactions with farmers/land holders and landcare groups, though these groups were not directly involved in the KIN project. CMAs also communicated frequently with knowledge coordinators, RGC and DERM. RGC appeared at the centre of the network with a high InDegree centrality value in communication and could be viewed as a good mediator in the process of spatial information sharing. There was little communication between DERM and the Landcare groups/farmers. The communication between CMAs also varied. There were greater levels of communication between adjacent regional NRM bodies compared with geographically distant bodies. However, it was found that if groups had common environmental concerns and good professional relationships they had a greater number of interactions. Further, the regional NRM groups had more frequent communication with external organizations (DERM, Landcare groups, etc) in comparison with internal regional NRM bodies. RGC and DERM both appear at the centre of the network. The organizations which appear at the centre of the network diagram indicate the importance of their role to maintaining communication relationships.

4.2.2 *Rate of Flow of Spatial Information*

The flow of spatial information was used as a unit to measure transactional relationships between organizations. Participants were asked to rate the flow of spatial information between their organization and other organizations. Their responses were measured on a five point Likert scale (from more to less).

Figure 5 shows the flow of spatial information and spatial information exchange between CMAs and other organizations. There were four different categories of organizations involved in spatial information sharing and the organizations are differentiated by node colours. The variations in line weights represent the rate of flow of spatial information between organizations. The thicker the line weight the greater the flow of information. The size of the node represents the value of InDegree centrality. As discussed earlier, there were both spatial information providers and users in the network and they had varying capacities for spatial information collection and management. NRM bodies provide spatial information to community groups like Landcare groups and farmers/land holders. The community owned spatial information is also provided to government (namely DERM). RGC is at the centre of the network so again it could be perceived that RGC is a key mediator and facilitator of the spatial information sharing process. Further, it was found that the flow of spatial information with adjacent CMAs is higher than with those that are more distant.

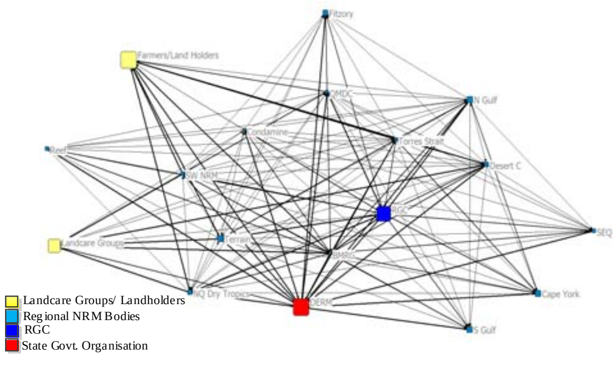


Figure 5: Flow of spatial information

4.2.3 *Role of Organizations in Achieving the KIN Goal*

The value of InDegree centrality was used to measure the role of an organization in achieving the KIN goal. Participants were asked to rate the importance of the role of organizations/professionals in achieving the KIN goal. Participants rated each of the organizations on a five point Likert scale (from highest to lowest) and their responses were recorded and used for social network analysis.

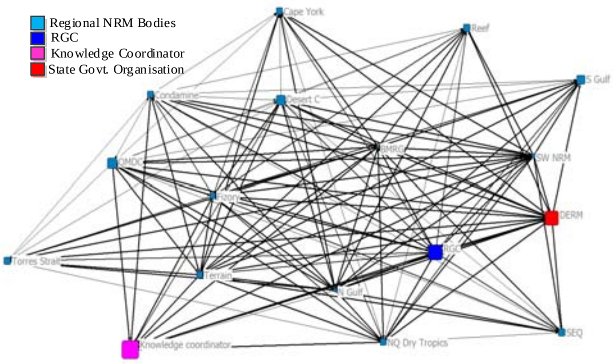


Figure 6: Role of organizations in achieving the KIN goal

Figure 6 shows the role of organizations in achieving the KIN goal. The importance of the role is demonstrated by the size of the node and the size of the node represents the value of InDegree centrality. The larger the node size, the greater the importance of the role of organization. The organizations which appear at the centre of the network diagram indicate the importance of their role in achieving the KIN goal. Three organizations were identified as having important roles in achieving the KIN goal. As RGC is at the centre of the network, it has one of the strongest roles. Knowledge coordinators also have very important roles. The role of CMAs varies, however, RGC could be seen as having a coordination role in bringing all the CMAs together. This is a state-wide project and DERM has provided the funding, so it also has an important role in the network. This network analysis demonstrated that intermediary organizations and professionals play a very important role in achieving the KIN's goal.

5 SYNTHESIS

This research followed the embedded mixed method design. In the embedded mixed method design, different datasets are connected within the methodology framed by other datasets at design phase to help in interpretation of the results (Creswell and Plano Clark, 2011). The case study results provided a supportive role and enhanced the findings from the national survey.

Following the national survey of CMAs and the case study, this list of factors has been classified into six major classes which are influencing, or contributing to spatial data sharing. These classes of factors are: governance (sharing environment), policy (rules for sharing), economic (value of sharing), legal, cultural (will to share) and technical (capacity to enable sharing). The first five classes of factors are non-technical factors and the last is a technical factor (Figure 7).

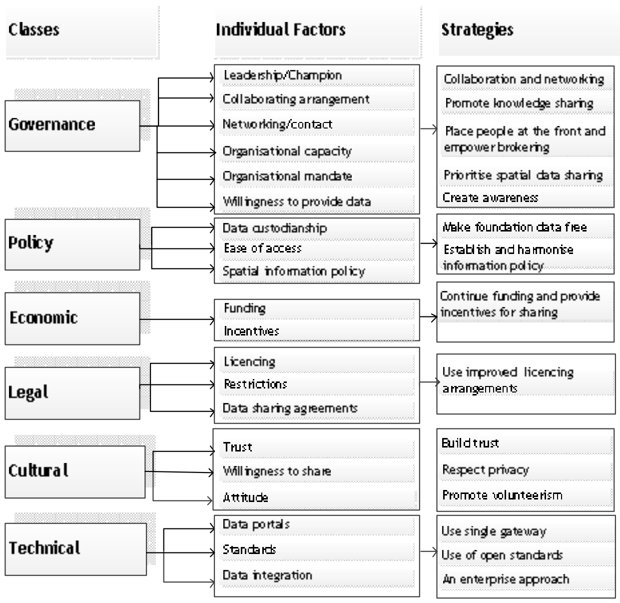


Figure 7: Spatial data sharing factors and strategies

The six main governance factors that influence the spatial information sharing between CMAs and state government organizations include leadership/champion, collaboration arrangement, organizational capacity, networking/contact, organizational mandate and willingness to provide spatial data. Spatial information policy, data custodianship and ease of access were the three main policy factors. There were no or limited policies/guidelines in CMAs to manage spatial information. Specifically, there was no policy to return the spatial information collected by CMAs to the state repositories or to utilize that spatial information for updating state-wide NRM databases. Spatial information sharing was not considered a part of the organizational mandate and was always considered a lower priority. The continuity of funding and incentives for spatial information sharing activities were the two main economic factors, whilst the data sharing agreements, licensing and restrictions were identified as the legal factors. CMAs (Regional NRM Bodies) were used to multiple licensing arrangements with state government organizations and showed interest in sharing data under the Creative Commons Framework. Trust, willingness to share and attitude were cultural factors. The landholders' data contained information that was considered private and they feared that their information could be used against them by government. The data portal, standards and data integration and the lack of a single gateway to access NRM related spatial information were identified as technical factors.

The strategies were developed to address the spatial data sharing factors. The adoption and implementation of these strategies can assist to improve spatial data sharing. Further, these strategies can accelerate the progress in the development of catchment SDI initiatives.

6 CONCLUSION

This paper has contributed to the current body of knowledge by exploring the spatial data sharing arrangements in catchment management areas and developing spatial data sharing strategies utilising mixed method research approach to facilitate spatial data sharing between catchment management communities and government agencies. The national survey provides a unique nation-wide perspective on the spatial data access and sharing for catchment management. The outputs from the survey will help to identify priority catchment management issues, national NRM datasets and information infrastructure in Australia. Spatial information plays a significant role in addressing the catchment management issues and majority of regional NRM bodies agreed this statement. The social network analysis was found to provide some useful measures to understand and visualize the various relationships including the communication relationship (frequency of interaction), transactional relationship (spatial information exchange), and authority-power relationships (role of organization) in collaboration and networking. It was clear there is growing utilisation of open models and social media for spatial information management and knowledge sharing at the community level.
The critical factors for improving data sharing across catchment management authorities were identified through triangulating the findings from the literature review, the results of the national survey of CMAs and the KIN project case study. Eighteen issues were identified as being highly significant and classified into the six major classes of organizational, policy, economic, legal, cultural and technical. The non-technical factors (organizational, policy, economic, legal and cultural) were found to be more significant in comparison with the technical factor. Based on these findings, spatial data sharing strategies were developed. The strategies from this research have the potential to improve spatial information sharing between CMAs and government organizations to support better catchment management decisions.

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CALENDER OF INTERNATIONAL EVENTS

FIG Working Week
Date: 2-6, May 2016
Country: Christchurch, New Zealand
Email: fig@fig.net
Website: www.fig.net
Organizer: FIG

Geospatial World Forum
Date: 23-26, May 2016
Country: Rotterdam, The Netherlands
Email: info@geospatielworldforum.org
Website: www. geospatialworldforum.org
Organizer: Geospatial World Forum

International Forum on GNSS and LBS
Date: 10-13, May 2016
Country: Moscow, Russia
Email: info@insidegnss.com
Website: http://www.insidegnss.com/

Group on Earth Observation (GEO) Planery
Date: 4-8, April 2016
Country: Paphos, Cyprus
Website: http://www.cyprusremotesensing.com/
Organizer: Cyprus Remote Sensing Society

28th International Cartographic Conference
Date: 2-7 July, 2017
Country: Washington D.C, U.S.A
Email: ICC2017reg@conferencemanagers.com
Website: www.icaci.org
Organizer: ICC

International Society for Digital Earth
Date: 19-21 September 2016
Country: Dushanbe,Republic of Tajikistan
Email: ilhomjon.oimahmadov@ingeos.tj
Website: http://www.iseoca.org/
Organizer: ISDE

Photogrammetric Week
Date: 11 - 15 Sept., 2016
Country: Stuttgart, Germany
Email: martina.kroma@ifp.uni-stuttgart.de
Website: www.10times.com/photogrammetric-week
Organizer: IFP

International Astronautical Federation
Date: 26 – 30 September, 2016
Country: Gaudalajara, Mexico
Website: www.iac2016.org
Organizer: IAC

South Asia Geospatial Forum 2016
Date: 2-3 March, 2016
Country: Delhi, India
Email: info@geosmartindia.net
Website: http://geosmartindia.net
Organizer: GeoSmart India 2016

37th Asian Conference on Remote Sensing
Date: 17-21 October, 2016
Country: Colombo, Srilanka
Email: acrs2016cmb@gmail.com
Website: www.acrs2016.org
Organizer: ACRS

ISPRS XXIII Congress
Date: 12-19 July, 2016
Country: Prague, Russia
Email: knyaz@gosniias.ru
Website: http://www.isprs2016-prague.com
Organizer: ISPRS

IDENTIFYING SPATIAL SCALE AND INFORMATION BASE: AN ESSENTIAL STEP FOR WATERSHED MANAGEMENT AND PLANNING

Shova Shrestha, PhD

1 BACKGROUND

All human, plant and animal life and interactions and physical processes are connected through river basins/watersheds. A river basin or watershed describes an area of land that contains a common set of streams and rivers that all drain into a single larger body of water, such as a larger river. Rainwater that falls subsequently drains into the watershed. Not only does water run into the streams and rivers from the surface of a watershed, but water also filters through the soil, and some of this water eventually drains into the same streams and rivers.

Nepal is drained by four major rives systems namely, Koshi in the east, Gandaki in the middle, Karnali in the west and Mahakali in the far west. Rivers and streams of these four major systems are grouped into three different categories based on their origin (Bogati et al., 1997). Rivers originating from High Himalaya region is categorized as Class I rivers. Rivers originating from high and middle mountains (Mahabharat range), most of which are tributaries of Class I rivers are categorized as Class II rivers. Class III rivers originate from Siwaliks and either flow into Class I and II rivers or flows directly into southern Gangatic Plain. These rivers and streams flowing through different physiographic regions constitute number of river basins and watersheds of varying sizes and characteristics. Mountain watersheds are characterized by high physical diversity and relatively high population densities with nearly all the people relying on watershed-based resources for their livelihoods. Watershed ecology is thus very important to the people of this country. Sharp physiographic and climatic contrasts in combination with other natural phenomena contribute to the fragility of Nepalese watersheds.

Basin and Watersheds form natural boundary and they do not follow political / administrative boundaries, and in fact encompass several cultural, regional and economic boundaries. What happens in one part of the watershed will impact resources and people who depend on it in the area downstream. Rational management of upstream and downstream of a watershed is equally important for the sustenance of the environment. Therefore it is extremely important to use an integrated spatial approach for managing watersheds and river basins. With the concept of multidisciplinary integrated approach got an impetus the integrated approach of GIS and Remote Sensing is being recognized universally as the unique, highly effective and versatile technology for planning, management, monitoring and evaluation of natural resources and environment (Ma, 2004). Because of the highly complex nature of human and natural systems, the ability to understand them and project future conditions using a watershed approach has increasingly taken a geographic dimension. With the advancement of earth science technologies, software environments, computers and availability of large volumes of digital data, GIS application in watershed management has changed from operational support to prescriptive modeling and tactical or strategic decision support system (Tim & Mallavaram, 2003).

2 GIS AND WATERSHED PLANNING

Many real-world spatially related problems, including river-basin planning and management, give rise to geographical information system based decision making. Data and information which are the basis for river basin management decisions are directly or indirectly linked with the geographical location, with the spatial entity. For this reason, geographical information systems (GIS) can play an important role in this process, since GIS is providing a convenient environment in spatial decision problem domain (Prah et. al. 2013). GIS has an advantage of assembling, developing, storing and analyzing vast amount of data from different source and in different format. Since watershed vary in size and characteristics and watershed planning need to deal with different types of data, GIS is a very useful tool to analyse and visualize relationship of the elements within watershed and how those elements interact. The establishment of linkage between various types of processes such as relationship between the hydrological processes, soil erosion and vegetation cover, human activities in current climate change and vulnerability context is very possible through GIS and other integrating tools. Some of the common application of GIS in watershed management planning includes:

- Delineation and identification of spatial scales of watersheds
- Inventory preparation of resources within watershed
- Assessment of available water and land resources
- Characterization and prioritization of watersheds for planning, feasibility studies
- Topographical analysis by extracting layers like slope, aspect, drainage density
- Thematic Mapping of resources and socio-economic aspects
- Action Plan maps for land and water resources development by integrating information

These applications are carried out during different steps of watershed planning process as outlined below:

Step 1: Inventory (Information base) and Resource mapping which includes existing status of resources, trend mapping mostly, temporal change between past and existing condition such as landuse and management practices. Most frequently used GIS data layers during this step included soils maps, land use maps and topographic data, climatic information, hydrologic information including streams, rivers, and lakes, as well as infrastructures such as roads and other information to facilitate orientation.

Step 2 & 3: During step 2 and 3 of watershed planning process topographical and other analysis will be carried out based on inventory prepared during step 1. Characterization and prioritization of watersheds and identification of problem/critical areas or high potential risk areas within a watershed is very important during this stage. Characterization and prioritization using GIS allows the relatively limited human and physical resources to be focused on the critical areas. Based on identified problem areas and issues, vision/ goals and strategies for plan could be developed.

Step 4: GIS during this step is very much useful as visualization tool for watershed management plans. GIS application is mostly confined to thematic mapping. Map output includes existing resources, socio-economic aspects such as population density, disadvantaged group cluster areas, intervention areas, conservation areas, buffer zones could be developed as supporting document.

Step 5: GIS is utilized for performance mapping after certain time period of implementation under monitoring and evaluation activities. Application could include mapping of change in status of resources, quality, quantity and access etc. after plan implementation.

3 CHALLENGES OF USING GIS

With the technological advancement and access to digital spatial database, GIS is becoming useful tool for integrated sector like watershed management and planning. But also associated with application of GIS are the challenges. GIS is a data dependent system. Unless there is up to date data, database inventory, standard methodologies and institutional mechanism GIS will not itself serve for informed and enhanced decision making. Imperative is also institutional aspects of GIS implementation. Some of the major challenges at the institutional levels are: familiarity with the tools, integration of watershed concept into GIS and integration of GIS into watershed planning process. Watershed planning and management process includes (i) technical (data, knowledge and technology) and (ii) social and ecological aspects which needs to be integrated into the process. Watershed planning and management is also an iterative process requiring an interactive process. A major challenge is facilitating the effective linkages among technical, social and ecological components through GIS. A framework is essential which highlights the institutional setting, partnerships and information technology. These three components should work synergistically to form the building blocks for GIS based watershed management planning. GIS for watershed comprises structured database of geospatial and temporal water, land and other resource data combined with tools for information processing to support watershed inventory, analysis, modeling and decision making. As GIS integrates vast amount of data from different sources and methods for analysis, development of basic methodological framework is required for watershed management planning. GIS process for watershed management planning involves data collection, database development, analysis and information and data production for decision making and management purpose. On the other hand, application of GIS tool for watershed management should be ascribed at three different stages, namely:

Making data GIS friendly is the first and foremost process. As stated earlier, GIS is a data dependent system which requires certain standard formats for data input. This process involves activities like: i) review existing data: a) collection of existing data from secondary sources b) collection of data from the field (ii) finding out mismatches and verification with reference data (iii) editing, refinement and updating data for further use and (iv) standardization and creating finalized data layers for the project area. After these processes, output will be created in the form of Information Base which includes: (i) final reference data (Watershed data at different spatial scale), (ii) updated watershed Boundary with codes (iii) updated river network data (iv) updated resource data

Use of tool for different type of spatial analysis and modeling can be carried out only after standardized database development. Use of GIS tool may range from basic map preparation to more advanced and complex spatial analysis and modeling integrating different data.

The third step though not directly related to watershed planning process is the evaluation of effectiveness of tools used. So that improvements needed, suggestions and recommendation of such tools could be done for future use.

4 DIGITAL WATERSHED BOUNDARY DATA AND CODING

The first step in any planning exercise is to identify the area the plan is to address (Meltz, 2008). But when planning for a watershed, the boundary is not as self evident as it is for administrative area such as city or district planning. Finer details of hydrological units for implementation of various watershed management schemes at lowest possible spatial scale is increasing with the community based participatory planning process in water sector. The importance of digital watershed boundaries at different spatial scale is also important due to limitation of resources such as skilled human resource, time, and cost for delineation and unavailability standard/consistent watershed boundaries at different spatial scale. This is also vital for visualizing and understanding the upstream and downstream relationships throughout a river basin at different scales. As the scale of the watershed changes from micro catchment to a larger river basin, the nature of the linkages and related effects varies. The effect which occurs at one scale (micro catchment) might have a different magnitude and impacts on another level (river basins). For the proper planning and implementation of any development program on watershed basis, it is essential to have watershed in the form of digital/hardcopy maps along with their relevant attributes. GIS as a tool has made it possible and there is increasing application of GIS tool and techniques for watershed level data creation and analysis.

The advent of GIS tools and technology, and availability of different resolution digital elevation models (DEMs) have resulted in the evolution of procedures to automatically map or derive channel networks and watershed boundaries. Due to the developments on these, much of the information that we gather from the topographic maps can now be gathered electronically using GIS (Shrestha & Miyazaki, 2006). Watersheds are not always easy to distinguish and define. Though watershed of a small stream (e.g. first order stream) is discrete and relatively easy to identify, watershed of large river is complex and difficult to define because it comprises number of smaller watersheds and catchments. There is also the matter of scale to consider.

5 REVIEW OF PRACTICES OF WATERSHED BOUNDARY DELINEATION AND CODIFICATION SYSTEM

Scale plays a critical role in preparation of effective management plan. Planning at too large scale is mostly a reason for failure of many plans because of more generalized planning objectives and clustering of sub watersheds with different characteristics into one management plan. Besides, it should consider increased number of stakeholders and varying interests, increased number of political/administrative units and generalized recommendations (Meltz, 2008). Range of standards and coding system have been developed in different countries (for example EPA and USGS in USA, Central groundwater Authority in India, Danube River System in Europe, Mekong River Basin in South east Asia etc) in an effort to understand, identify, catalogue, and name watersheds at different spatial scale. Digital spatial layers of watershed boundaries facilitate spatial analysis at different scale and nesting of lower level information into higher level data. Similarly, the codes facilitate simple hierarchical aggregation and querying using only the tables without using GIS files (e.g. shapefiles) of the stream network and watershed datasets (Furst & Horhan, 2009).

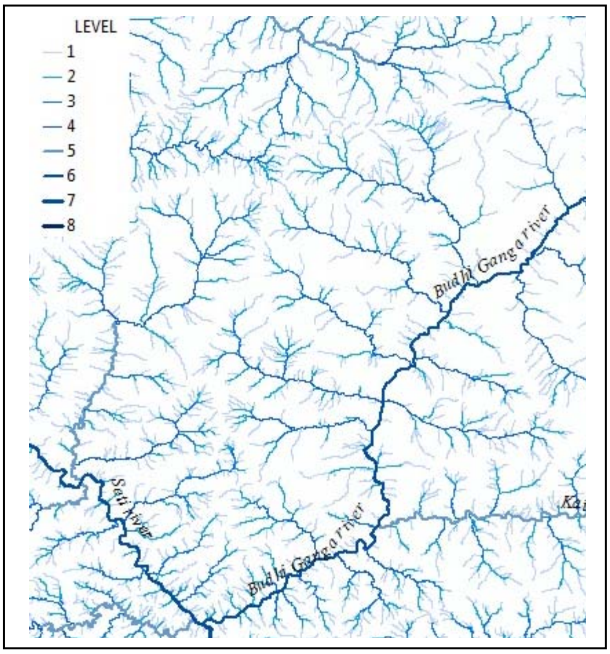
In order to standardize and catalogue watersheds in the USA, a hierarchy of Hydrologic Units was first the developed in 1974 by USGS (USGS, 2015). Each hydrological unit was assigned a code number based on where in the hierarchy the watershed belonged for very broad planning efforts. In the early 1990's, with GIS technology delineation of small scales watersheds and sub watersheds (under States responsibility) for large areas is carried out by Federal Geographic Data Committee (FGDC). The underlying concept is a topographically defined set of drainage areas organized in a nested hierarchy by size. Lowest Planning unit identified is of 25.9 sq. km. and appropriate management area unit identified is 5.18 km2. Similarly, in India, Watershed Atlas has been developed by Central Ground Water Board for entire country which includes digital boundary, name and codes for each spatial level of watersheds. It has developed a system for delineating and codifying the water region from larger areas into smaller hydrologic units i.e. sub watersheds following the 4 stage delineation which serves a national level framework of watersheds. Development of watershed oriented coding systems in Europe began more than 30 years ago and since then many different kinds of system depending on the natural conditions have been developed in various European countries (Brilly, 2010). Danube river basin system has been categorized into three levels for trans-boundary integration. Similarly, Mekong river basin has been categorized into 4 different levels for trans-boundary integrated analysis. Besides, national level sub-divisions of watersheds of each country both in case of Danube and Mekong river basin are also emphasized.

6 DISCUSSION

Need for delineation and coding of watershed boundary using GIS

Delineation of functional sub-watersheds of sizes ranging between 15-50 sq. km. within a district into a certain number and prioritization based on land use, land system and population density was initiated during 1990s in Nepal for sub-watershed level management and planning maps (Bogati et. al. 1997). However, sub-watershed prioritization is manually performed using topographical, landuse and landcover. The use of digital geospatial data for the purpose of river basin management is tightly connected with the quality and connectivity of data. The quality of spatial data is considered in accordance with certain standards that involve positional and attribute accuracy, logical consistency, completeness etc., but also in the wider context such as functional connectivity, semantic accuracy and usage (Prah et. al. 2013).

A systematic delineation of river basins for the whole country at institutional level is not yet attempted in Nepal and project area based delineation of river basin is more prevalent. Those have served the immediate project purpose but the attempts made so far for delineation of watershed units has some limitations as different data sources and methods have been employed. Previously, watersheds were delineated manually using 1:50,000 topographical sheets. It was followed by using 1:25,000 scale topographical maps with 20 meter contour interval. More recently, automated watershed boundary delineation is becoming common using GIS tool and data sources such as 20 meter digital topographical data sets, digital DEMs such as SRTM, ASTER and other high resolution



satellite imageries (DSCWM, 2016; IWMI, 2012; Shrestha & Miyazaki, 2006; WECS, 2006). Though most of the organizations use similar data sources, number and boundary shape of sub-basins and watersheds derived from those vary widely (for example DSCWM identified 42 watersheds whereas IWMI identified 33). It is realized that there is a need for systematic delineation of the river system and watershed boundaries at a national scale for a suitable spatial working scale which will aid to systematic and standard spatial units to be utilized for planning, management and development of surface water resources of the country. Keeping in view the growing requirement of watershed boundary at different spatial scale for implementing diverse development activities for different departments/ agencies for various purposes, the current need is to provide platform and base map adopting a simplified and easily understandable approach as well as coding system which will serve as a tool for assessment, planning and implementation of water resources at various spatial scales.

The thorough review of watershed boundary data and coding system of different countries provide basis for watershed boundary derivation and coding at different spatial scale for Nepal. Evaluation of prevalent watershed boundary delineation process and data used for it by different organizations in Nepal, it is realized that common standard baseline is requisite. In this context, use of river network digital topographical data set at scale 1:100, 000 produced by Survey Department of Nepal at district level could be the baseline for either contour based or DEM based watershed delineation. This database provides standard river names for main rivers, stream order (based on Strahler's classification, 1957) and reference basin number (figure 1). As required, subsequent lower order sub-watershed and catchment boundaries could be delineated nesting into standard watershed created using the baseline data.

7 CONCLUSION

A watershed cannot be delineated without knowing the river and streams it is based on and using only contour/DEM. So the first step to making data GIS friendly for watershed management is to identify river/stream and its tributaries and delineate watershed boundary. Though, GIS technology and available data has advanced to the point where watersheds for any area can be delineated by agencies, organizations, or individuals at a level of precision, it does not replace but augments the need for a standardized system of watershed boundary delineation, use of standardized spatial data and cataloging. This also facilitates identification of gaps and providing base for more detailed boundaries where required.

Importance of finding reliable GIS methodologies for identifying and visualizing watershed characteristics at different scales is unambiguous. This is especially important for watershed boundary delineation where a small local change may have a dramatic impact on planning and management efforts. The current issues related to GIS data source and watershed boundary delineation are i) same data source but variable definition and variable watershed boundaries, ii) no or variable coding for the same watershed and iii) irregular feature boundary representation of watershed boundary due to raster to vector conversion in case of automated watershed generation. Thus immediate solution to such issues are use of standardized data source e.g. topographical digital data set with existing contour/DEM data and development of standard coding system which will reinforce creation and use of standard spatial scales and codes for watersheds of the country.

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NECESSITY OF DISASTER MAPPING UNIT IN SURVEY DEPARTMENT: THE CONTEXT OF 2015 GORKHA EARTHQUAKE AND DISASTERS IN NEPAL

Kalyan Gopal Shrestha

1 BACKGROUND

Last year Nepal witnessed deadly earthquake disaster on 25th April 2015. This severe earthquake measured 7.6ML with epicenter in Barpak, Gorkha district is the largest since the 1934 big earthquake, killed about 9000, other tens of thousands injured and become homeless, destroyed housing in Kathmandu and other 13 districts, damaged many World Heritage sites, and triggered deadly avalanches around the Mount Everest. 17 days later on 12th May another big earthquake of magnitude 6.8ML with epicenter in Dolakha district escalated the casualties and destruction. The highest number of fatalities have been reported from Sindhupalchowk followed by Kathmandu and Nuwakot districts. Thirty-one of the country's 75 districts have been affected, out of which 14 were declared 'crisis-hit' (see Figure 1) for the purpose of prioritizing rescue

FIGURE 1: CATEGORIES OF EARTHQUAKE-AFFECTED DISTRICTS

Source: GoN/MoHA as of 21 May 2015

and relief operations; another 17 neighbouring districts are partially affected. Nepal is particularly prone to earthquakes as it is sitting on the boundary of two massive tectonic plates – the Indo-Australian and Asian plates. Due to the collision and the ongoing convergence between the Indo-Australian and Asian tectonic plates that has progressively built the Himalayas over the last 50 million years.

Disasters occur almost every year in one part of the country or the other causing loss of life and heavy damage to physical properties. The earthquake of 2015, 1988, 1980, 1934 and the flood of Sunkoshi in 2014 in Sindhupalchowk the Mahakali river flood in Darchula in 2013, the flood of Koshi River 2008 July, were the most devastating disasters of Nepal. In this way, the country has been found to be a disaster prone country. Each year flood, landslide, fire, epidemic, avalanche and various other natural and manmade disasters cause the casualty of thousands of human lives and destruction of physical properties worth billions of rupees. The Figure 2 shows Nepal's disaster ranking in Global perspective.

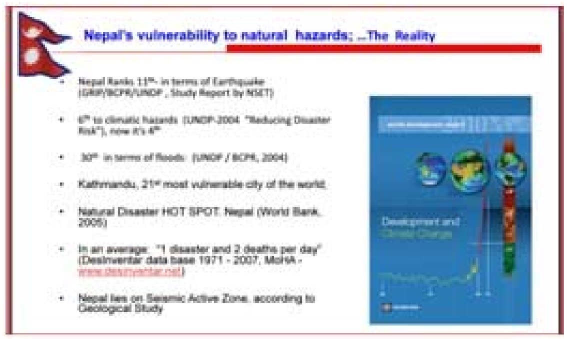

Figure 2: Nepal's disaster ranking in Global perspective

2 DISPLACEMENT OF EARTH SURFACE

Beside the damage to buildings and infrastructure, the altitude of the Kathmandu Valley has been elevated following the April 25 earthquake. Survey Department's study from 24-hour GPS survey over five control points on hills surrounding the Kathmandu valley four days after the devastating quake revealed horizontal displacements of 0.92m to 1.82m south west and elevated the surface by 0.63m to 1.16m. Even after this study, hundreds of aftershocks have been continuing. More than 425.aftershocks greater than 4 magnitudes have been recorded till the time of writing this article. So, this study doesn't reveal the complete picture of displacement. The positions of Nepal National Geodetic network is supposed to have been suffered greatly from this earthquake. A complete revival of the network is a must. Survey Department, therefore, is facing a serious challenge to publish a new set of recalculated Post- earthquake coordinates of National Geodetic network.

Figure 3

S. No.	Station	Horizontal Shift	Vertical Shift
1	Nagarkot	1.82m Southwest	1.158m up
2	Phulchoki	0.92m Southwest	0.63m up
3	Bungmati	0.99m South	0.77m up
4	Swayambhu	1.64m Southwest	0.98m up
5	Kumari (Nuwakot)	1.71m Southwest	1.093m up

3 DISASTER RISKS IN NEPAL

Nepal is becoming a disaster hotspot, with natural hazards increasing over the past two decades. Flood, earthquakes, landslides and debris flows, epidemics, fires, droughts, storms, glacial lake outbursts, avalanches, hot and cold waves etc are among the disasters gripping the Himalayan nation with increasing intensity.

This earthquake and its continuing aftershocks are the results due to tectonic action and universal planetary action. Such activities are pronounced in the Himalayan region. The constant tectonic action of different degree has adverse effect on stability of earth surface and river course.

More than 800 people die annually in Nepal because of natural hazards (with almost 1 disaster 2 people deaths per day in average), 300 deaths due to floods and landslides alone, the UNDP report,2004 stated. According to the Report, Nepal ranks fourth in the world among climatic hazards, eleventh in terms of earthquake and thirtieth in terms of flood. It is increasingly recognized worldwide that the devastating effects of natural disasters is linked to shortcomings of development policies.

4 DISASTER PREPAREDNESS AND RISK MANAGEMENT IN NEPAL

The History of Disaster Risk Mitigation in Nepal is relatively short compared to the rest of the world. Only after 80's the people as well as the government have been aware of the potential risk and have been active in disaster risk mitigation. The Udaypur earthquake of 1988 was a major awakening for the country as well as for the people. The Government of Nepal declared 16 January as the National Earthquake Safety Day (ESD). Since then various projects were implemented and workshops organized to raise the awareness of the disaster risk in Nepal.

Since the realization of the effects of earthquake disasters on the population, various programs have been launched with considerable success for Peopleawareness. For these reasons, Nepal is boosting its disaster-preparedness activities between the government and aid agencies. In spite of some such activities, greater challenges remain. Aid workers focus concentrate on post-disaster response preparedness rather than pre-hazard situations. The preparedness had to be strengthened on a par with the frequency of the disasters intensifying every year.

5 EXISTING LEGAL AND INSTITUTIONAL SYSTEMS

The legal framework for disaster management started in Nepal with the Natural Disaster (Relief) Act promulgated in 1982. This Act allocated the responsibility for preparing and responding to disasters in Nepal to the Government. The Act, for the first time in history of Nepal, provided for a disaster management administrative structure in the country. The Act recognizes earthquake, fire, storm, flood, landslide, heavy rainfall, drought, famine and epidemics as disaster. Immediate rescue and relief works as well as disaster preparedness mitigation activities are governed by the Natural Disaster Relief Act 1982 of the Government of Nepal.

According to this Act, GON has Central Disaster Relief Committee (CDRC) in Ministry of Home under the chairmanship of the Home Minister in order to formulate and implement the policies and programs relating to the natural disaster relief work and to undertake other necessary measures thereof. Moreover, the Central Committee prepares specific norms of relief assistance to be provided to the disaster victims through the District Disaster Relief Committees. Figure 4 shows the current institutional arrangement.

Disaster Management has assumed great importance in recent times. The government has been doing a lot in disaster relief operations but now there is a need to focus also on pre-disaster and mitigation efforts. To handle the situation efficiently, we need to be well-

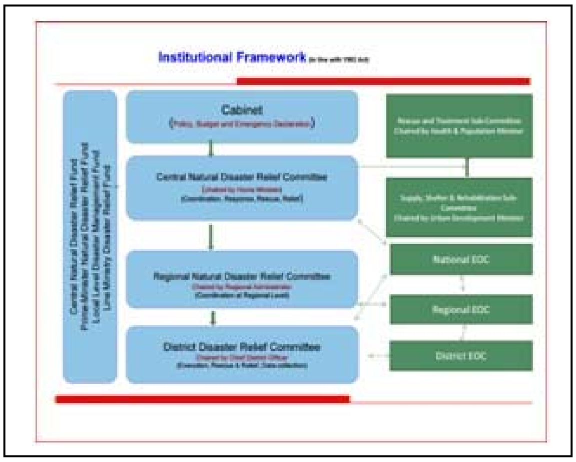

Figure 4: Institutional Framework

equipped with latest technologies for early warning system. It is unfortunate that disaster early-warning systems, except for weather forecasting, are not yet developed in Nepal to mitigate its impacts.

For an effective early warning system, it is needed to develop a scientific detection system to monitor changes in the physical environment. The system of hazard mapping, vulnerability assessment and risk analysis has to be developed.

There are basically three phases in Disaster Management:

- Pre-disaster planning and preparedness phase for Risk Reduction by Prediction and early warning,
- Post-Disaster Risk Reduction (DRR) Phase and
- Damage assessment and relief management Phase.

6 DISASTER RISK REDUCTION (DRR)

Disaster risk reduction (DRR) is a broad term that covers preventative measures to reduce the damage caused by natural hazards. Survey Department must be aware of the fact that the inability to access baseline data about the city and lack of capacity to handle a variety of new data hampers humanitarian response efforts. The creation of timely, accessible, geographic data is a critical need to establish evidenced-based DRR policies and programs.

Disaster Risk Reduction has major 5 modules, namely

- **Understanding disaster risks** - Providing a platform for seamless viewing of hazard maps. Disaster Managers could generate maps both at micro and macro level indicating vulnerability to different extents under different threat perceptions.
- **Understanding disaster impacts** - Comparison of Air Photos/satellite pictures taken before and after the Disaster. Locations remained unaffected or remain comparatively safe could be identified.
- **Assisting immediate responses** - Keeping maps up-to-date. Alternate routes to shelters, camps, and important locations in the event of disruption of normal surface communication could be worked out. Rescue workers from remote areas rely on maps in the planning of their operations. If maps don't show latest features, their smooth rescue work and evacuation operations might be significantly hampered.
- **Assisting information sharing** - Platform for Real-time Data Sharing. Locations suitable for construction of shelters, godowns, housing colonies, etc. can be scientifically identified.
- **Assisting recovery from disaster** - New mapping of the damaged areas initiates the recovery from disaster. Rehabilitation and post-disaster reconstruction works could be properly organized.

7 EXISTING TECHNICAL CAPACITIES

Nepal has a National Comprehensive Plan on Disaster Management. This plan emphasizes on improvement of national capacity for disaster management and institutional structures. This plan focuses on hazard mapping, risk assessment, vulnerability analysis and so on.

Nepal has a significant cadre of scientists, engineers, and professionals of allied disciplines, have conducted mapping of a variety of natural hazards at suitable scales, and have installed physical capacities for monitoring, analysis, and dissemination of user-friendly information to the public. Some representative examples of such capacities are:-

Department of Mines and Geology has Geological maps of entire country at 1:50,000 scale, Engineering geological maps at 1:10,000 scale for several cities, a network of 21 seismic stations capable for monitoring up to Magnitude 2 Richter earthquake,

Department of Hydrology and meteorology has countrywide hydro-meteorological stations, weather monitoring tracking, analysis, forecast, and dissemination of information for public use.

Similarly, Department of Water Induced Disaster Prevention Technical Centre (DPTC), Department of Urban Development and Building Construction (DUDBC), Department ofSoil Conservation (DOSC) and The Department of Roads (DOR) have capacities of related manpower and research labs with concerned data.

8 ROLE OF SURVEY DEPARTMENT IN DISASTER MANAGEMENT ISSUES

Department of Survey has done mapping of the country at 1:25,000 and 1:50,000 scales, digital maps of VDCs, municipalities, aerial photographs at various scale, real-time operation of continuous GPS stations, access to latest satellite mapping and interpretation capacity.

Being a National Mapping Agency and a major constituent of the geospatial community, Survey Department should take the lead in applying geospatial information technology in disaster risk reduction. Geospatial information plays a key role in disaster risk reduction (DRR). Policy makers should have better understanding of the importance of geospatial information.

But disappointingly, the role of Survey Department, which is responsible for spatial information, is ignored in the Natural Calamity Act. Hence, Survey Department, has no official representation in this CNDRC. There is a strong link between natural hazards and environment as the hazards, especially those leading to disasters, are normally caused by sudden or systematic changes in the state of inner and outer earth's surface. Geodetic Survey Branch, Topographical Survey Branch and National Geographical Information Infrastructure Project (NGIIP) under Survey Department have archived GeoInformatics: Global Positioning Systems (GPS), Geographic Information Systems (GIS), Remote Sensing (RS) data. The employment of such data in Geomatic engineering technologies could greatly contribute to the decision support system for the effective Disaster Management. Negligence of such knowledge and practices make the Nepalese Disaster Management system poor and vulnerable.

Even though Survey Department is not given a mandate by Natural Disaster Relief Act, Survey Department had, with a profound filling of responsibility to the nation, provided Topographical maps of affected areas of 17 districts free of costs promptly to the rescue teams for planning rescue works during the 2015 earthquake. The data includes transportation, hydrography, VDC boundary and Place names. The department published useful Geoinformation and Post-Disaster web maps for free download in its website to facilitate rescue teams. Survey Department had also published an interactive web map in its website http://old.ngiip.gov.np/EARTHQUAKE2072/Earthquake.html with regular updated number of deaths and injured, number of damaged houses etc among other information.

An International Workshop on "Role of Land Professionals and SDI in Disaster Risk Reduction: In Context of Post 2015 Nepal Earthquake" was held, November 25-27, as a Joint Event of FIG Commission 2: Professional Education and ISPRS Technical Commission in collaboration with Nepal Institution of Chartered Surveyor and Nepal Remote Sensing and Photogrammetric Society with support from Survey Department. The workshop offered an excellent program covered the various aspects of spatial technologies and the role of spatial data infrastructure in the context of disaster risk reduction.

In view of the above situation, the amendment of the Natural Disaster Relief Act, 1982 is must to include related organizations like Survey Department and mandating (the role, functions, duties and responsibilities) of all the disaster management-related jobs should be re-specified. For lack of mutual understanding and dialogue between the agencies, duplication of work and delays in rescue and relief work have been experienced in the past. There is a need for close co-operation and mutual understanding among all the agencies concerned.

Since the role of mapping remain very critical for all stages of the disaster management cycle: prevention, mitigation, preparedness, response and recovery, Survey Department should expand the field of mapping and geo-spatial information production and proper use of these information for the disaster management. Survey Department should undertake the task of geo-spatial data generation (especially on the basis of satellite images), map making and contribute to evaluation of the disaster risks, reduction or mitigation of disasters by providing information of the land movements to various government/non-government organizations especially devoted to the field of disaster management. Efforts of Survey Department alone may not be sufficient to generate required geo-spatial data and information required for disaster management. Survey Department should explore the possibilities of working with different national, regional and international partners working in the field of geospatial data and information for disaster management. The major roles to be played by Survey Department can be envisaged as follows:

8.1 Revival of National Geodetic Network and datum

National Geodetic Network and datum is a foundation of all kinds of mapping. So deformed Network should be adjusted. As Nepal lies on most active seismic zone, the crustal deformations caused by plate subduction will more or less always continue. Nepal cannot afford much time and money for every time revision of network by repeated field observations to all the control points. Recent earthquakes in Nepal has pushed Survey Department to develop a dynamic/semi-dynamic datum which will be based on the most current available ITRF and have the capacity to correct for tectonic deformation similar to that of Japan and New Zealand.

8.2 Providing Geospatial Information

National Mapping Agencies (NMAs) have been a sole provider of official or authoritative geospatial information in their countries. Survey Department, as NMA of Nepal should improve its mission by actively contributing to the disaster risk reduction through the applications of geospatial information technologies and the cooperation with relevant disaster management offices in the government. Disaster preparedness and rehabilitation works are humanitarian efforts to mitigate and rescue the affected people. Survey Department should take necessary actions to develop a policy to avail baseline geo-spatial data to the concerned organizations free of cost.

8.3 Developing Topographic Information

Mapping has become an integral part of a modern decision support system. Remote sensing and GIS provides a data base from which the evidence left behind by disaster that have occurred before can be interpreted, and combine with the other information to arrive at hazard maps, To make people’s lives safer, SD should support disaster management by providing precise geospatial information about the natural characteristics of land to make more accurate evaluations of disaster risks.

8.4 Hazard Map Portal Site

SD should manage a one-stop service portal site, through NGII, which allows users to search and browse various hazard maps prepared by various agencies.

9 CONCLUSION

In light of the growing applications of geospatial information in disasters, the role of National Mapping Agency is becoming increasingly important in providing relevant and timely data in the right format to users. The importance of geospatial information technology at every phase of disaster cycle, enabling decision makers to prepare for and respond to disasters in a timely manner as well as assisting individuals in understanding potential risks and taking prompt actions in case of disasters must be recognized. Survey Department of Nepal, being a national mapping agency, should setup a disaster mapping unit for the sake of enhancing country’s disaster mitigation efforts. It could work as a coordinating agency for various other institutions dealing with various types of disasters in the country so as to produce disaster hazard maps. Investment towards making use of the space technology is worth because improvement in instrumentation and time prediction will bring about reduction in disaster damages; and subsequently improved decision making in planning stages.

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REMOTE SENSING AND GIS APPLICATION IN LANDSLIDE RISK ASSESSMENT AND MANAGEMENT

Dinesh Pathak

Keywords: Geo-hazard, landslide disaster, risk assessment, disaster management, RS and GIS

Abstract: *Small as well as large scale landslides are common in the Himalayas, especially in the monsoon period. This natural disaster occurs in all the physiographic divisions of the Himalayas. Landslide is the result of a wide variety of processes which include causative and triggering factors. A complete landslide hazard assessment requires an analysis of these factors leading to instability in the region. Therefore, there is a need of multidisplinary studies of landslide hazards, which combines geology, hydrogeology and, geomorphology.*

The landslide risk is directly associated with the development activities, which will increase with increased urbanization and development, continued deforestation in landslide-prone areas, increased precipitation and seismic activity. In order to reduce the landslide risk, it is necessary to understand the underlying the processes, study the impact of landslides on the socio-economic development of the affected areas, prepare landslide hazard zonation maps to minimize the risk involved in developmental schemes, evolve a methodology for mitigation and control measures, monitor change in land use pattern and landslide occurrence, establishing early warning system and development landslide 'databank' on national level and identify potential landslides zones and prepare population maps of the critical areas.

Landslide disaster management includes a series of actions and instruments aimed at reducing the landslide risk in endangered regions and mitigating the extent of disasters. The application of Remote Sensing using aerial photographs and satellite images for landslide study, identification and inventory as well as GIS digital formats of data layers including the social data all form an integral part of landslide risk assessment and management. This paper provides synopsis about the various methods for landslide risk assessment with the use of remote sensing and GIS, which will be supportive to landslide disaster management.

1 INTRODUCTION

The mountainous region of Nepal belongs to active Himalayan Range with complex geological set up represented by many geological structures, fractured rocks, steep hill slope, diverse climate and intense precipitation. Nepal faces many natural hazards like earthquakes, floods, GLOFs, landslides and debris flows. Every year floods and landslides kill hundreds of people and causes loss of hundreds of millions rupee due to the natural disasters. About 28 percent of Nepal's total land area is degraded, when all the poorly managed forests, sloping terraces and pastures and areas damaged by floods and landslides are considered (MoEST, 2008).

Landslide is a common geological phenomenon that is dominantly affecting the human activity and development process in the mountainous region. The loss of lives and property is taking place due to landslide and flood each year in the Himalayan region. However, huge damage on human life has been occurring during the monsoon period (Pathak et al., 2010). In 2014 alone, 113 people died, 129 were missing and 96 were injured and 491 families were affected with the estimated loss of around 24 million rupees due to landslide event alone (DWIDP, 2015). Number of livestock loss is found many times than the human loss and the damage to infrastructure costs unbearably high in comparison to the economic condition of the country.

Landslide risk mapping and risk management should be aimed to reduce the disaster risk. The relevancy of Hyogo Framework for Action is equally valid till date that has identified five priorities of actions focused to risk mapping and risk management (UNISDR, 2007). These areas mainly concerned to policy issues, early warning mechanism, disaster education, risk reduction and strengthening disaster preparedness at all levels. In this context, the system of hazard mapping, vulnerability and risk assessment have to be properly developed in a systematic manner for better management of the landslide disaster.

2 LANDSLIDE HAZARD, VULNERABILITY AND RISK ASSESSMENT IN GENERAL

Hazard is defined as a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (UNISDR, 2009). Thus, landslide hazard indicates the probability of landslide event with a certain magnitude, which is the function of a number of factors that includes causative and triggering. It represents the existing condition of the slope that has potential to develop a disastrous consequence. The magnitude of landslide hazard can be classified as high, moderate and low (number of classes varies as per the objective and site condition) based upon the volume, duration, possible effect in terms of distance, area and speed at which the slope fails.

Landslide vulnerability assessment is a process to identify what elements are at risk and to analyze the root causes of why these elements are at risk. This information is useful in decision making process leading to landslide disaster mitigation measures; guide to land use zoning; helps as planning tool in landslide management plan; information dissemination to general public; enhancing institutional capacity; public awareness raising and to establish emergency management and response mechanism like establishment of early warning system. It provides technical basis for policy formulation. Landslide vulnerability can be categorized as physical (potential loss of buildings, assets, infrastructure, lifeline facilities etc.); social (age, gender, poverty, culture, attitudes of population etc) and economic (potential loss of investment, crops, etc). The latter two factors is directly associated with the coping capacity. In other words, landslide vulnerability is the expected degree of loss of the elements at risk with the scale ranging from 0 (no vulnerability) to 1 (highly vulnerable). It is concerned about the degree of damage that the event can impose which is a function of magnitude of landslide event and type of element at risk.

Landslide risk is the expected number of lives lost, people injured, or economic losses due to a potentially damaging landslide event within a period of time. Thus, landslide risk can be expressed as the product of landslide hazard, vulnerability and elements at risk. The elements at risk could be population, infrastructures, economic activities and environment exposed to landslide hazard, which are likely to be adversely affected by the impact of the hazard. The first step towards landslide risk assessment is the identification of landslide hazards followed by deciding who/what might be harmed and how. Once the landslide risk is evaluated, appropriate mitigation measures can be proposed for landslide risk reduction: The risk assessment must be updated with time as there might be changes in hazard condition and elements at risk.

3 REMOTE SENSING DATA: SOURCE OF INFORMATION

3.1 The remote sensing (RS) data

The use of remote sensing data (satellite imageries and aerial photographs) in geohazard studies is common nowadays (Pathak, 2014; Subramani and Nanda Kumar, 2012; Farina et al., 2005). Extraction of relevant spatial information related to landslide occurrence is an integral part of hazard assessment. Remotely Sensed (RS) data combined with Geographical Information System (GIS) are proved to be effective tools for generating and processing spatial information. The advancement in earth Observation (EO) techniques facilitate effective landslide detection, mapping, monitoring and hazard analysis (Tofani et al. 2013). Remote sensing data are the major source of information required for landslide risk information. High spatial resolution satellite imageries are useful for terrain feature extraction, which are the major sources of data for the preparation of different thematic layers and spatial data analysis in GIS. Some of the thematic layers are lithology, slope, land use, lineament density, precipitation distribution, altitude, slope aspect, drainages and roads etc.

3.2 Extraction of geological information

Remote sensing technology is an effective and widely established analytical method in geological investigations, especially at the inaccessible sites (Kruse and Dietz, 1991; Al Rawashdeh et al., 2016; Schetselar, 2001). Aerial imagery acquired from hyperspectral and multispectral imaging sensors such as Landsat, ASTER, AVIRIS, ALOS, IRS, Quickbird etc. are applied to geological surveys, and geomorphology applications. Nowadays, wide varieties of satellite imageries from various sensors are available at affordable cost. Moreover, limited financial resources is not the constraints like before because the satellite images can be downloaded free of cost from various sources and Google earth covers significant area of the country with high resolution imageries and it is being constantly updated with the new images. Satellite imagery correlated with ground truth data is also used for assessments of change due to natural events such as floods, landslides and earthquakes. Lineaments are the expressions of geological and structural features and form an important parameter in landslide hazard assessment (Fig. 1). These can be identified well on the aerial photograph and satellite image, which otherwise would be very time consuming and difficult to map the entire study area in the field (Rowan and Bowers, 1995). Thus extracted lineament is used to prepare lineament density map, which is an integral part of landslide hazard mapping.

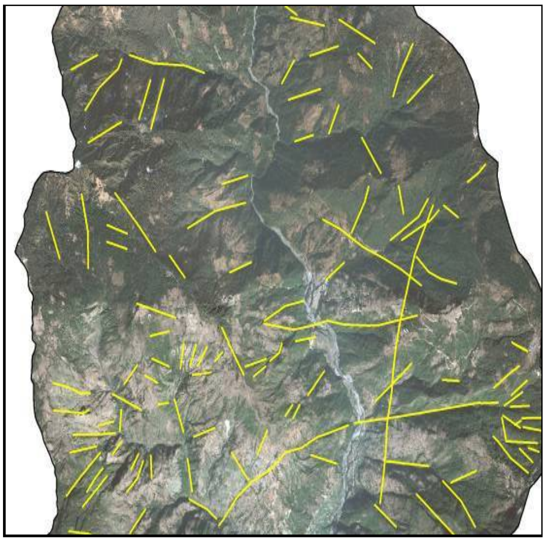

Fig. 1: Lineament extraction from the satellite image

In addition, the satellite imageries can be a valuable resource through which the small scale geological maps can be updated to large scale followed by field verification (Crippen and Bloom, 2001). Likewise, the landslide (or mass wasting) risk to settlement and infrastructure that are at the proximity of major geological structure (like thrust) can be effectively evaluated on the images and photographs (Fig. 2).

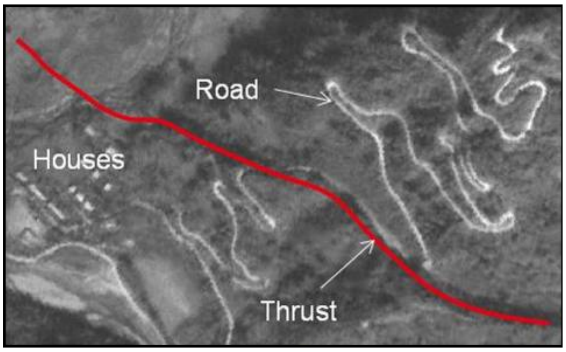

Fig. 2. Settlement and infrastructure at the proximity of major geological structure.

Such information is very useful for the image based assessment of various elements at risk due to landslide disaster.

3.3 Landslide inventory and monitoring

Preparing landslide inventory is always a difficult task if it is to be carried out through the field observation. However, use of aerial photograph and satellite image always makes it possible to complete the task at less time and effort with considerable accuracy.

The landslide activity can be well monitored through the satellite image, assessing the disastrous consequence. The temporal images of Mankha VDC, Sindhupalchowk district clearly shows the landslide disaster that occurred on August 2, 2014 (Fig. 3). The comparison of imageries before and after the event would be helpful to plan the disaster management through identification of the affected area and its severity.

Fig. 3. Monitoring the landslide activity through satellite image (Jure landslide, Sindhupalchowk). Images of 13 Feb. 2013 (left) and 10 Aug. 2014 (right).

The satellite images are equally important to assess the earthquake induced landslides through visual inspection of the images before and after the occurrence of earthquake event (Fig. 4). The earthquake may either generate new landslide or reactivate the existing landslide. The figure shows the reactivation with increase in areal extent of existing landslide.

Fig. 4. Assessment of landslide reactivation due to earthquake. Images before (left image) and after (right image) Gorkha Earthquake of April 25, 2015.

The information on spatial location of landslide, its size and activity, relationship with geology and major geological event helps to prioritize the landslides for further intervention through the application of mitigation measures. The mitigation measures at the upper catchment area and at the lower catchment area could be different.

4 LANDSLIDE ASSESSMENT IN GIS AND APPLICATION IN DISASTER MANAGEMENT

The data required for landslide hazard assessment are slope, aspect, geology and structures, land use/land cover, road network, slope curvature, drainage density, lineament density and many more. These data are obtained from existing maps, digital data, remote sensing as well as from field observation, which are stored in GIS database for analysis.

The data required for vulnerability mapping are principally the socio-economic data like population, economic condition, educational condition, awareness level in terms of disaster etc. that overall represents their coping capacity. However, the risk map incorporates both social as well as technical aspect and hence helpful to prioritize the areas for intervention leading towards landslide risk reduction initiatives (Fig. 5). Furthermore, the individual landslides should be considered as unique in nature and hence each larger landslide that could potentially harm infrastructure, settlement and agriculture fields should be studied in detail.

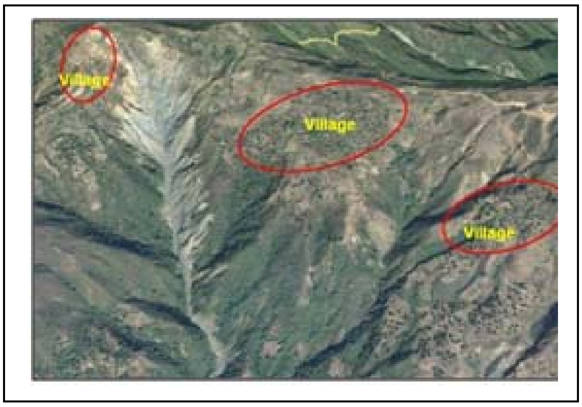

Fig. 5: The risk of landslide to settlements is clearly visible in satellite image.

Once the elements at risk are identified through the landslide assessment, the required risk reduction measures can be applied at various locations in connection to the landslide disaster management activities (Fig. 6).

Fig. 6: Landslide mitigation measure at the source area.

The type of mitigation measures to be adopted at the source area (upper catchment) and at the affected areas (lower catchment) can be assessed well. The first step towards landslide hazard assessment is to make the inventory of existing landslides in the study area and spatially locate them (Fig. 7).

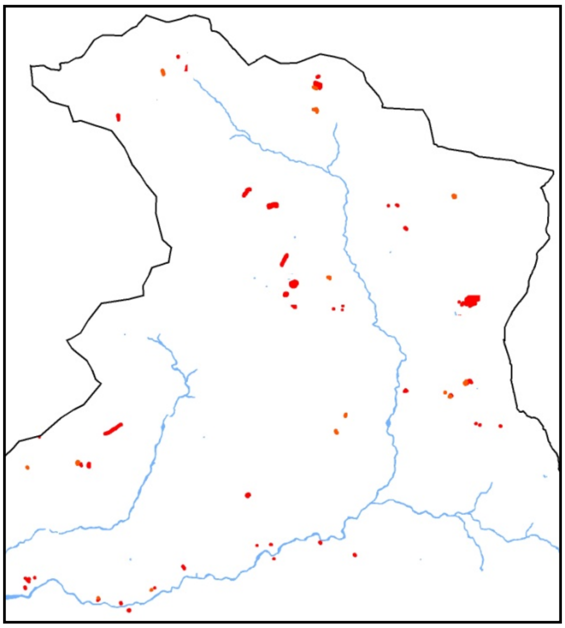

Fig. 7: Landslide inventory made through remote sensing and field survey.

So far as the complete database is prepared, landslide hazard map can be prepared through the established methodology like bivariate, logistic, knowledge based etc. (e.g. Pardeshi et al., 2013; Dahal et al., 2012; Pradhan et al., 2010; Lee, 2004; van Westen, 1997). The classified landslide hazard map is an important output to be used for the landslide disaster management activities (Fig. 8).

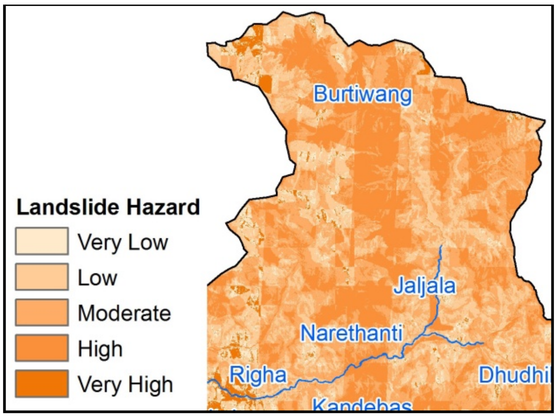

Fig. 8: Classified landslide hazard map.

Landslide hazard map prepared in this way can be used to assess the possible impact of hazard to different elements like building, infrastructures etc. Delineating the building locations with respect to landslide hazard classes provides important information regarding the consequences to be faced by the residents in case of occurrence of landslide disasters (Fig. 9). The disaster management experts should be specially focused to the buildings falling within high to very high hazard classes so as to ensure that required mitigation measures are adopted to reduce the loss of lives and properties.

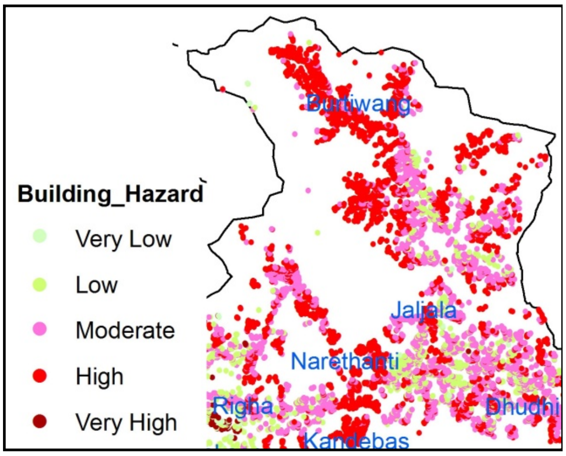

Fig. 9: Location of buildings at different hazard classes.

More importantly, the disaster risk reduction practitioners always seek for the possible evacuation center in case the disaster occurs. The possible evacuation sites should have open space, can accommodate many people and itself should be safe from the landslide disaster. Public schools are the appropriate sites to be used as evacuation centers. The schools located at the low landslide hazard can be considered to be the suitable schools to be used as evacuation center (Fig. 10).

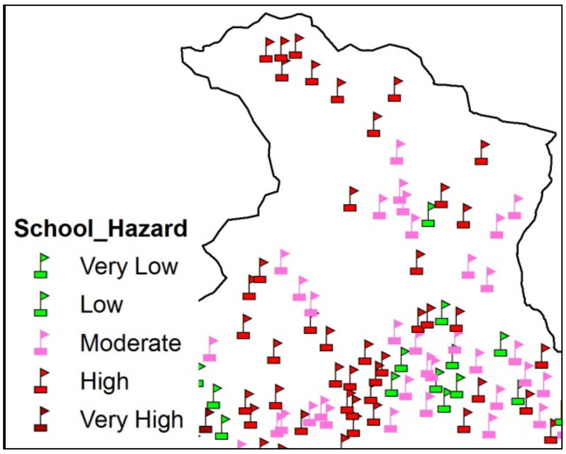

Fig. 10: Location of schools with respect to landslide hazard classes.

The schools situated at very low and low hazard classes need to be further upgraded to be suitable to accommodate large number of people and required relief materials can be stored. The facility and materials can be made available to the people taking shelter during the landslide disaster at nearby locations. The people living in the area falling within moderate to very high hazard zones need to be made aware to use the specific safe route to reach the evacuation centre. Thus, an effective landslide disaster management system can be established in the mountainous area.

5 CONCLUSIONS

The use of remote sensing and GIS for landslide risk assessment and management presented in this article are only indicative from a wide realm of potential use of remote sensing data and GIS tools. This shows that RS data can significantly contribute in various programs related to the natural resources management including landslide disaster management. The spectrum of satellite sensors with large swath and moderate-low spatial resolution to those with narrow swath and very high spatial resolution are valuable remote sensing resources for geological applications. The following conclusions can be drawn based on the various aspects of remote sensing and GIS application in landslide risk assessment and disaster management:

- Landslide hazard map is pre-requisite for assessing the landslide risk in a watershed/sub-watershed scale. However, individual landslide should be studied particularly to assess site condition and adopt appropriate mitigation measures.

- Interpretation of remote sensing data (satellite image and aerial photograph) is useful to locate/monitor the landslide whether it is rainfall-induced or earthquake-induced.

- RS is also useful to update the existing geological map and extract lineaments.

- Remote Sensing is a good tool for mapping elements at risk, especially through high-resolution satellite imagery.
- An updated GIS database forms basis for further analysis of hazard, vulnerability and risk leading towards the activities of disaster management.

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ROLE OF LAND PROFESSIONALS AND SPATIAL DATA INFRASTRUCTURE IN DISASTER RISK REDUCTION: IN THE CONTEXT OF POST 2015 NEPAL EARTHQUAKE: GENERAL REVIEW

Ganesh Prasad Bhatta
Susheel Dangol
Ram Kumar Sapkota

1 BACKGROUND

On September 22, 2014 a meeting was held at Survey Department, which formally opened up an idea of organizing an international event in Nepal. The meeting was participated by the Presidents and some members of Nepal Institution of Chartered Surveyors (NICS) and Nepal Remote Sensing and Photogrammetric Society (NRSPS), Officials from Survey Department, Professors, and veteran freelancers from Surveying and Mapping sector. The presidents of NICS and NRSPS shared the idea of organizing the event jointly which came after a number of informal discussions and meetings at home as well as abroad. The meeting endorsed the title of the event as "International Workshop on Strengthening Education for Land Professionals and Opportunities for Spatial Data Infrastructure Development", which was discussed informally prior to that meeting. The event was to be organized as a joint event of the Commission 2 of the International Federation of Surveyors (FIG) and Technical Commission IV; Working Group 4 (WG IV/4) of the International Society for Photogrammetry and Remote Sensing (ISPRS). The date was also endorsed as November 25-27, 2015. This meeting was the first formal step to move ahead in the line of organizing the event. Several committees were proposed, and some important jobs were allocated for preparatory works.

The joint meeting of NICS and NRSPS held on October 23, 2014 formalized and endorsed all the preparatory works as well as different committees such as Advisory Board, Steering Committee, Organizing Committee, and Technical Committee. Secretariat was established in the Survey Department Complex and accordingly all the preparatory works began. Everything was going smoothly. Suddenly, in the midday of April 25, 2015, the country was hit by the traumatic earthquake of M 7.6. The earthquake was followed by several aftershocks and one of which was of M 6.8 on May 12. Aftershocks are still continuing and more than 400 of them greater than 4.0 magnitudes have been recorded so far.

This traumatic earthquake greatly devastated the central part of the country killing more than 8000 people and injuring thousands, and causing a great loss to the country. That situation made the organizers to re-think if it was possible to organize the event. Consultations were made with the FIG Commission 2 and ISPRS WG IV/4 if it was possible for them to change the theme of the event. Their response was more motivating than the organizers expected. Several discussion and consultations were held at local level. After receiving encouraging responses from all those who were consulted, the organizers decided to move ahead with the same spirit but aligning the theme of the event with the changed context and further efforts were put forwarded.

Different committees worked hard for making necessary preparations for the event. In the meantime, the country faced political unrest in the terai region as well as economic blockade from India, which greatly affected the preparatory works. However, the strong efforts from the determined group of people made it possible to bring things under control.

2 INTRODUCTION

As mentioned above, the theme of the event was aligned with the changed situation that brought by the devastating earthquake and the title of the event was reformulated as "International Workshop on the Role of Land Professionals and Spatial Data Infrastructure (SDI) in Disaster Risk Reduction (DRR): in the Context of 'Post 2015 Nepal Earthquake'"

Main objective of the event was set to exploit the international expertise for enhancing professional capacity to contribute in the effort of DRR in the situation like currently in Nepal. The event further aimed to explore opportunities for strengthening and promoting good practices in professional geospatial education and advancing SDI concepts and spatially enabled societies. The workshop specifically focused on role of land professionals and SDI in rehabilitation of devastation caused due to recent earthquake and its aftershock.

Apart from NICS and NRSPS, the event was greatly supported by the Ministry of Land Reform and Management (MoLRM), Survey Department and Land Management Training Center (LMTC) of Government of Nepal as the co-organizers. A number of organizations supported in a way or another to make the event a success. The list of the supporters is given in the following sections.

Approximately 355 participants including professors, researchers, experts, survey professionals, students, young surveyors, entrepreneurs and media persons participated the workshop from Nepal and abroad including India, China, Bangladesh, Bhutan, Japan, South Korea, Taiwan, Malaysia, Singapore, Australia, New Zealand, Turkey, The Netherlands, Austria, Switzerland, France, United Kingdom, Macedonia and United States of America.

3 INAUGURAL SESSION

The event began with the Inaugural session on the 25th of November, 2015. The event was inaugurated by Hon' Deputy Prime Minister Mr. Kamal Thapa, who also holds the portfolio of the Ministry of Foreign Affairs. In his inaugural address, Hon' Thapa extended warm welcome to all the international and national guests and participants, and expressed his gratitude to the organizers for organizing such a great event in the difficult situation.

Ms. Liza Groenendijk, Chair Commission II (FIG), Vice President of ISPRS Prof. Dr. Marguerite Madden, President of NICS Mr. Buddhi N. Shrestha, President of NRSPS Mr. Rabin K. Sharma and Chair of the Advisory Board Mr. Babu Ram Acharya deliberated their speeches, whereas Chair of Organizing Committee, Mr. Ganesh Prasad Bhatta deliberated his welcome speech.

The distinguished speakers of the session expressed happiness on organizing such a useful event in the difficult times in the country and wished for its grand success.

There was the presence of high level Government officials in this session including the Minister for Land Reform and Management Hon' Ram Kumar Subba, State Minister Hon' Bikram Bahadur Thapa, Assistant Minister Hon' Dinesh Shrestha, Secretaries and Joint Secretaries of different ministries, dignitaries from different universities, professors, professionals, media persons and registered participants.

The chief guest of the session Hon' Thapa and high level officials visited the exhibition stalls upon the conclusion of the inaugural session.

4 KEYNOTE SESSION

The inaugural session was followed by Keynote session. Prof. em. Dr. Armin Gruen (ETH Zurich, Switzerland) , Prof. Dr. Arbind Man Tuladhar (ITC, the Netherlands), and Mr. Rajan Aiyer (Trimble, India) were the keynote speakers.

Prof. em. Dr. Gruen deliberated on "Image based modelling for emergency management". He talked about a large spectrum of different sensors, operating from a variety of platforms like satellites (optical, radar), aerial (images, LiDAR, helicopters, UAVs) and terrestrial (Mobile Mapping systems, flying “mosquito” robots) which can be used both for simulation of events, risk analysis and for the empirical analysis of events and prevention, and for the monitoring of actual events. According to him the true challenge today lies not so much in sensing, but in data processing, especially if on-line processing and real-time responses are required.

Dr. Tuladhar under his presentation entitled "Land Issues and Geo-information: Responding Post Disaster Earthquakes in Nepal" elaborated the issue of land as a fundamental to the recovery process. He further stated that access to land for shelter, security of tenure and protection of land rights, livelihood and early recovery from the earthquakes are the important land issues to be incorporated into an action-oriented framework for recovery.

Mr. Rajan Ayier, under his presentation on "Geospatial Technologies for a Disaster Resilient Community" deliberated on innovative geospatial technologies available today to respond the disaster.

5 PLENARY SESSIONS

Two plenary sessions were conducted in the beginning second and third day each. Altogether nine presentations were held from the plenary speakers namely; Dr. Amod Mani Dixit (NSET, Nepal), Prof. Dr. Marguerite Madden (USA, the Second Vice President of ISPRS), Prof. Dr. Alexander Densmore (UK), Prof. Dr. Kevin McDougall (Australia), Associate Professor Dr. Donald Grant (RMIT University, Melbourne, Australia / Former Surveyor General of New Zealand), Mr. Chee Hai Teo (Immediate Past President of FIG / Honorary President of FIG, Malaysia), Mr. Alistair Greig (New Zealand), Dr. Christopher Pearson (New Zealand) and Mr. Igor Cvetkovski (Disaster Management Expert from International Organization for Migration, IOM).

Dr. Dixit highlighted, while delivering the lessons learnt from the devastating earthquake, the strong need of empowering local community to exploit local knowledge and resources not only to respond the present situation effectively but also for future disasters. He further highlighted some safety measures that were found effective to save schools and hospitals, those were retrofitted in the past.

Prof. Dr. Madden discussed the role of geospatial technologies for disaster preparation, response and recovery. She presented some case studies how multi-temporal imagery from satellite, airborne and unmanned aerial systems platforms can be used to document present conditions and establish baselines for assessing future changes. She stressed that easy access to the geospatial data should be ensured as it is the most important component of disaster management.
Dr. Grant shed light on the lessons learnt from earthquake disasters of Haiti and New Zealand. He presented key land administration challenges faced during the recovery and reconstruction, such as priorities for tenure security, land use planning, and property valuation.

Mr. Greig presented the lessons learnt from the recovery efforts of Christchurch earthquake in 2011. He stressed the importance of geospatial professionals to support the prompt response to the disaster, with examples how the professional supported the rescue efforts made by Urban Search and Rescue, Civil Defense, Police and Army. He further informed that the importance of surveyors and GIS experts increased as the emergency response turned into recovery and to rebuild the city.

Prof. Dr. Densmore presented specific case of Nepal. He highlighted that lack of adequate data hampered the efforts of land slide mapping caused due to the recent devastating earthquake in the country. He stressed that availability of cloud-free imagery would have helped them in identifying seismic landslides. He also found lacking in coordination between the different teams, data providers, and potential end-users. Their team reviewed the earthquakes and the patterns of co-seismic landsliding, emphasising the key role of satellite imagery in allowing rapid assessment of the landslide hazard, and also described the longer-term effects of the earthquake on landslide occurrence in the region, focusing in particular on the Upper Bhote Koshi valley, Sindhupalchok, as a representative example of the wider earthquake-affected area.

Prof. Dr. McDougall presented that crowd support and crowd generated spatial data have the potential to speed up disaster management actions and disaster mitigation activities. He mentioned that OpenStreetMap, Google Maps or Bing Maps can be considered as commonplace for crowd sourced mapping. He further discussed the role of crowd sourced mapping during disasters, the challenges, data quality and credibility, the opportunities that crowd sourced data presents, and the role of government agencies in spatial data access in support of disaster management.

Dr. Pearson, who was studying the effect of the earthquake in the national geodetic network of the country, presented a preliminary velocity field developed by his team by taking published velocities

for Nepal and adjacent pars of China and India from five previous studies and aligning them to the ITRF. He mentioned that they were working on developing patches for the co-seismic part of the deformation using published dislocation models. He highlighted that those models could be improved by developing revised grids that would incorporate increased GPS and INSAR measurements of the deformation field. He further highlighted top level control would be based on a CORS network based around the existing Nepal GPS Array. Coordinates for existing lower order coordinates would be determined by readjusting existing measurements and these would be combined with a series of new control stations spread throughout Nepal.
Mr. Cvetkovski highlighted the importance of land and property rights in responding the effects of disaster. He stressed that balance between the needs and the rights of affected population, existing legal frameworks and societal demands, and available resources should be found out. He further stressed that there should be adequate institutions for addressing housing, land and property issues before, during and after the natural disasters.

Mr. Teo highlighted the role of surveying professionals, especially in addressing the Development Goals set by United Nations and other issues related to humanitarian concerns including climate change.

6 TECHNICAL SESSIONS

There were held altogether nine technical sessions at which 56 technical papers were presented. The sessions were categorized into six different themes: Spatial Planning and Environment, SDI Development, Responding Disaster, Geospatial Technology, Professional Development, and Land Administration and Management. All the presentations were focused on role of the land professionals and SDI in disaster risk reduction in the context of recent Nepal earthquake. Besides this, the presentation were also on the use of technologies for relief support during disaster, probable challenges in rehabilitation and reconstruction, need of land use planning for management of disaster prone area, other probable disaster after earthquake and their management, challenges in land administration and management of disaster affected region etc.

Some other fields covered in the presentation were new technologies in SDI developments, geo-information and climate change, public participation in geo-information, role of satellite science in geo-information, opportunities for land professionals, challenges and issues in 3D cadaster etc.

7 SIDE EVENTS

7.1 Pre-conference Event

A one day tutorial on Spatial Data Infrastructure (SDI) was organized on November 24 at Kathmandu University as a Pre-conference event. The event was supported by Global Spatial Data Infrastructure Association (GSDIA). Land Management Training Center was one of the local supporters of the event. About 50 students and young surveyors participated the event. Distinguished experts including Prof. Dr. Margurатte Madden, Prof. Dr. Kevin McDougall, Dr. Dev Raj Puadel, among others deliberated on the SDI issues.

7.2 Business Exposition and Exhibition

A business exposition was organized during the event. All the branded sponsors Trimble (Platinum Sponsor), Hexagon Group (Gold Sponsor), Digital Globe Group (Silver Sponsor), JAXA and Topcon (Bronze Sponsors) made presentations about their products and geospatial technologies including their applications. The exposition was attended by all the participants including representatives from the Government of Nepal.

At the same time, the branded sponsors and some supporters made exhibition of their products parallel throughout the event.

7.3 FIG Young Surveyors' Network Session

FIG Young Surveyors Network organized a special session for the Nepalese young surveyors. The session was attended by more than 50 young surveyors. The session was chaired by Eva-Maria Unger and supported by Paula Dijkstra. In groups, four disaster risk reduction ‘tools’ were proposed and elaborated and ‘pitched’ in a so-called market place.

8 CLOSING SESSION

The event ended with the closing ceremony held on the 27th of November 2015. Minister for Land Reform and

Management Hon' Ram Kumar Subba were the Chief Guest of the Ceremony. Hon' Subba congratulated the organizers on the success of the event and extended sincere thanks to all the distinguished presenters and participants of the event. Ms. Liza Groenendijk, Chair FIG Commission II, Dr. Dev Raj Puadel, Co-chair of ISPRS WG IV/4, Mr. Buddhi N. Shrestha, Mr. Rabin K. Sharma (Chair of the Session), Mr. Babu Ram Acharya deliberated their closing remarks. They expressed their happiness on the grand success of the event and extended thankfulness to all the supporters. Mr. Ganesh Prasad Bhatta, the Chair of Organizing Committee, acknowledged all the supporters, sponsors and contributors.

Based on the presentations during the event, some key points that would contribute in the initiative of the Government of Nepal in Building Back Better were drawn as workshop resolution, which was presented at the closing ceremony. Main points of the resolution, that recommended the Government of Nepal for necessary actions, are as follows:

- formulate, enact and implement a comprehensive land and land use policy in order to address pertaining land issues brought forth by the disaster
- design a multi-stakeholder and action oriented framework which ensures clear and crisp action points, responsibility allocation, implementation time and monitoring system in order to avoid duplication of efforts and resources to respond the disaster
- adopt fit-for-purpose land administration and tools developed by Global Land Tool Network (GLTN) in order to ensure tenure security and adequate rehabilitation of the households residing in informal/non-formal settlements
- adopt appropriate tools and technique for accurate and timely geo-information acquisition, processing, visualization and dissemination and as well as strengthen Spatial Data Infrastructure (SDI) technique in order to facilitate effective and efficient data sharing and use
- carry out capacity building activities for continuous professional development in order to support Disater Risk Reduction (DRR) in long term

The resolution was submitted to the Government of Nepal through the Minister for Land Reform and Management at the closing session of the event. The detailed resolution can be accessed at workshopnepal2015.com.np.

9 SUPPORTERS, SPONSORS AND CONTRIBUTORS

The workshop was supported by internationally recognized organizations. Dutch Kadaster of the Netherlands and Faculty of Geo-information Science and Earth Observation (ITC), University of Twente, the Netherlands were the ***Prime Supporters*** of the event.

Trimble, an internationally recognized organization for new and updated technology and equipment in the field of surveying and mapping supported the ***Platinum Sponsor***. Similarly, other organization well known for technology and equipment in the field of Surveying and Mapping and development of Land Information System, the Hexagon group supported as ***Gold Sponsor*** whereas, the satellite image provider, Digital Globe supported as **Silver Sponsor**. Japan Aerospace Exploration Agency (JAXA), Government of Japan, and Topcon, a leading equipment producer in the field of surveying and mapping, sponsored as ***Bronze Sponsors***.

Besides this, International Centre for Integrated Mountain Development (ICIMOD), International Organization for Migration (IOM), United Nations Development Program (UNDP), United Nations Human Settlements Program (UN-HABITAT) and Nepal Academy of Science and Technology (NAST) supported as **Strategic Partner**s. ICIMOD, IOM, UNDP and UN-HABITAT not only supported as strategic partners but also financially.

Similarly, the event also supported by Institute of Engineering (TU), Central Department of Geography (TU), School of Engineering (KU), Nepal Surveyors Association and CAN Federation as ***Institutional Partners***. Similarly, Global Spatial Data Infrastructure Association (GSDIA), Coordinates, GIM International and Geo-Spatial Media and Communications supported as ***Media Partners***.

Ministry of Land Reform and Management coordinated with other line agencies for the participation in the workshop. Survey Department played extraordinary role to make the event a grand success not only by supporting its management part but also providing financial support. The Department sponsored the welcome reception among other supports.

Different committees were formed for successful organization of the workshop. Advisory board was chaired by Mr. Baburam Acharya, former Secretary of Government of Nepal. Steering Committee was chaired by Mr. Buddhi Narayan Shrestha, former Director General of Survey Department and Chair of NICS and co-chaired by Mr. Rabin K. Sharma, former Director General of Survey Department and Chair of NRSPS. Similarly, Organizing Committee was chaired by Mr. Ganesh Prasad Bhatta, Deputy Director General of Survey Department, and Technical Committee was chaired by Prof. Dr. Hikmat Raj Joshi. Joint Secretary of MoLRM, Mr. Nagendra Jha, then Director General of Survey Department Mr. Madhusudan Adhikari, and then Executive Director of LMTC Mr. Krishna Raj B.C. provided invaluable support to the management of the workshop. Chief Survey Officer Mr. Susheel Dangol and Survey Officers Ms. Shanti Basnet and Mr. Ram Kumar Sapkota supported from starting till the end of the workshop. Similarly, Mr. Janak Raj Joshi, Under Secretary, Ms. Laxmi Thapa, Ms. Eliza Shrestha, Mr. Mahesh Thapa, Mr. Prashant Ghimire and other staff provided the volunteer service which helped a lot in successful conduction of the workshop. The conduction of this workshop in Nepal has proved that Nepal is capable of conducting big international events. Conduction of the event despite the devastating earthquake during the preparation of the event and economic blockade and participation of scientist and experts from different countries concludes that the event is grand success.

10 REVIEW REMARKS ON THE EVENT FROM SOME OF THE DIGNITARIES

Chryssy Potsiou; President, FIG

I really wish to congratulate the organizers of that great event! I really admire them. They deserve all our support, love and respect. I am thankful for their contribution and their willingness to share their experience and knowledge with us. They are great professionals.

Prof. Dr. Marguratte Madden, the Second Vice President, ISPRS

Dear Ganesh, […] but I left with a better appreciation of the strength and potential of your people...] I really enjoyed Nepal and one of the best organized and informative conferences I have ever attended. Best of all was meeting the students, researchers and decision makers of Nepal. As a country you have many challenges, but I left with a better appreciation of the strength and potential of your people. Thank you so much for making my stay such a wonderful experience. I am sure we will meet again!

Liza Gronendijk; Chair, FIG Commission II

[…] Considering the difficult situation in Nepal after the 2015 Earthquake and the recent fuel crisis in the country the organizers have achieved the almost impossible. In particular the chair of the local organizing committee, Ganesh Prasad Bhatta, did a tremendous job, beyond expectations. He really deserves an 'honorable membership' of our FIG Commission 2.
[http://fig.net/news/news_2015/2015_11_nepal.asp]

Dr. Donald Grant, former Surveyor General of New Zealand

Dear Ganesh, […] Thank you also for the invitation to the excellent workshop and congratulations for managing a very successful international meeting in such an engaging and professional manner.

Kees de Zeeuw; Director, Kadaster International, the Netherlands

Dear Mr Ganesh Prasad Bhatta,
On behalf of Kadaster I would like to congratulate you and your team for organising an excellent 'Workshop on the role of land professionals and SDI in disaster risk reduction: in the context of the post 2015 Nepal Earthquake'.
Mrs. Paula Dijkstra and Mrs. Christelle van den Berg who participated the workshop, informed me about the well organised workshop and the relevance of the keynote speakers and technical sessions to the topic of the workshop. It is impressive to deliver such a high

level event shortly after such devastating earthquakes in Kathmandu earlier this year.
As land professionals of Nepal you have raised the bar for other international workshops of FIG and ISPRS. As I understood an event with the size and quality like this, should be considered as a conference rather than a workshop.
[…]

Dr. Rishi Raj Datta, Asian Disaster Prevention Center, Bangkok

Congrats to ganeshji and his enthusiastic team of dynamic young professionals of surveyors who with their exceptional hard work and perseverance have made this International Workshop a grand success. As I have said earlier, the response to the workshop has actually taken the event along the lines of a conference. Great job and good luck to you and your team once again.

Eva- Maria Unger, FIG Young Surveyors' Network

… and this is a special thanks to Ganesh […] ! Ganesh as chair of the LOC did an amazing job in organising the workshop! and you could really feel the heart he put into it! But he is not just an organiser he is a friend and his heart warming hospitality made it even more special!

11 CONCLUSION

The devastating earthquake of April 25, May 12 and consecutive aftershocks have caused a great human as well as economic loss to the country. It is a responsibility of all sectors of society to contribute to the Government's efforts in recovering from this difficult situation. The same applies to the land, and surveying and mapping professionals. This workshop was considered as a tiny contribution in this respect. It could not contribute much but remained instrumental in acquiring some examples of international best practices as well as knowledge that a land professional can apply in his or her professional career, especially in the current situation of the country. The presentation made were very useful for the targeted professionals. The international speakers placed the Nepalese experiences in a broader international context; while at the same time Nepalese experiences showed new approaches and tools in support of disaster risk reduction that were not used before. It is expected that professors, researchers, professionals, policy makers, students must have been benefited in their professional capacity development. Young students and surveyors were expected to receive information about the new technology and ideas as well as helpful in their professional capacity development.

The country was facing difficult situation, not only due to aftermath of the earthquake disaster but also economic blockade, during the event. Despite such situation, the organizers and organizing committee worked hard to make the event a success. Their tireless effort and hard work made it possible to organize the event successfully. The participation was beyond the expectation not only from the country but also from abroad. The expressions from the international guests as well as national dignitaries were highly encouraging. The details about the event and proceedings are available at www.workshopnepal2015.com.np , which will remain alive at least for two years.

In nut shell, the event was successful in achieving its objectives and was a great success!

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TOWARDS A MODERNIZED GEODETIC DATUM FOR NEPAL FOLLOWING THE APRIL 25, 2015 MW 7.8 GORKHA EARTHQUAKE

Christopher Pearson, Niraj Manandhar

Abstract: *Along with the damage to buildings and infrastructure, the April 25, 2015 Mw 7.8 Gorkha earthquake caused quite significant deformation over a large area in central Nepal with displacements of over 2 m recorded in the vicinity of Kathmandu. In this paper we consider options for a modernized geodetic datum for Nepal that will have the capacity to correct for the earthquake displacements and ongoing tectonic deformation associated with Nepal's location on the India/Eurasian plate boundary. In the scenario we present here, the datum would be based on ITRF2014 with a reference epoch set some time after the end of the current sequence of earthquakes. We have developed a preliminary velocity field by collating GPS derived crustal velocities from four previous studies for Nepal and adjacent parts of China and India and aligning them to the ITRF. We developed preliminary patches for the co-seismic part of the deformation using published dislocation models. By combing the velocity and co-seismic models we have developed an NDM that can correct coordinate for both the effect of the earthquakes and continuous deformation associated with Indian / Eurasian plate boundary.*

High order control would be a CORS network based around the existing Nepal GPS Array. Coordinates for existing lower order control would be determined by readjusting existing survey measurements and these would be combined with a series of new control stations spread throughout Nepal.

1 INTRODUCTION

Currently Nepal uses a classical datum (the Nepal-Everest datum) developed in 1984 by the Military Survey branch of the Royal (UK) Engineers in collaboration with the Nepal Survey Department (Spence 1987). However, Nepal is located at the conjoint of two converging plates and due to the regular convergence of these plates the existing passive geodetic control network had become distorted with time. This combined with the effect of the April 25, 2015 Mw 7.8 Gorkha earthquake, which caused significant deformation over a large area centered on the Kathmandu Valley means that the integrity of the current Nepal-Everest datum cannot be assured. In this paper we consider options for a modernized geodetic datum for Nepal that will have the capacity to correct for the earthquake displacements and ongoing tectonic deformation associated with Nepal's location on the India/Asia plate boundary.

2 SEMI-DYNAMIC DATUMS

Modern semi-dynamic datums are based on a version of the International Terrestrial Reference Frame which is based on four techniques, (Satellite Laser Ranging, Very Long Baseline Interferometry, DORIS: Doppler and GNSS). This produces a global datum with unparalleled accuracy but it is not suited to use as a national datum because it lacks a mechanism to produce stable coordinates. In semi-dynamic datums, stable coordinates are produced by projecting each coordinate to its position at a common date called the reference epoch. In order to make this technique work we need a model of how the earth is moving due to plate tectonics. In stable areas, the effect of earthquakes will be small and the motion of the points will follow the motion of the tectonic plates. In areas that are located on the boundaries of tectonic plates, the motion is more complicated. In this case a mathematical model called a National Deformation Model, is used to calculate the trajectory of points. This usually includes a way of estimating the constant or secular velocity of each point and a way of calculating the effect of any earthquakes that may have occurred between the time that the coordinates were measured (epoch of observation) and the reference epoch. The effect of earthquakes is an instantaneous offset while the effect of the velocity increases linearly with time. This process is illustrated in Figure 1, which shows the trajectory of a point effected by a constant velocity and two earthquake shifts.

In contrast, older classical datums such as the Nepal-Everest datum, which were usually established before the reality of plate tectonics was widely accepted, establish fix coordinates for a network of control points with no mechanism to correct for tectonic motion. As a result the marks will drift off their true position. Thus the datum will become distorted as the bearings and distances between marks calculated from their coordinates become increasingly different from what we would measure on the ground.

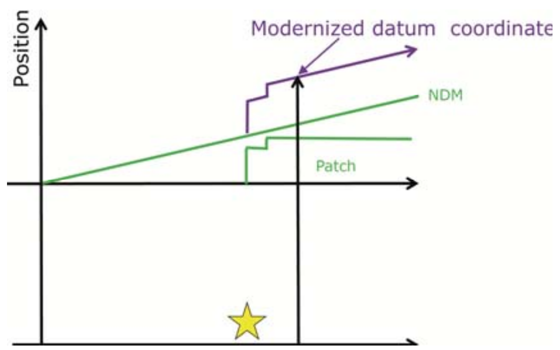

Figure 1 Schematic diagram of a dynamic datum. Green shows the secular velocity and co-seismic contribution to the deformation model. The purple line shows the deformation model with both contributions.

3 POSSIBLE OUTLINE FOR A SEMI-DYNAMIC DATUM FOR NEPAL

Normally, a dynamic datum is aligned to a realization of the ITRF that is current at the time that the datum is released. In the case of Nepal, the datum would be based on be ITRF2014. For the reference epoch, we propose to use a date after the end of the current sequence of earthquakes is over.

The Deformation model is the tool that allows coordinates to be projected either backward or forward in time to the reference epoch. As shown in Figure 1, a deformation model contains two distinctly different elements. The first is a model of the variation of the long term (or secular) crustal velocity across the country and the second is a model or models of the co-seismic deformation associated with any large earthquakes. Both the velocity model and the co-seismic deformation models are grid files so that the estimates of the velocity or co-seismic shifts can be determined using a process of linear interpolation (Stanaway et al. 2012).

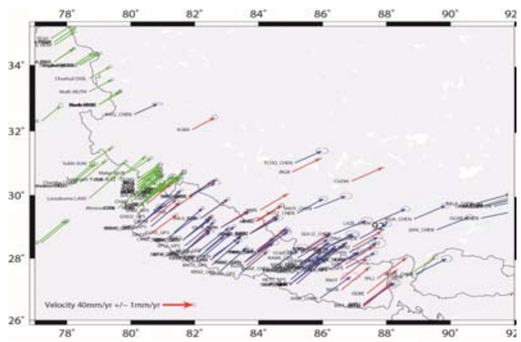

Figure 2 separate solutions transformed into ITRF2008. red is from the Ader et al, (2012) study, Black is Jade (2004), Blue is Jade et al (2014) and Betenilli et al. (2006)is green.

Our model of the velocity field for Nepal was developed by combining published velocities for Nepal and adjacent parts of China and India from four geodetic studies in the Nepal region. These include 96 measurements from Betenilli et al. (2006), 70 from Jade et al. (2014), 38 from Ader et al. (2012), and 228 from Banerjee et al. (2008). In addition we included 1000 official IGS13 velocities for IGS stations. The five studies provide good coverage of the Nepal area but, because each study was conducted separately over a period of 10 years, they are in several different realizations of the ITRF (ITRF 2000, ITRF2005 and ITRF2008). The velocities are shown in Figure 2.

These velocity solutions were then aligned consistently with ITRF2014, using a least square technique from (Snay et al. 2015). Using these velocities we developed a grid file that covers the region from 80°E to 89°E and

26°N to 31°N (Figure 3). While Figure 3 shows velocity vectors on a half degree spacing the actual gridded velocities have a spacing of 20 points/degree (0.05°).

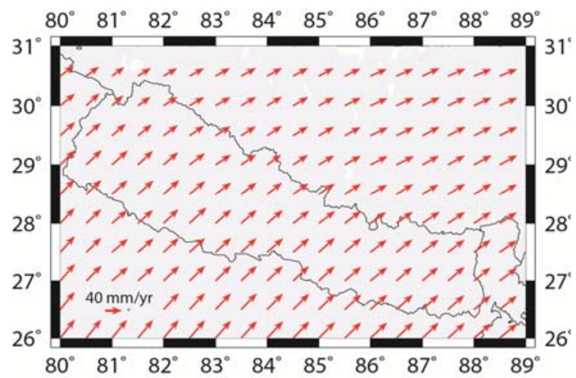

Figure 3 Velocity grid for Nepal

An NDM also must include patches or gird files that can be used to predict the earthquake deformation at any point. We have developed preliminary patches for the co-seismic part of the 25th April 2015 Gorkha Earthquake and the 12th May ML 6.8 aftershock using published dislocation models (Galetzka et al., 2015). Figure 4 and 5 shows the co-seismic slip from the 25th April 2015 Gorkha Earthquake and the 12th May ML 6.8 Aftershock. Note that the Kathmandu Valley has moved by up to 1.9 m.

The velocity grid and the two earthquake patches have been combined to make a preliminary national deformation model (NDM) for Nepal. This model would form a key part of a semi dynamic datum for Nepal and be transformation coordinates from the epoch of observation to reference epoch of Nepal's national datum.

In order to test the effectiveness of a semi-dynamic datum to correct for the deformation from the April 25, 2015 Mw 7.8 Gorkha Earthquake, we adjusted GPS

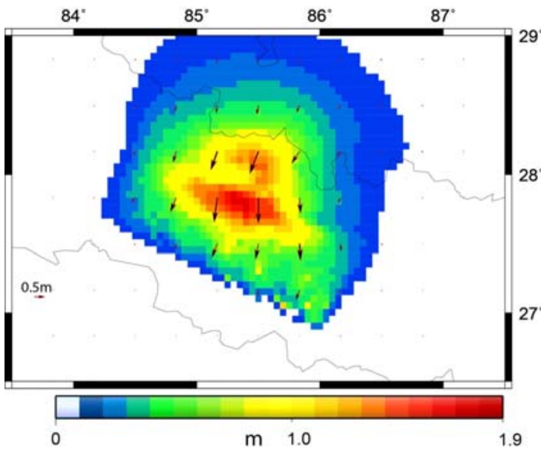

Figure 4 Predicted displacement associated with the 25th April 2015 Mw 7.8 Gorkha Earthquake

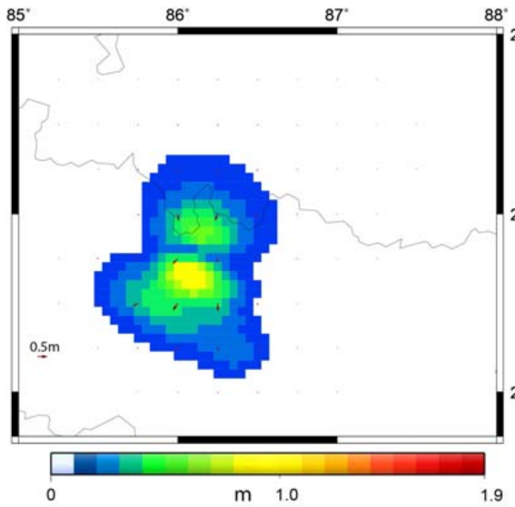

Figure 5 Predicted displacement for the Mw 7.3 12 May Aftershock

data that contained both pre and post-earthquake measurements using a version of the Land Information New Zealand's (LINZ) Survey Net Adjustment (SNAP) program (LINZ 2013) which has been modified to support the option for a modernized datum for Nepal. These test points (See figure 6) define a polygon extending about 40 km in the NW SE direction centered on Kathmandu. Between these points there are nine GPS baselines, three of which were recorded in April 2013, before the earthquake and six of which were observed on 08 May 2015, in the period between the 25th April 2015 Gorkha Earthquake and the 12th May ML 6.8 aftershock.

The first adjustment was conducted without using a deformation model while, in the second adjustment, the deformation model was used to correct all the measurements to pre-earthquake values. The Standard error of unit weight for the adjustment which does not apply the NDM is more than a factor of 3 times greater than the SEUW for the model which does apply the NDM. This difference demonstrates that the deformation model is effective in correcting for crustal deformation between the two surveys. The improvement in the SEUW due to applying the NDM is significant the 99.99% level of confidence.

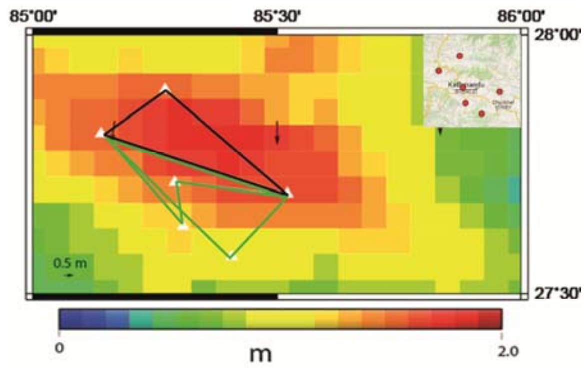

Figure 6 Location of test points plotted on a map of maximum displacements from the 25th April 2015 Gorkha Earthquake. Arrows show vector displacements. Black lines show baselines from the pre earthquake survey and green lines show the show baselines from the post earthquake survey. Inset shows a map of the test points.

Of course least square adjustments require control. Top level control for a new Nepal datum could be based on a CORS network with coordinates being rigorously aligned to the ITRF. This network could adopt as many of the existing Nepal GPS Array (http://www.tectonics.caltech.edu/resources/kmlnepal.html) stations as possible. A preliminary evaluation of the stations in the array indicates that 20 of these sites maybe available to act as a CORS network for Nepal. Coordinates for existing lower order coordinates would be determined by readjusting existing measurements combined with new surveying data using software that can apply the deformation model correctly..

4 CONCLUSIONS

Because of the effect of the 25th April, 2015 Gorkha earthquake, significant earth deformation has occurred in a large area of Nepal centered on the Kathmandu Valley. As a result, the geodetic control in this region is significantly distorted with published geodetic control coordinates being displaced from their true position on the ground by up to 2 m. Correcting these distortions will require a new geodetic datum. In this paper we consider the possibility of Nepal adopting a semi-dynamic datum, which would be based on ITRF2014 and include a national deformation model capable of correcting for the recent earthquakes and normal tectonic motion. We demonstrate that it is possible to develop a deformation model for Nepal incorporating the Gorkha earthquake and the variation of the long term (or secular) crustal velocity across the country using published information. While this model is preliminary our test shows that its use does a good job of correcting survey measurements for the effect of the earthquake.

5 ACKNOWLEDGEMENTS

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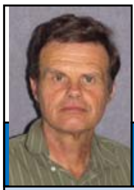

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PARCEL FRAGMENTATION AND LAND CONSOLIDATION

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Keywords: Parcel, Parcel Fragmentation, Land Consolidation

Abstract: *Parcel Fragmentation is the division of parcel into smaller pieces having individual ownership. The main parameters used for measurement of Parcel Fragmentation have been considered the spatial location of parcel, shape & size of parcel and number of parcel. The main causes of Parcel Fragmentation are; inheritance, population growth, land market, historical/ cultural perspective, personal prestige & status, economic & physical process, quality of soil and physical condition of parcels. The main impacts seen due to the Parcel Fragmentation are as reduction of agricultural production, increases of agricultural production cost, increases land disputes, increases transport cost, wasted time for the workers travelling, supervision, securing & management, reduce parcel area due to walls & fences and cannot use modern equipment in agricultural activities.*

Land Consolidation is the reverse act of Parcel Fragmentation. It is the process of formation of single or individual parcel by merging several parcels having enough size& suitable shape and helps to reduce those impacts which are seen in the fragmented parcels so it is profitable to move in the direction of Land Consolidation.

1 PARCEL FRAGMENTATION

Fragmentation, in literal meaning, indicates a small or incomplete part or piece broken off to which it originally belongs. Parcel fragmentation is the scattering or division of parcel in which a single farm consists of numerous spatially separated parcels (Demetriou, The Development of an Integrated Planning and Decision Support System for Land Consolidation, 2014). According to the Harvey, Kaim and Gajda (2014) the main area of parcel fragmentation were located along the transportation corridors it means along the road and railway. In the same way, according to the King & Burton (2014) land fragmentation is the sub-division or scattering of the existing parcel into individual ownership and parcellization is the spatial division of the parcel. They further wrote that fragmentation &land consolidation are the spatial process. The sub-division or fragmentation of land seems like the act of dividing land or houses into smaller pieces. The main purpose of sub-division of land has been found for commercial or industrial development. The main parameters used for measurement of parcel fragmentation have been considered the shape characteristics of parcel, the spatial location of parcel, shape & size of parcel, number of parcel and size of parcel in practice. World census of Agriculture (2006) estimated that more than 80 percent of World's farm land is fragmented. Land fragmentation had been documented in all parts of the world. However closely associated with Europe, some examples are Mexico, Taiwan, Peru, Malaysia, Kenya, Uganda, the United States and Japan (Sendqvist & Andersson, 2006). According to Jha, Nagarajan, & Prasanna (2005) parcel fragmentation could raise land holdings. They also described that in India, the Jamindari System located in many river valleys that enhanced the land fragmentation. According to the Chapagain (2004) the root of parcel fragmentation is traditional Hindu law where parental property as well as land is divided into their sons.

So far Nepalese practice is concerned, CBS (1994) has, mentioned that the parcel fragmentation information in the ecological regions of Nepal has been illustrated as in table 1

Table1: Parcel Fragmentation based on Ecological Region

Regions	Average parcels per farm	Number of parcels per hectare
Nepal	3.96	4.2
Mountains	4.63	6.8
Hills	3.92	5.1
Terai	3.85	3.1

Source: CBS, 1994

Dijk& Van (2003) have described four types of land fragmentations including fragmentation of land ownership, land use, internal fragmentation and separation of ownership and use. Land ownership fragmentation refers to the number of land owners and their use of a given piece of land. Similarly, land use fragmentation refers to the number of users and also tenants of the parcel. In the within or internal fragmentation parcel size, shape and distance are the main issues. When there is discrepancy between ownership & use, then there occur separation of ownership & use. In Nepal, fourth type of land ownership & use type of fragmentation is appeared.

You (2010) claimed that there are mainly two kinds of land fragmentations: one is land ownership fragmentation and the next is land use fragmentation. He further described that in the land ownership fragmentation, there are number of separated land parcels which are registered in the cadastral system. But in the land use fragmentation, there are distinct numbers of separated land parcels which are being used in the fragmented land use situation.

2 CAUSES OF PARCEL FRAGMENTATION

Land fragmentation may vary country to country and from region to region (Demetriou, The Development of an Integrated Planning and Decision Support System for Land Consolidation, 2014). There are main four factors which play the role of catalyst in parcel fragmentation. These four factors are inheritance, population growth, land markets and historical/ cultural perspectives. He further added that inheritance is the primary cause of land fragmentation, in which land fragmentation happen by the equal sub-division of parcel among all heirs or sons. Due to this region, land fragmentation has become a continuous process and hence parcels getting smaller and smaller. Population growth is directly related to the inheritance. People wish to acquire a parcel not only for agricultural activities but for investment, enhancing personal prestige & status and also for future of family.

According to the King & Burton (2014) the main causes of land fragmentation are social, cultural, economic and physical process. Land use for dowries, new buildings, charities or religious organizations.

Lusho & Papa had written when landowners land was divided among all their heirs, it was divided on the basis of quality of soil (fertility, irrigation, capacity, cropland), distance between house and parcels and physical conditions (hilly, flat and mountainous land) due to these causes each land parcel was fragmented. Institutional, political, historical and social factors also played vital role in the parcel fragmentation (King & Burton, 2014). The large amount of parcel fragmentation was caused by the residential development (Neal, Doye, & Brorson, 2012).Bullard (2007) also agreed that the major causes of land fragmentation are population growth, laws of inheritance and poverty.

3 IMPACTSOF PARCEL FRAGMENTATION

King& Burton (2014) described that land fragmentation may have social and psychological impacts. They also further noted that land fragmentation reduce inequalities among farmers and reduce land disputes in the case of shared or multiple ownership. The social tension is caused by disputes over access and ownership (King & Burton, 2014). According to the Lusho& Papa (1998), the negative impacts of parcel fragmentation which are classified as; restricts agricultural modernization, in some parcels there is problem to the improvement of land and increased risk of abandonment and created economic and production problem because of work, time & parcel distance increased which could be measured by using the digital elevation model (DEM) of that regions. In small parcel mechanization was inefficient, the previous irrigation system was inefficient because of the initial parcels were fragmented into numerous parcels. Neal, Doye, and Brorsen (2012) wrote in their research paper that while parcel size decreased, the price per acre was increased. As other researcher Sendqvist & Andersson (2006) also wrote that land fragmentation constrained crop production and modernization on agriculture. They also described that land fragmentation is a significant barrier to gaining from agricultural productivity. They further claimed fragmented parcels / plots increased transport costs, wasted time for the workers travelling, supervision, securing and management of scattered parcels took more time and costly, wasted land area and also required more land area for fencing or wall construction & path or roads. It also increased risk of disputes among neighbours. Similarly in the more fragmented parcels more profitable like fruit crops could not grow because of lesser plot area. According to the Bullard (2007) the negative impact of parcel fragmentation was as increased in boundaries, overgrown land, increased in pests, disused farm buildings, decreased in cultivated land and abandoned machinery. In the fragmented parcels the production cost is high and modern mechanization technology is almost impossible, time is wasted in moving workers, animals & carrying seed and manure from one parcel to another, expensive on making fences, threshing floor & water supplying. Similarly due to the parcel fragmentation social tension also increased. In fragmented parcels more manpower and other resources are required than necessary.

4 LAND CONSOLIDATION

The food and Agriculture organization (FAO) has defined the land consolidation as the formation of single or individual farms which have enough size, structure and suitable for productive use. Land consolidation means landowner gives up their scattered parcels in order to get an equivalent area or value of land in fewer or more continuous parcels (Sendqvist & Andersson, 2006). According to the You (2010) the main tasks in land consolidation are elimination of land fragmentation, land reclamation & soil improvement, improvement of the pattern of settlement and improvement of the farm size pattern. The main objectives of land consolidation were grouping of neighbour parcels that reduce the negative effects of fragmentation, reduction of total agricultural production costs and enhance more effective agricultural plans and projects (Lusho & Papa, 1998). According to the Lusho & Papa some land consolidation methods are; exchanging parcels of land, planting the whole ex-cooperation field with the same crop, farming in the groups, creating the land market. He further described the benefits of land consolidation that could help to create viable farms, improvement of the landownership structure, enlargement fragmented holdings, construction of infrastructure, avoidance of land abandonment, reduction of production cost, improvement of irrigation system and mechanization. Ahmadpour, Feali & Soltani (2013) pointed out that land consolidation is the planned readjustment of pattern of ownership & parcels, which integrates and decreases the number of parcels and it also helps to make the proper suitable structure of farm and provides the required infrastructures including drainage network, irrigation system and road for agricultural development. Ayranci (2007) described that the farm land is scattered into very small parcels in many Countries which is unfavourable for agricultural production so land consolidation is one activity or one kind of instruments or tools which can consolidate or integrate such scattered parcels. He further wrote that land consolidation is weapon that re-organizes the fragmented parcels and makes suitable structure for agricultural use, improving of parcellation, water control, accessibility and improvement of land protection or recreation of land is generally includes in the land consolidation project. The main three activities that should do in land consolidation are administration, allocation and mapping. He again claimed that in land consolidation the parcellation design is very complex because it is difficult to settle the new formed parcel according to previous.

Akkaya, Aslan, Gundugdu, Yaslioglue Kirmikil & Arici (2007) described main principles of modern land consolidation which are; the objective should to improve rural likelihood rather than the agricultural production only, the output should be oriented in the sustainable economic & political development as well as sustainable management of natural resources, the process should democratic & participatory and approach should be comprehensive, cross-section and integration of rural & broader regional area development, while forming the land consolidation strategy it should recognize that rural society is diverse, not all fragmentation is a problem, protects and enhances the environment, need for diverse local solution and accommodate national and sub-national priorities and strategy should address institutional, financial, legal, international cooperation & capacity building issues. Vitikainen (2004) described two types of land consolidation procedures one of them is 'cadastral surveyor model' and the next is 'committee model'. In the cadastral surveyor model a cadastral surveyor is appointed in the post of in charge to implement the project but in the committee model the committee is appointed by the ministry. The main objective of the land consolidation is varies as countries wise but it may effects by the culture, historical trends, traditions and legislation of that countries.

Figure 1: Changes by Land Consolidation

New apartment formed by China government after land consolidation in picture a & b

Barren land converted into cultivated land after land consolidation in China in picture c& d

5 PROCEDURE OF LAND CONSOLIDATION

The process of land consolidation is the method of reversing the action of fragmentation which is not new. Some of the earliest attempts at consolidation, as a method of land reform, took place in Scandinavia, particularly in Finland (FAO 2003), Sweden, and Denmark, in the 18th and 19th centuries. The three main land reforms in Sweden took place between 1750 and1920, resulting in severe fragmentation being replaced by land consolidation (Osterberg and Pettersson,1992). However, with the subsequent population increase subdivision leading to fragmentation has occurred thereafter (Lindskogand Millgard, 1983). In Finland the first law was passed in 1757 (King and Burton, 1982), and nearly all of the land has been consolidated at least once (Leppikangas, 1994). In Denmark the first Consolidation Act was introduced in 1781 (Binns, 1950). Legal aspects of land consolidation may be complicated by different procedures. In The Netherlands four types of land consolidation exist (Sonnenberg, 1999); in Germany five, and in France seven (although only three are commonly used - Brussaard and Grossman, 1992). In many African societies, land remains the paramount resource base (Deng, 1988) and whether communalor individual ownership forms of tenure are implemented, it is important that the peasants are encouraged to remain and work on the land (Kiamba, 2001; Törhönen and Goodwin, 2001).The major activity of land consolidation has been to bring fragmented parcels of land together to produce economic units. Additionally, during the process of land consolidation, particularly when it occurs over a large area, it is usual to undertake major land development, which would otherwise have been uneconomic when only a few parcels were consolidated. The process of consolidation is long-term, and benefits from a continuous dialogue between government officials and the farming community.

Different countries have developed different types of Land Consolidation procedures. Similarly FAO (2003) has set out one of the more recent comprehensive procedures for land consolidation which is listed below:

5.1 Initiation of the land consolidation project

(a) Request for initiation of a project.
(b) Analysis of the situation and identification of what is needed and wanted.
(c) Preparation of an initial concept plan that states the aims of the proposed project and approximate estimates of costs and sources of financing.
(d) Approval of the request by participants and the state.
(e) Formation of a local management team with representation from the community.

5.2 Design of the project

(a) Selection of consultants to design the project.
(b) Precise definition of the area and scope of the project.
(c) Preparation of cost-estimate and schedule for project.
(d) Evaluation of projected costs and benefits.
(e) Preparation of cost-sharing formula.

5.3 Inventory of existing situation

(a) Identification or adjudication of boundaries and the legal status of parcels, including lease rights, mortgages, easements or servitudes.
(b) Delimitation of important environmental areas.
(c) Determination of the value of the parcels.
(d) Handling of objections related to boundaries, ownership and valuation.

5.4 Elaboration of the detailed land consolidation plan

(a) Preparation of the draft consolidation plan showing the new parcel layout, location of new roads and other public facilities, and identifying those roads and facilities which will be removed.
(b) Presentation of several plan alternatives with cost-benefit and environmental impact assessments.
(c) Review of the options for consolidation by participants.
(d) Preparation of the final detailed consolidation plan to accommodate comments of participants.
(e) Handling of objections.
(f) Approval of the detailed consolidation plan.

5.5 Implementation of the detailed consolidation plan

(a) Selection of contractors for construction works, etc.
(b) Construction of public works (agricultural improvements, levelling, drainage, new roads with bridges and culverts, etc.)

(c) Survey of new boundaries on the ground.

5.6 Concluding phase:

(a) Working out compensation and apportionment of costs.

(b) Final updating of the cadastral map.

(c) Issuing and registration of new titles.

6 ADVANTAGES OF LAND CONSOLIDATION

The main advantages of Land Consolidation are described below;

- Improving the agricultural sector by enabling farms to become more efficient and competitive, and better integrated in agricultural chains.
- Encouraging alternative ways of agricultural production such as the implementation of agro-environmental measures and good agricultural practices.
- Strengthening the rural economy by promoting broad-based growth, including supporting non-farm activities and providing access to credit, markets and infrastructure support.
- Improving social conditions by promoting employment opportunities and providing increased access to social services, water and sanitation.
- Providing greater protection of natural resources and for their sustainable management.
- Ensuring greater participation in the development process by those usually left out of it.
- Improvement of agricultural land division.
- Improvement of property division in village centres.
- Re-allotment of leasehold areas.
- Enlargement of the farm size.
- Land use planning in village centres.
- Acquisition of land for the municipality/state in village centres.
- Readjustment of building land (homestead areas) in village centres.
- Improvement of road network in the land consolidation area.
- Improvement of drainage network in the land consolidation area.

- Implementation of environment and nature conservation projects, etc.
- Promotion of regional development projects.

7 CONCLUSION/ RECOMMENDATION

The objective of this paper is to describe the meaning of parcel fragmentation, the major causes of parcel fragmentation, the impacts seen in the fragmented parcels and introduction, procedure & of land consolidation. The main impacts which are seen in the fragmented parcels can be solved by the land consolidation techniques so the government has to make the proper land policy to reduce the parcel fragmentation and encourages applying the land consolidation process which may help in the social, cultural and economic development of the society.

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IMMEDIATE RECOVERY VISION FOR GEO-INFORMATION SECTOR IN THE CONTEXT OF POST 2015 EARTHQUAKE RECONSTRUCTION

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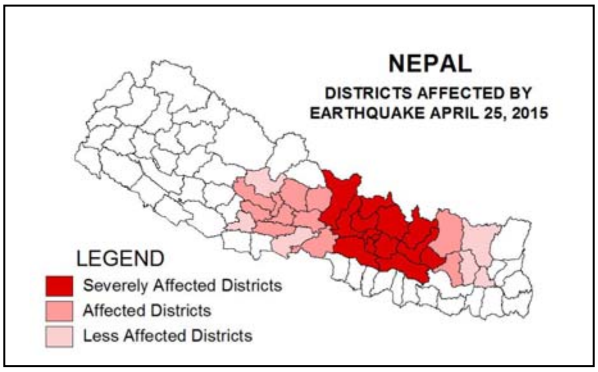
Keywords: Earthquake, CORS, Geodetic Network, Rehabilitation, Orthophoto Image, DTM

Abstract: *The devastating Earthquake - 2015 has not only caused heavy loss of human lives and properties but also destructed the base of surveying and mapping. Maps and geo-information are the foundation for resettlement and development activities whereas Geodetic Control Network is the fundamental base for all kind of mapping activities. Accurate and reliable Geo-information is the foundation for any Post Disaster planning, resettlement activities, Disaster Risk Reduction and all kind of development activities. The Geodetic Network is the infrastructure of the infrastructures. For any development activities, mapping is a must and that the mapping to be of sufficient accuracy, the accuracy of Geodetic Network must be ascertained. Every developmental activities, reconstruction, rehabilitation, reconciliation processes require geo-information and other census data. Successful implementation of this programme will ensure the reduction in data redundancy and ultimately reduces the time and cost for geo spatial data production.*

1 BACKGROUND

The devastating earthquake of April 25, 2015 and a series of aftershocks have not only caused heavy loss of human lives and properties but also destructed the base of surveying and mapping or geo-information. The main reason behind the destruction is the shift of the earth mass in the earthquake affected region, which disturbed the geodetic control network, which is the fundamental base for surveying and mapping activities. The preliminary results from the study undertaken by Survey Department, soon after the April 25 earthquake, showed that the Kathmandu valley has been shifted by 1.8 m, in average, southwestwards and raised up nearly a meter in ellipsoidal elevation. This shift in the land mass of the reason shows that there has been considerable disturbances in the geodetic control network, which is passive in nature, in the earthquake affected region affecting its connection with the entire national network. Such disturbances in the geodetic control network necessitated its rehabilitation before carrying out future activities of surveying and mapping or geo-information production in order to acquire required accuracy. At the same time, in absence of accurate geodetic network, mega projects of national importance such as hydropower, irrigation, among others, will be greatly affected.

The reconstruction effort will need a large scale maps and relevant geoinformation products in the region to carryout overall planning of the reconstruction and rehabilitation. Land resource maps will be required to ensure the resettlement of disaster prone villages to safer location and formulating village level land use plans. In the same way, the property boundaries have to be rehabilitated after the devastation. So, exiting cadastral maps have to be spatially corrected in order to accurately delineate the parcel boundaries.

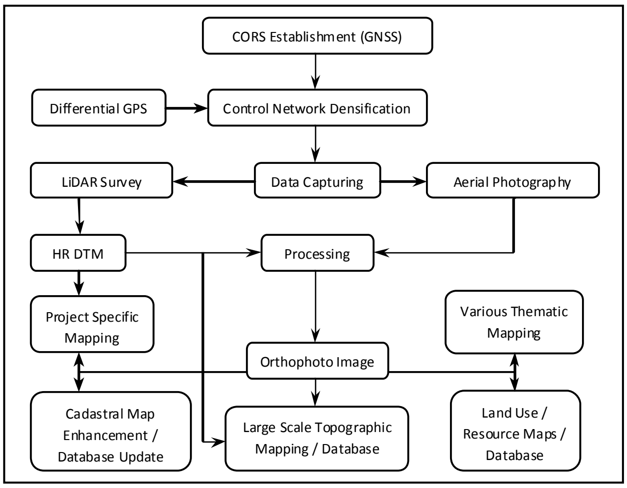


Thus, there are various geoinformation related needs and depending upon the availability of resources priority has to be set to begin with, especially to support ongoing reconstruction efforts of the government in the region. Survey Department, under the Ministry of Land Reform and Management, being National Mapping Organization of the country, as per its mandate, has to bear this responsibility. In this context, this 'Strategic Recovery Vision' has been proposed based on the overall vision of the Department for the future activities.

2 FUTURE VISION OF SURVEY DEPARTMENT

With the dramatic evolution in the sector of Geo-information and communication technologies, spatial enablement of the society is growing rapidly. Emerging technologies have provided opportunities for making use of geoinformation not only for the projects of infrastructure development but also every sector of human society including planning and policy making. Therefore, in order to meet the changing needs of the society, Survey Department has to shift from its traditional way of producing supply driven products to demand driven ones. Being National Mapping Organization of the country, the department has to focus on the base data that can support the production of other geoinformation for specific purposes.

In this context, Survey Department has envisioned that its future activities will be based on the most modern technologies and methodologies. Workflow of the envisioned multipurpose mapping project is as follows.



Workflow of the envisioned integrated multipurpose mapping project of Survey Department

Main concept of this project, in brief, is that a dynamic geodetic datum is defined based on Continuously Operating Reference Stations (CORS) established throughout the country. Existing geodetic control network is rehabilitated and strengthened based on the newly defined dynamic datum. Newly defined dynamic datum and rehabilitated passive datum both are used for mapping activities of the future. Precise levelling will also be carried out as required.

Similarly, aerial photography along with LiDAR survey is carried out to produce high resolution digital terrain model (DTM). Orthophotomaps are produced based upon the aerial photographs and the DTM. The orthophotomaps and DTM are further processed for producing various kinds of geoinformation products including updating existing National Topographic Database, producing new series of Topographic Maps in larger scale; 1:10,000, updating land resource maps, producing maps of different thematic areas, enhancing spatial accuracy of cadastral maps among others.

3 RECOVERY STRATEGY IN THE CONTEXT OF POST 2015 EARTHQUAKE

3.1 Setting Priority

As mentioned in the Background Section, there is a need of multiple geoinformation products in order to facilitate ongoing efforts of reconstruction. However, availability of resources and organizational capacity may not be in favor to take all the needs at a time. Therefore, setting priority is important, and criteria for the recovery programs have been judged on the basis of need assessment for the reconstruction process as well as the long term stability of the products resulted from the implementation programs. Based upon the judgment, the Department has prioritized as follows:

3.1.1 *Establishment of Continuously Operating Reference Stations (CORS) & Rehabilitation of Geodetic Network*

The geodetic network is considered to be the infrastructure of infrastructures, as without it no mapping activities, which are fundamental infrastructure for developmental activities, are possible. For any development activities, mapping is a must and that the mapping be of sufficient accuracy, the accuracy of geodetic network must be ascertained. Since the April 25 Earthquake and series of following aftershocks have damaged the existing geodetic network, it is high time that we rehabilitate the damaged network. This is why the establishment of CORS including the rehabilitation of existing network has been on priority.

CORS Station

3.1.2 *Production of high resolution Digital Terrain Model (DTM) and Orthophoto Map*

Similarly, every developmental activities, reconstruction, rehabilitation, reconciliation processes require various kinds of geo-information along with other data. Accurate and reliable Geoinformation is the foundation for any Post Disaster planning,

S.N.	Programs	Results	Indicators	Application Areas
1	Establishment of CORS & Rehabilitation of Geodetic Network	Rehabilitated and Strengthened Geodetic Network	• About 150 CORS established throughout the country • Geodetic Control Points of different orders rehabilitated • Geodetic Datum updated • Real time GNSS solutions commenced	• Geodetic Studies including deformation studies • National Mapping Activities • Mines and Geology • Hydropower • Development Activities • Academia • Research
2	Production of high resolution Digital Terrain Model (DTM) and Orthophoto Map	Newly acquired and updated geo-information products	• High resolution DTM prepared • High resolution Orthophoto map prepared • Feature extracted to produce various kinds of geoinformation products	• Updating of National Topographic Database • Land Use Planning • Cadastral Mapping • Infrastructure Development Projects such as Hydropower, Irrigation, Roads etc. • Disaster Risk Mitigation • Resettlement

Expected Results and Indicators

resettlement activities, Disaster Risk Reduction and all kind of development activities. Proper evaluation and analysis of geoinformation with socio economic data will guide to plan in organized way which lead to better disaster risk management and ultimately facilitate for good governance.

Existing geo-information provided by the Department are based on the aerial photographs of early 1990s, which are quite old to support the required need. Due to lack of update, these geo-information are currently outdated. In order to effectively plan and implement the post disaster reconstruction process, need of updated geo-information is inevitable. Hence, the programme of preparation of high resolution orthophoto and DTM has been placed in the same priority.

3.2 Implementation Strategy

3.2.1 *Establishment of CORS & Rehabilitation of Geodetic Network*

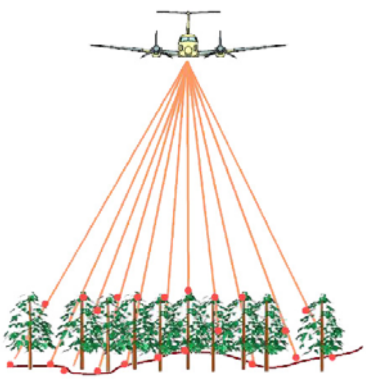
Establishment of CORS may require international expertise or outsourcing, whereas the rehabilitation of geodetic network and further extension of the established points is to be done with in-house expertise. Even if the establishment of CORS is done by using international expertise, there will be the involvement of competent staff in the project from the Department. This will help in building the capacity to own and operate the CORS Network and after the successful completion of the project, there will be a number of competent staff for the rehabilitation of the geodetic network. In the first phase, the project will be concentrated in the earthquake affected areas, and can be extended beyond the region as per the availability of required resources.

The data from the CORS has to be processed for the accurate positioning of control points and these data are also useful for other sectors such as Department of Mines and Geology (DoMG) for seismological studies, sectors requiring locational information, sectors working in the field of rescue operation and different navigational purposes. Recent studies on GNSS has shown that the data from CORS are equally useful to predict upcoming earthquakes to some extent. Therefore, establishment of CORS will further contribute in societal benefits.

3.2.2 *Production of high resolution Digital Terrain Model (DTM) and Orthophoto Map*

Production of high resolution DTM and Orthophoto map may also require outsourcing or international expertise, as the aerial survey as well as LiDAR survey are beyond the capacity of the Department. However, there will be the involvement of competent staff in the program. This will help in building the capacity to own and operate the above mentioned products. This capacity can be utilized to derive various other geo-information products such as topographic base maps and several thematic maps.

High resolution orthophoto map and Digital Terrain Model (DTM) of the earthquake affected 31 districts will be prepared through aerial photography and LIDAR surveying. Production of high resolution DTM



Data collection by LiDAR

and Orthophoto Image could be the foundation for multipurpose mapping. As DTM provides information about elevation and rectified orthophoto shows the ground reality, combination of both will be the milestone for geospatial analysis and every kind of mapping activities like disaster response, topographical data acquisition, cadastral map enhancements, land use planning, geological mapping and many more. Apart from these, the data will be highly useful for the mega projects of infrastructure development like hydropower, irrigation, among others. These all kind of products can be prepared with in-house capacity. The geo-information can be shared to other stakeholders which will reduce data redundancy.

3.3 Expected Results and Indicators after implementation

After the successful completion of "Establishment of CORS & Rehabilitation of Geodetic Network" programme, it is expected that the Geodetic Network of Nepal will be rehabilitated and strengthened.

Similarly, after the successful completion of "Production of high resolution Digital Terrain Model (DTM) and Orthophoto Map" programme, it is expected to have newly acquired and updated geo-information products.

More details on expected results and indicators has been presented in the table "Expected results and indicators" in previous page.

3.4 Source of Financing and Budget Estimation

Government of Nepal has considered both of the above mentioned projects of high importance and hence both are included in the Post Disaster Recovery Framework (PDRF) sector plan of the National Reconstruction Authority (NRA). This shows the full commitment from the Government to accomplish the projects, however, the source of financing has to be explored. The duration has been planned for five years and the total budget estimation is about 5,102 million NRs.

4 CONCLUSION

Devastating earthquake of April 25, 2015 and series of aftershocks irreparably damaged the geodetic control network apart from heavy losses in different sectors. It has severe impact on the overall surveying and mapping activities of the country. Recovery efforts of the Government require updated geoinformation products for effective planning and implementation of various programs and projects. Survey Department has the mandate of producing and disseminating geoinformation products of national need. However, at the current stage, the Department is not in position of providing the geoinformation of current need, as the source of the data is quite old. In this respect, newest effort is required, at least in the earthquake affected region and hence the two prioritized programs have been put forwarded. Upon successful implementation of the programs, the Department will be able to meet the current geoinformation need, which will be readily available to share with the different organizations from public and private sectors. This effort will not only support the Department to make technological shift but also help reduce redundant efforts as well as investment for the same purpose by different organizations.

NEPAL REMOTE SENSING AND PHOTOGRAMMETRIC SOCIETY (NRSPS)

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1 GENERAL ASSEMBLY OF NRSPS

The General Assembly of Nepal Remote Sensing and Photogrammetric Society (NRSPS) was organized on, March 1, 2015. The main agenda was to elect new Executive Committee Officials of NRSPS as the working time period of the then Executive Committee Officials were terminated. The meeting was initiated by Mr. Rabin K. Sharma, President, NRSPS. After opening of the programme, the election procedure was commenced by Mr. Mohan Chand Thakuri, Deputy Director General, Geodetic Survey Branch of Survey Department. In the process, the same Executive Officials were unanimously elected by the members of NRSPS. Then Mr. Babu Ram Acharya, former Secretary of Government of Nepal released Earth Observation: Volume VII; Annual Newsletter of NRSPS in which two articles: Integrated approach for building extraction from Insar and optical image using object oriented analysis technique by Mr. Bikash Kumar Karna and Unmanned Aerial Vehicles: Usability and barriers by Ms. Shanti Basnet were included. Besides the regular columns of the Newsletter, a message of Dr. Dinesh Pathak, President, Nepal Geological Society was also included. Mr. Acharya also delivered a very inspiring speech as a Chief Guest of the programme.

2 INTERNATIONAL GEOSPATIAL WORKSHOP

International workshop on the Role of Land Professionals and SDI in Disaster Risk Reduction in the context of 'Post 2015 Earthquake in Nepal' an event of FIG Commission 2 and ISPRS Technical Commission IV, Working Group 4 was held from November 25-27, 2015 in Kathmandu. The workshop was jointly organized by Nepal Institution of Chartered Surveyors (NICS) and Nepal Remote Sensing and Photogrammetric Society (NRSPS). The Co-organizers were Ministry of Land Reform and Management, Survey Department and Land Management Training Centre. The organizers could able to draw attention of 355 participants from 22 countries of the globe.

The workshop was inaugurated by Deputy Prime Minister and Foreign Minister, Hon. Kamal Thapa. The opening ceremony was chaired by Mr. Buddhi Narayan Shrestha, President of NICS. The major attractions of the workshop were the keynote speeches delivered by Prof. Dr. Armin Gruen, Prof. Dr. Arbind Man Tuladhar and Mr. Rajan Iyer, capacity and products of 8 national and international organizations displayed in their corresponding exhibition stalls, lecture delivered on plenary sessions by 9 eminent professionals, 56 technical papers including 11 peer reviewed papers were presented in respective technical sessions and conducted a special session for young surveyors. A very interesting and entertaining programme of the workshop was a cultural programmee followed by the welcome dinner hosted by Survey Department, Nepal in honour of the participants on 25th November 2015. Closing ceremony was organized on 27th November 2015, chaired by Mr. Rabin K. Sharma, President of NRSPS. In the ceremony, Hon. Ram Kumar Subba, Minister of Land Reform and Management and Mr. Babu Ram Acharya, former Secretary of Government of Nepal were the Chief Guest and Special Guest respectively. The workshop concluded with six point resolution which was handed over to the Minister by the chair of the closing ceremony.

3 SILVER JUBILEE CELEBRATION OF NRSPS

NRSPS is completing its 25 years of period in 2016, therefore NRSPS Executive Committee officials decided to celebrate 2016 as a year of Silver Jubilee with varieties of programmes in order to outreach to larger mass to promote the knowledge of remote sensing in the country. Some of the major programmes will be as follows:

- Felicitation and recognition of the past Presidents of NRSPS
- Review presentation on major achievements of past 25 years
- Discussion on the role of NRSPS for Nation Building and Reconstruction and vision of NRSPS for next 10 years
- Outreach and Capacity Building Programme
- Publication of the 25th year souvenir of NRSPS and many more.

"Request to NRSPS Members not to miss to participate in the programmes of Silver Jubilee Celebration of NRSPS"

Nepal Surveyors' Association (NESA)

Background

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

Objectives

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

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

Organizational Structure

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

Membership Criteria

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

Activities

- Nepal Surveyor's Association (NESA) celebrated its Silver Jubilee this year organizing different programmes like Cleaning Campaign, construction of NESA Monument in Survey Department Complex.

- NESA celebrated Surveyor's Day (Bhadra 18, 2072) organizing different programmes like blood donation, sports activities. Surveyors from different districts participated in those activities.

- Surveyor's Day (Bhadra 18, 2072) was also celebrated in different districts organizing different programmes like blood donation and interaction programmes.

NESA CEC
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Mr. Madhusudan Adhikari
President

Mr. Ambadatta Bhatta
Chief Vice President

Mr. Saroj Chalise
General Secretary

Mr. Prakash Dulal
Secretary

Mr. Durga Phuyal
Secreatry

Mr. Sahadev Ghimire
Treasurer

Mr. Dadhiram Bhattarai
Co-treasurer

Mr. Hari Prasad Parajuli
Member

Ms. Jyoti Dhakal
Member

Other Officials

Mr. Ram Sworup Sinha
Vice President
Eastern Development Region

Mr. Tanka Prasad Dahal
Vice President
Central Development Region

Mr. Gopinath Dayalu
Vice President
Western Development Region

Mr. Ramkrishna Jaisi
Vice President
Mid-Western Development Region

Mr. Karansingh Rawal
Vice President
Far-Western Development Region

Other Members:
Mr. Premgopal Shrestha
Ms. Geeta Neupane
Mr. Laxmi Chaudhari
Mr. Kamal Bahadur Khatri
Mr. Bibhakta Shrestha
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By Abhasha Joshi, Janak Raj Joshi, Nawaraj Shrestha, Saroj Sreshtha, Sudarshan Gautam

5. Potential Use of GPS Technology For Cadastral Surveys in Nepal
By Rabindra Man Tamrakar

6. Replacement of Professional Photogrammetric Workstations with Low Cost or Free of Charge Photogrammetric Software and Services for Image Triangulation and Image Matching
By Umesh Kumar

7. Urban Sprawl Modeling using RS and GIS Technique in Kirtipur Municipality
By Bikash Kumar Karna, Umesh Kumar Mandal, Ashutosh Bhardwaj

Journal 13 (Published in 2071 B.S.)

1. Importance of Geo-informatics Professional Organizations of the World
By Rabin K. Sharma

2. Influential Factors of Geo-Information Sharing
By Shanti Basnet

3. Integrated Approach for Building Extraction from InSAR and Optical Image using Object Oriented Analysis Technique
By Bikash Kumar Karna, Ashutosh Bhardawaj

4. Multihazard Mapping of Banepa and Panauti Municipalies
By Laxmi Thapa, Shrijana Panta, Sanjeev Kumar Raut, Florencia Ma na Tuladhar Janak Raj Joshi, Nawaraj Shrestha, Prashant Ghimire, Anish Joshi

5. Road Network Planning for Sustainable Urban Development in Kirtipur Municipality, Nepal
By Bikash Kumar Karna

6. Technical Aspects of Digitization of Cadastral Maps
By Ram Kumar Sapkota, Ganesh Prasad Bhaatta

7. Use of Geo-Informatics in Flood Hazard Mapping: A Case of Balkhu River
By Susheel Dangol

Journal 14 (Published in 2072 B.S.)

1. Bye-Bye EQ2015,11:56AM
By Kalyan Gopal Shrestha

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

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

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

Joint Field Inspection of Nepal – India Boundary field works, January 10 – 20, 2016.

Mr. Krishna Raj B.C., Director General participating in the "GEO SMART India 2016" conference (March 1 - 3, 2016).

Opening Ceremony of the "International Workshop on the Role of Land Professionals and Spatial Data Infrastructure (SDI) in Disaster Risk Reduction (DRR): in the Context of 'Post 2015 Nepal Earthquake" 25-27 November, 2016 in Kathmandu; in which Survey Department is one of the Co-organizer.

Mr. Ram Kumar Sapkota, Survey Officer, Survey Department participating in the 'Training Seminar on Geographical Information System and Land Management' from 2nd March-15th March 2016 conducted by International Centre for Land Policy Studies and Training held at Taiwan.

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

Available Maps and Data

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

Available Services

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

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