ALIGNMENT OF MULTIPURPOSE CADASTRE (MPC) DATA FOR FLOOD DISASTER RISK MANAGEMENT (DRM): A CASE STUDY IN NEPAL

PRADEEP SAPKOTA UPADHYAYA
Enschede, the Netherlands,
February, 2013

SUPERVISORS
Ir. WALTER DE VRIES
PROF. DR. JAAP ZEVENBERGEN

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SUPERVISORS
Ir. WALTER DE VRIES
PROF. DR. JAAP ZEVENBERGEN

THESIS ASSESSMENT BOARD
Chair: PROF. Ir. P. VAN DER MOLEN
External examiner: DR. C. J. VAN WESTEN
First supervisor: Ir. WALTER DE VRIES
Second supervisor: PROF. DR. JAAP ZEVENBERGEN

ABSTRACT

Potential use of Multipurpose Cadastre (MPC) is still unclear, whether the useable sectors are numerous i.e.; food security, climate change, natural resource management and gender equality. The main focus of this research was the alignment of MPC datasets for floods Disaster Risk Management (DRM) activities in Nepalese case. This research explores use of MPC data for flood DRM activities, one of the usable sectors of potential use of MPC datasets. The users' requirements are extracted by experts view in qualitative way and system requirements are extracted by practice from international land administration organizations. Data requirement for flood DRM activities are extracted from experts' views and literatures. Need and gap analysis of MPC data for flood DRM activities alignment carried out by experts view and existing MPC class diagram. The newly designed system based on users' requirements and system requirement. The system mainly focused on data sharing mechanism between central and local governments. The web based system designed by using postgres database, apache server, Geo-server and PHP and JAVA web language to overall system managements. The hazard class map was performed by flood simulation process. Accordingly, prototype outputs are prepared for future works. Mainly hazard classes, value of parcel and house, number of residence, number of floor and building type are added for value added information in DRM activities. Contours can be downloaded from the system for Digital Elevation Model (DEM). Parcel and buildings are used for analysis of element at risk as exposer. The hazard map, element at risk map for building and parcel; and summary risk information are the main outputs from the system. This system can be useful for both LA and DRM organizations. The system tested based on the outputs required for flood assessments i.e.; hazard map, element at risk map and risk information. The system was validated based on experts' opinions' by using (V-Model) and 4Q approach. The validation result was satisfactory.

Key words: *Multipurpose cadastre (MPC), Data sharing mechanism, Web based system and Disaster Risk Management (DRM)*

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Pradeep Sapkota Upadhyaya
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ABBREVIATIONS AND ACCRONYMS

ADPC	:Asian Disaster Preparedness Center
ADRC	:Asian Disaster Reduction Center
IRCS	:International Red Cross Society
JICA	:Japan International Cooperation Agency
UMN	:United Mission to Nepal
USAIDMN	:United States Agency for International Development Mission to Nepal
CAPRA	:Central American Probabilistic Risk Assessment
CARE	:Cooperation for American Relief Everywhere
DDC	:District Development Committee
DDG	:Deputy Director General
DEM	:Digital elevation model
DG	:Director General
DHM	:Department of Hydrology and Metrology
DoLIA	:Department of Land Information and Archive
DoS / DOS/SD	:Department of survey, Nepal
DRM	:Disaster Risk Management
DSM	:Digital surface model
DTM	:Digital terrain model
DWIDP	:Department of Water Induce Disaster Prevent
EU	:European Union
Geo-ICT	:Geoinformation and Communication Technology
GIS	:Geographical information system
GPS	:Global positioning system
GTZ	:Technical Cooperation of the Federal Republic of Germany
ICIMOD	:International Centre for Integrated Mountain Development
INGOs	:International Non-Government Organizations
LA	:Land Administration
LULC	:Land use land cover
LUP	:Land Use Project, Nepal
LWS	:Lutheran World Service
MoLRM	:Ministry of Land Reform and Management
MPC	:Multi-purpose Cadastre
NGOs	:Non-Government Organizations
NSET	:National Society for Earthquake Technology-Nepal
SCF	:Save the Children Fund
UNDP	:United Nations Development Program
UNDP	:United Nations Development Program
USD	:United State Dollar
VDC	:Village Development Committee
WB	:World Bank
WFP	:World Food Program

1. INTRODUCTION

1.1. Background

ICRS (2012) explain 302 major disaster event recorded in 2011. 29782 fatalities, 206 millions of people affected and 366 million USD damaged in 2011. Disasters are hazardous events, dynamic in nature and difficult to predict. For its managements, it is necessary to understand the term hazard, vulnerability and risk information and how to use that information in Disaster Risk Management (DRM). Hazard maps indicate the degree of probable loss or damage in particular place at a particular time. Vulnerability map indicates elements at risk and degree of risk at the hazardous zone. Risk information relays on the probably expected loss or damage created by that natural hazards. Risk can also be defined as intersection of vulnerability and hazard information (Frigerio & van Westen, 2009). This information plays vital role in disaster mitigation, rescue and post disaster response, which is useful in every stage of disaster cycle i.e. pre, during and post disaster phase. Hapuarachchi (2008) concentrated on use of spatial data and use of Geo-ICT in the field of disaster management.

The Geo-ICT works as a potential bridge between spatial data and DRM. Due to the dynamic nature of the disaster, there is a requirement of a variety of spatial data to carry out the DRM activities. The data required to carry out flood DRM is daily rainfall data, land use data (surface characteristics data), digital elevation model (DEM), building information (including number of residence), watershed boundary, characteristics of building (including strength of building) and price of building. Some of the data can be extracted from Multi-Purpose Cadastre (MPC). Figure: 1-1 indicates the DRM activities carried out by using MPC. It shows the relation between MPC and DRM activities using Geo-ICT as a potential bridge between the two. DOS Nepal (2006) indicates the possibilities to use MPC in different development activities. In current studies, it is seen that the international literature is also focusing on different uses of Multi-Purpose Cadastre (MPC) data for development activities in various fields, at different administrative levels.

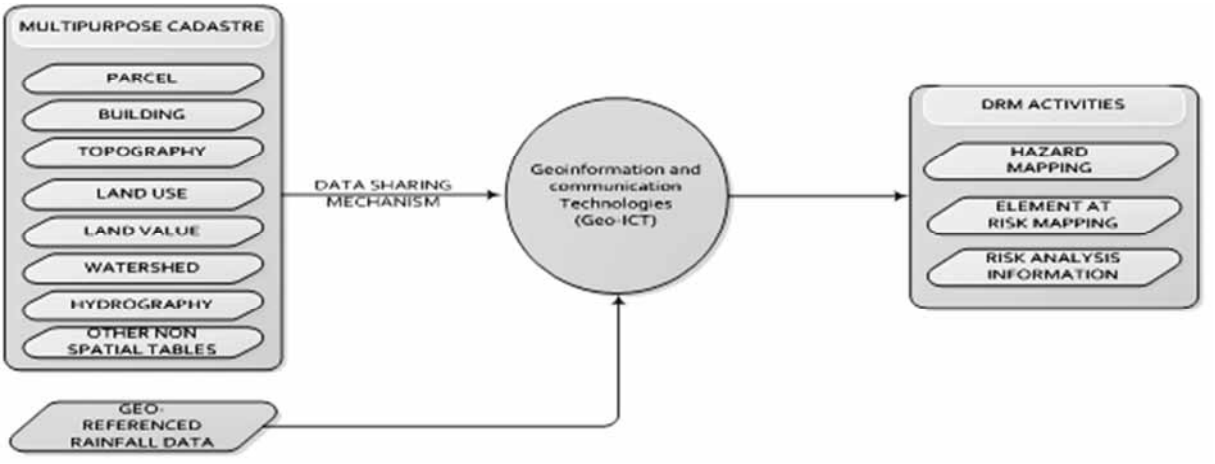

Figure 1-1: Sketch of flood DRM by using MPC and GIS technology

A central theme for developing the multipurpose cadastre was to increase the emphasis on users (Acharya, 1992). Majid (2000) discusses the effects of having simultaneous users of multi-purpose cadastre (MPC) at the same time. These users are central government, regional government, local government, individuals and academia. The publications of FAO and UNDP (2004) suggested that the primary use of land resources data is in the fields of 1) Land utilization 2) Climate evaluation 3) Watershed management 4) Soil evaluation 5) Topography information 6) Crop prediction 7) Socio economic evaluation 8) Land cover change and 9) environmental management. It is not possible to solve all the above mentioned issue by only using MPC, without the use of other thematic datasets.

Another user's emphasis concern is its different types of uses or the spread of MPC over different type of domains. This problem is visible when aiming to implement the SDI visions. Nebert (2004) made this clear when relating cadastral data to other types of data sets. Hence, while the cadastral data has its own purpose in defining their relation with other data sets and other data users, the ideal (or most appropriate) connection is still unclear. There are however various attempts in defining this connection. Turkstra *et al.* (2003) literature indicate cadastre as a tool for good land governance and that can solve different problem on land and other environmental issues.

The main focus of this research is to carry out DRM activities by using MPC, which is one of the uses of MPC. Enemark (2010) focused on several aspects of land governance (By using digital multipurpose cadastre as a tool) such as 1) Guarantee of land 2) Equal access to land 3) sustainable land policy 4) Recognize rapid urban growth 5) Secure investment for the land 6) transparency 7) Easy access to land for resolving poverty issue 8) Avoid land grabbing 9) Environmental protection 10) Disaster Risk Management (DRM) and 11) Food security; mainly focused on transparent land administration system including climate change by using MPC. Selod (2012) focused on land governance assessment panels including DRM issue in national governance framework. This means that the national MPC is helpful in contributing in the field of providing the information to the DRM activities. Zevenbergen (2009) indicated that a good LA (including cadastral data) helps in disaster management. The question then is how MPC data can play a role for DRM in international community?

1.2. Review on International concept for DRM by using MPC

Several scholars have argued and demonstrated how MPC can serve many sectors. Article of van der Molen (2010) explores the use of MPC's within the fields of land use planning, land taxation, land tenure security and many related environmental and climate change issues. The primary use of MPC entails boundary information, land use information; land ownership information, land value information, topographic information and natural resources information. The main advantage of MPC is that it contents information related to land as an input for planning, taxation, tenure security and environment. It is essential to include more information to make a meaningful MPC data for multipurpose use. Therefore in designing MPC system, it is essential to include all possible uses of land related issues such as climate change, food security, disaster management and land distribution.

It is necessary to collect all possible data for multi-purpose use, along with the potential users of MPC from national LA organization. Tuladhar *et al.* (2004) focused on parcel based information to manage resources such as watershed area, forest resources area and hazardous area. They indicated a class diagram of cadastral dataset having spatial hierarchy including sub-classes related to natural resources area, hazardous area and watershed area helpful for disaster risk analysis. There is a large amount of literature focusing on post disaster management by use of MPC. Williamson (2001) emphasizes on MPC as user demand tool which can be useful in different fields including DRM. Bennett *et al.* (2012) indicate that the national LA infrastructure can address the DRM at national level.

A particular (potential) application of MPC data is in the field of disaster management. According to Augustinus *et al.* (2004) cadastral data is useful for pre, during and post disaster phase. The data is useful for right protection in post disaster response phase and preparedness phase. Fitzpatrick and Zevenbergen (2010) focus on land administration and DRM. Spatial data plays vital role in hazard mapping, elements at risk mapping and risk analysis phase of DRM. Therefore, the above types of mappings and information would help in the preparedness phase and the response phase of disaster.

1.3. Review on DRM practice in Nepal

Institutionally, several Non-Government Organizations (NGO's) and International Non-Government Organizations (INGO's) are participating in risk assessment mapping in Nepal. NSET (2012) indicates the lists of national level partners involved in DRM, but do not include National mapping agency (Land Administration Organization) as a partner. NSET and other international DRM partners are working on different phases of DRM in Nepal. Here NSET is one of the agencies which are not using MPC data for

DRM activities. But the DOS Nepal (2006) states that there are possibilities in future, where MPC data would be used for DRM activities.

The above examples show the wide variety in potential use of MPC and the conditions at which use may be meaningful or successful. In this research, I aim to use MPC data in the field of DRM. The key unknown is, which attributes of MPC data can help DRM in which way and what are the additional attribute required for DRM activities to get value added information for DRM activities? What are the conditions in which the MPC data sharing mechanism for DRM can be useful for the practitioners?

1.4. Research problem

As discussed in the above mentioned sections very limited contributions have been done in the field of DRM activities by using MPC data. While the MPC data sets of the Nepalese Cadastre are available, it is unclear how they can support national activities of DRM. So, the challenges are to determine the minimum requirements to make MPC data usable for DRM which can be used for local level decision making support system.

To align the MPC data for the DRM activities there are various possibilities, such as data sharing mechanism with certain mandates to DRM practitioners and adding additional attributes in MPC data collection phase to get value added information for DRM activities. The main focus in this research will be on How to make Nepalese MPC useable for flood DRM activities.

The research seeks to examine the above stated ideas and to find out what attribute information in MPC data sets are necessary in the collection phase of cadastral mapping. This will give value added information for DRM and the ability for DRM practitioners to share information from MPC.

1.5. Research Objective

The main objective of this research is to determine the minimum requirement under which the MPC data would be more usable for flood DRM activities local level in Nepal.

Sub objectives

1. To evaluate the main data requirements for flood DRM activities (literature study / synthesis of publications on user requirements of DRM)(Theoretical work)
2. To evaluate the existing MPC data, whether it will fulfil the minimum requirements for flood DRM or not (Empirical work)
3. To search the possibilities for value added information by adding additional attributes to the existing MPC data which are useful for flood DRM (Literature study and empirical work)
4. To investigate how to improve the data sharing between the LA organizational system and DRM practitioners. (System prototype work , design and validate)

1.6. Research Questions

In relation to sub-objective 1:

1. Which type of data is required for flood DRM activities?
2. Which type of MPC data is required for flood DRM activities?

In relation to sub-objective 2:

3. What is the process followed by Nepalese cadastre in order to collect, stores and shares MPC data?
   - 3.1 How survey office collects the MPC data?
   - 3.2 How survey office stores and shares MPC data?
   - 3.3 What are the activities involved to collect, store and share MPC data?
4. Which type of information can be extracted from existing MPC data which would be useful for DRM activities?
   - 4.1 What type of information can be extracted from existing MPC data?
   - 4.2 What type of information from existing MPC could be useful for DRM activities?

In relation to sub-objective 3:

5. Which additional attributes in MPC would be beneficial for DRM purpose?

In relation to sub-objective 4:

6. What is the suitable way for MPC data sharing mechanism to flood DRM practitioners?
   - 6.1 What could be the system to store, maintain and share system for MPC to DRM practitioners?
   - 6.2 How to test and validate that system?

1.7. Conceptual framework

The overview of some of the involved components in this research is in figure: 1- 2 which explain about the data sharing mechanism between DRM practitioners and LA organization. Different types of dataset attribute information of particular feature class and other thematic data are essential to be entered in GIS to get hazard map, element at risk map and risk analysis information which is useful for flood DRM at local level.

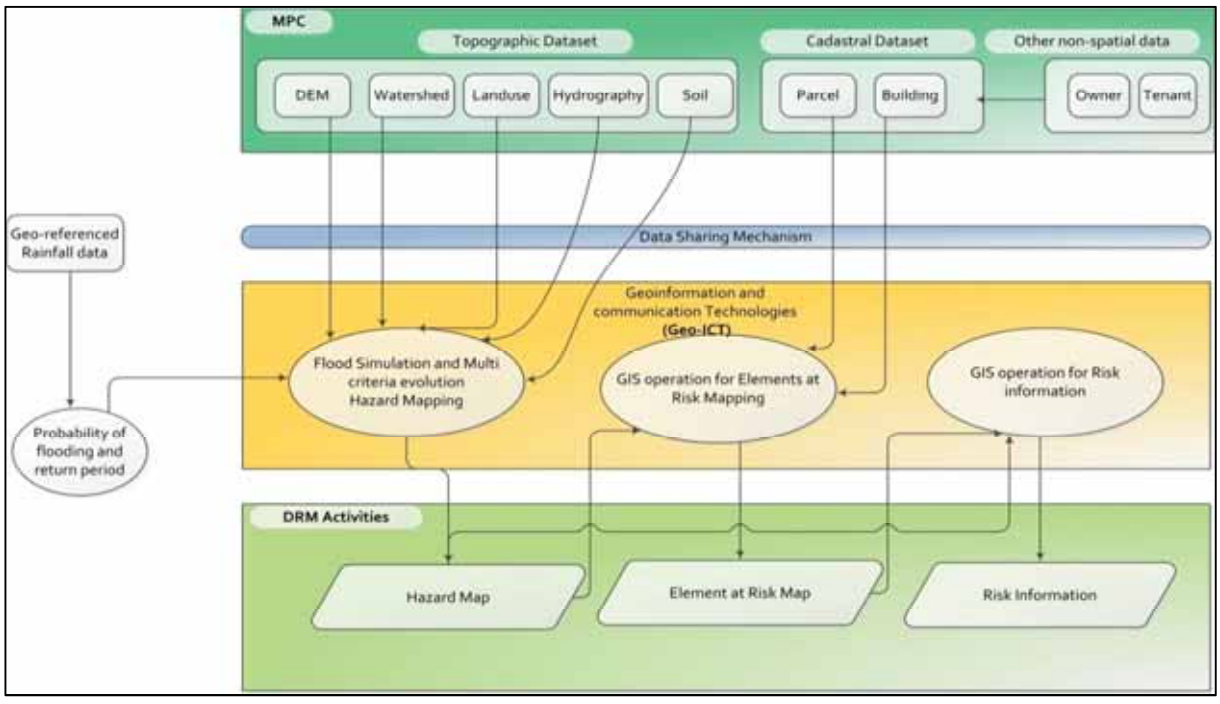

Figure 1-2: Conceptual framework

1.8. Methodology

The steps followed in this research are desk study, field data collection for case study approach and design study. Multi criteria assessment and GIS operation for DRM assessment are carried out by DWDIP. The major activities are system designing, testing and validation done in the research. The brief introduction of the above steps is as follow:

a) Desk research

Desk researches are based on literature review, tele-calling, mails and interviews. Review on the land and disaster management activities are useful to sort out different sources of data useful for DRM activities. Information about the MPC data layer and attribute information are useful for DRM activities. Other task of desk research is data processing, analysing the collected data from the field.

b) Case study research

Case study research is useful for DRM analysis at the local level. The integration of all local level datasets is useful for regional level DRM analysis. Thus, MPC data and other thematic data set is required for DRM. The case study would help in understanding the gaps between MPC data and DRM activities and recommend possible solution to fill up those gaps. The field study will also help in validating the results from desk study. Nepal has similar problem in several places, I choose Chitwan as a sample study area for MPC data sharing at the local level for DRM.

a) System design research

After data collection from field I analysed the transcripts of interview in ATALAS TI software for coding the statements to explore the needs and gaps in MPC data used in the GIS platform for flood DRM activities. By addressing those gaps and needs I designed the prototype and the system for DRM activities by using UML modelling software. I tested and validated the result by client server approach.

1.9. Study Area

Several attempt of research related to LA and DRM are previously carried out in this area. This area is located in the central part of Nepal and one of the biggest water drainages in Nepalese watershed. Subsequently, this area is most vulnerable zone in Nepalese cases. Charoenkalunyuta (2011) carried out a research in this area, in which she focused on resilience factors of tenure security in the disaster phase. She used some cadastral data to overlay in the hazardous zone, in that area. This shows that the MPC was used only in post disaster phase. Consequently, there is a requirement of further research in this area. The tasks for this research would be to collect the information, data and conducting interview as mentioned in data collection section, in this study area.

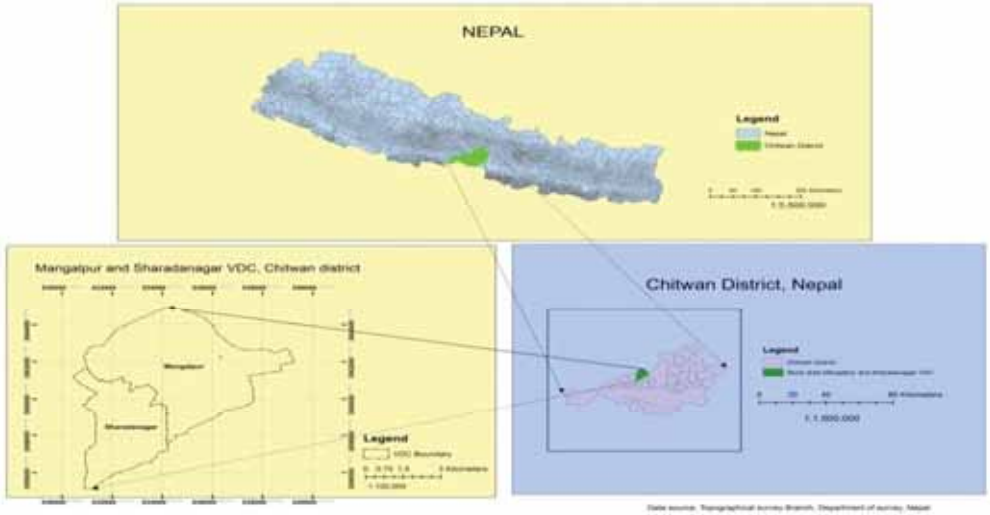

Figure 1-3: Study area, Chitwan, Nepal

1.10. Research Design

The research plan is useful for the getting the answers of research questions in scientific and systematic way. Table 1-1 gives the overall idea of getting the answers.

- Answer of research questions 1 &2 are extracted from the LA and DRM related articles, books, papers, web sites of LA and DRM organizations. From the above type of literature, I extracted list of activities, data requirement, and source literature in the tabular format.
- Answer of research questions 3 is extracted from activities observation in cadastre offices and reviewed land measurement act 1954 and land related rules and regulation.
- Answer of question 4 is extracted from the semi structured interviews to disaster practitioners, LA policy makers and land surveyors. The focus of interview was on existing MPC data layers and attribute information which is useful for DRM. Transcripts from the interview were coded in ATLAS TI. The answer of research questions 1, 2 and 3 was validation from the analysis of semi structure interviews.
- Answer of research questions 5 was extracted from the semi structured interview with disaster practitioners, LA policy makers and land surveyors. And study of existing MPC class diagram.
- Answer of research questions 6 were extracted from interview with planning officer of DOS, director of cadastral survey branch and IT staffs in order to design prototyping by using UML modelling software and result were validates in the client server application.

Three stage of research would be conduct

Pre-Field Work

The literature review was carried out related to the Disaster management and land administration. Various LA and DRM related reports would help in extracting the mentioned list of data, activities and source of literature in tabular format. The technical specification report of DOS, Nepal will help to make a list of data layers and attribute information of MPC.

Field Work

This part of research focused on the primary data collection. Interviews were carried out with DRM practitioners, technical experts, planning officers and directors of LA organization and DRM organizations at local and regional level. Secondary data was collected in the digital format, maps, papers, photographs and list of data and sources mentioned in data collection section.

Post Field Work

After completion of two phases, I gained information about how MPC data is collected, shared and stored by LA organization. The list of data, usable activities and sources of literature would help in exploring the usable MPC feature class and attribute information on that layer. Qualitative analysis was carried out from the collected interviews. Collected MPC data was an input in GIS for DRM activities and helped in producing maps. The information compared the result with the existing hazard map, elements at risk map and risk information. From interview, I got information about the elements to be included in system design. By using UML and Client server application I tested and validated the results.

The research framework is given below:

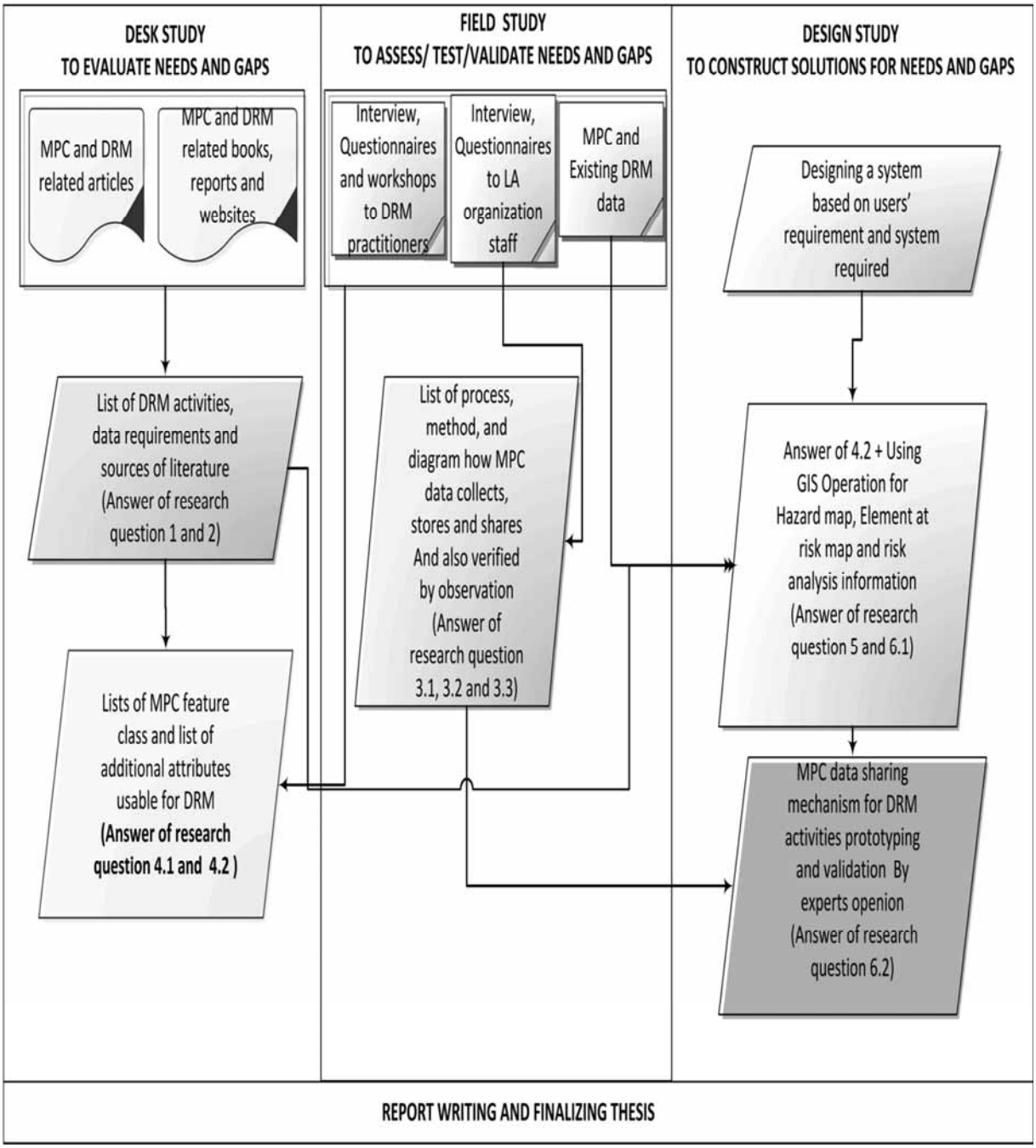

Figure 1-4: Research framework

Table 1-1: Details of research design

Research Objective	**Main**	To determine the necessary conditions under which the MPC data would be more usable for DRM activities or decision support systems at the local level in Nepal.				
	Sub	To evaluate the main data requirements for flood DRM activities (Theoretical work)		To evaluate the existing MPC data, whether it fulfills the necessary conditions for flood DRM or not (Empirical work)		To explore the possibilities for value added information by adding additional attributes to the existing MPC data which are useful for flood DRM (Empirical work)	To explore the possible data sharing mechanism between LA organization and DRM practitioners in technical aspect. (System prototype work , design and validate)
Research Question		Which type of data is required for flood DRM activities?	Which type of MPC data is required for flood DRM activities?	What is the process followed by Nepalese cadastre in order to collect, stores and shares MPC data?	Which type of information can be extracted from existing MPC data which would be useful for DRM activities?	Which additional attributes in MPC would be beneficial for DRM purpose?	What is the suitable way for MPC data sharing mechanism to flood DRM practitioners?
Data Source		**Secondary data:** Papers, articles, Books , reports related to LA and DRM	**Secondary data:** Papers, articles, Books , reports related to LA and DRM	**Primary data:** Transcripts of Interview **Secondary data:** MPC data from DOS	**Primary data:** Transcripts of Interview list of answer of research question 2 **Secondary data:** MPC data from DOS	**Primary data:** list of answer of research question 2, 3 and 4 **Secondary data:** MPC, Rainfall data, Existing hazard, element at risk and risk information	**Primary data:** Transcripts of Interview to planning officer of DOS, director of cadastral survey branch and IT staffs. **Secondary data:** MPC data
Methods		(literature study / synthesis of publications on user requirements of DRM)	(literature study / synthesis of publications on user requirements of DRM)	Interview to planning officer of DOS, director of cadastral survey branch and surveyors. (Coding interview in ATLAS.TI)	Interview to Disaster practitioners and list of answer of research (Coding interview data in ATLAS. TI)	Comparison study of existing MPC and need for DRM activities. GIS operation based on multi criteria method	UML modeling Design, test and validate service: Experts opinions
Expected Output		List of activities, data requirement and source literature	List of activities, MPC data requirement and source of literature	List of gap and needs to align MPC data to input in GIS platform for DRM activities.			Prototype system and validated results

1.11. Data collection

Primary and secondary data is used for this research. Primary data was collected from direct interviews with the policy makers, DRM practitioners, IT experts' staffs at local and regional level. Secondary data was collected from various organizations in digital, paper and other formats. Different types of DRM related reports and articles were useful for gathering information related to DRM. Questionnaire was semi-structured. A workshop was a useful tool for getting maximum participation from DRM practitioners at local and regional level.

Table 1-2: Overview of data collection

Serial number	Data type	Sources
1	MPC datasets	Survey office Chitwan, Nepal
2	Existing Disaster management documents (Hazard map, Element at risk map and risk information)	Department of Water Induced Disaster Prevention, Nepal
3	Transcripts of interview with director of surveyors, cadastral survey chief, planning officer, IT staff and district survey chief MPC datasets	Department of survey and district survey office Chitwan
4	Transcripts of interview DRM practitioners	Department of Water Induced Disaster Prevention, Nepal and VDC secretary in VDC office
5	Rainfall data/ Hydrographical information	Department of Hydrology and meteorology, Nepal

1.12. Resources Required

Table 1-3: Resources required

Hardware	Software
• Video camera, sound recorder • Laptop computer • GPS (Optional)	• Arc GIS/Q GIS for visualization of data • MS word and excel for report writing • ILWIS and QGIS and post GIS and python • Qualitative analysis software such as NVIVO or ATLAS TI • Postgre SQL and MS access • UML modelling software • Web Server • Geo Server

1.13. Thesis Structure

Chapter 1: Introduction

This chapter describes the general background, formulation of research problem and objectives, research questions, research methods, research design, data requirements and short description on the study area.

Chapter 2: Review on flood disaster risk management (DRM) and multipurpose cadastre (MPC)

This chapter describes the literature review on LA and DRM activities and searches the overlap between those concepts.

Chapter 3: Data collection and analysis method

This chapter gives the method adopted for data collections, data requirements and short description on study area and tentative data analysis method

Chapter 4: Data analysis

This chapter explores the user requirements, information can be extracted from MPC, need analysis for adding information for value added information for DRM.

Chapter 5: System designing and prototyping

This chapter explores the system requirements, user requirements and system components and prototyping for the system.

Chapter 6: System outputs, GIS operation and validation

This chapter explores the system outputs and output information for DRM activities. And validate the system.

Chapter 7: Conclusion and recommendation

This chapter explores the conclusion and recommendation for each user group of MPC.

2. REVIEW ON FLOOD DISASTER RISK MANAGEMENT (DRM) AND MULTIPURPOSE CADASTRE (MPC)

2.1. Introduction

This chapter addresses research question 1 and 2. The main addressing issues are what type of data contents in Land administration? And what types of spatial data necessary for hazard mapping, element at risk mapping and risk information? In land administration it is necessary to identify the relationship between Multipurpose Cadastre (MPC) and Disaster Risk Management (DRM) from literature. Identification of overlap between LA and DRM in spatial data and activities aspects is necessary along with identification of spatial data involved in LA activities and spatial data required for DRM activities.

In this section, technical terms used in this research are defined and described based on DRM and LA related literature. Some of the terms are already well know from chapter 1 but needs to be elaborated in detail.

2.1.1. Disaster

The disaster contents set of concepts such as hazards, element at risk, vulnerability and risk information. Amongst various definitions on the above concepts, most common definitions used are given below: The meaning of core concept of disaster is "intersection of hazard and vulnerability" which is sometime described as "element at risk". See figure 2-1. In this research the overlap between elements at risk and hazardous area for risk analysis are used from real practice.

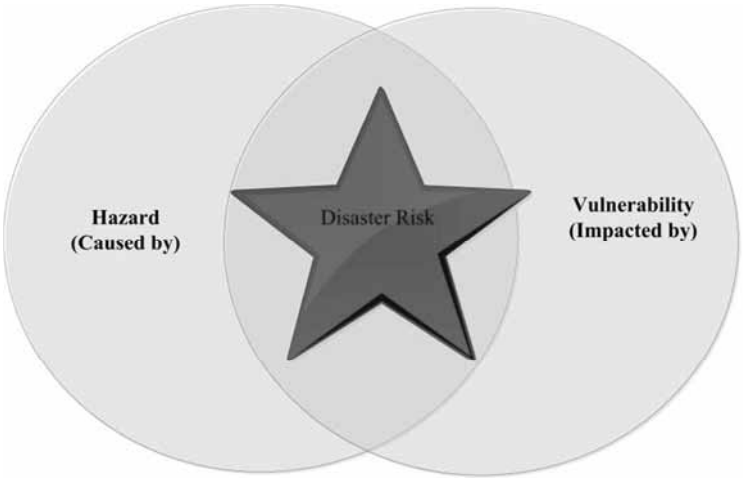

Figure 2-1: Disaster Concepts

Natural hazard: The hazards are defined as the probability of loss or damage in a particular time and zone due to the natural calamity. In some cases hazard may occur due to Industrial activities by human beings which are commonly known as man-made hazard. In this research only flood hazard i.e. natural hazard will be addressed. Common definition of natural hazard is "*Natural hazard is a possibility of a natural event that causes harm to humans – or to other things that we care about, though usually the focus is on a human (which, we might note, is anthropocentric). The hazard is distinguished from an extreme event and a disaster. An extreme event is simply an unusual event; it does not necessarily cause harm. A disaster is an event that does cause harm in significant amounts. So, a disaster is a type of an extreme event: specifically, it is an extreme event that causes significant harm. Likewise, a hazard is a threat of a disaster. A natural hazard is a threat of a natural disaster. Note that many hazards have both natural and artificial components."* (College of Earth and mineral science, 2012).

Element at Risk: The overlap between hazard zone and the exposure which are intended to calculate level of risk is called elements at risk for e.g. human, agriculture crops, buildings, and other properties (EXCIMAP, 2007). This research is dealing with human, building and parcel at flood hazardous zone. Perception of social and cultural vulnerability will not be addressed.

Vulnerability: indicates the strength of physical objects and perception of human beings or society in hazardous zone. The most common definition of vulnerability is *"The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Vulnerability includes the likelihood of disproportionate impacts on certain social groups, including women, children and the poor. Vulnerability may arise from physical characteristics (such as age, sex, etc.), but it can also arise from economic, social, political and cultural processes. Conditions such as extreme poverty, food or land tenure insecurity are often linked with vulnerability since they reduce an individual's ability to cope with or respond to an unexpected shock, especially when he or she has no other source of livelihood"* (UNHABITAT, 2010). In this research I am dealing only with elements at risk. Due to time frame it would be difficult to measure the perception of human beings and strength of building to address in prospected system.

Disaster Risk Management (DRM): I reviewed 5 articles and I found the most appropriate definition of DRM is *"The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster"* (UNISDR, 2009) . In this definition includes all types of hazards, elements at risk and risk information for DRM activities and also covered the strategy to implement the policies to increase coping capacity, mitigation and post disaster management activities.

Disaster Cycle: In general there are 3 phases in disaster such as pre, during and post disaster. As mentioned as figure2-2 there are 7 steps of disaster mentioned as prevention/mitigation, preparedness planning, response, recovery, risk assessments. Here pre disaster phase contented two sub phases as prevention/ mitigation, preparedness planning phase. Disaster phase contents response phase while post disaster phase contents recovery and risk assessment phase. It is necessary to identify what are the processes of LA activities involved in different phase of DRM activities.

Figure 2-2: Disaster cycle Adopted from (van Westen *et al.*, 2012)

Risk communication and information management: Risk communication is a risk reduction activity. It plays a vital role in preparedness and mitigation during the disaster phase and post disaster phase to minimize or sometimes avoid the risk of disaster. The figure shows the relation between communications in different activities of DRM. The Figure 2-3 shows the two sides of DRM activities as management sphere and assessment sphere which are major activities for reduction of vulnerability. Risk communication acts as a bridge between the two spheres.

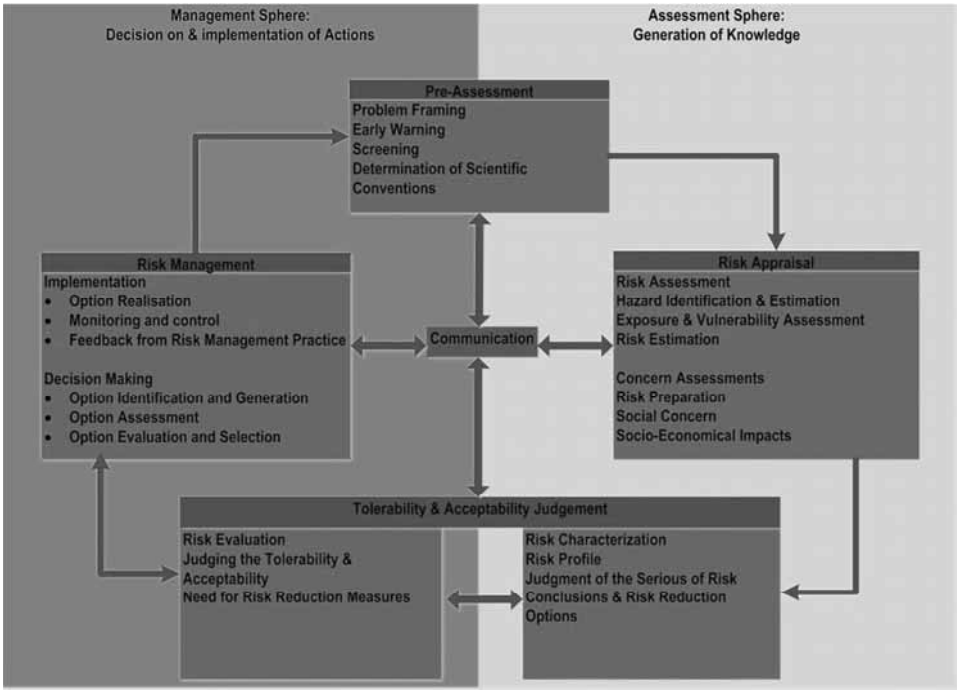

Figure 2-3: Risk communication adopted from (The international risk governance council, 2006)

This figure 2-4 shows two sphere of DRM as management and assessment spheres which consists of seven phases such as hazard analysis, vulnerability analysis, mitigation and preparedness, preparedness and planning, prediction and warning and response and recovery. For the above mentioned activities, communication plays a major role in carrying out these activities efficiently and effectively. Therefore we can say that the Information system and management plays a vital role for risk reduction and DRM activities.

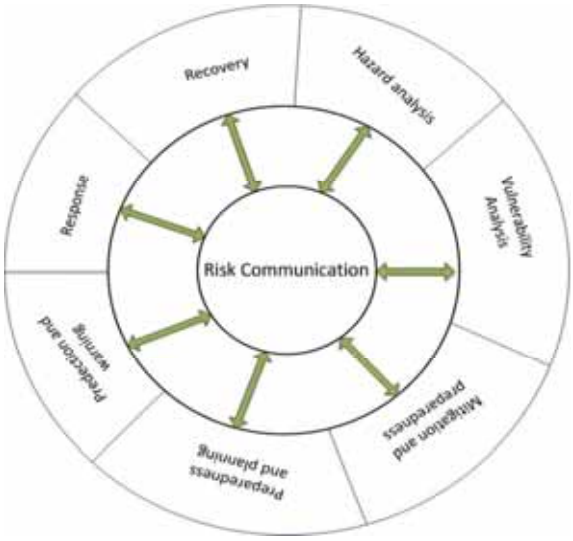

Figure 2-4: Risk communication and DRM activities

Based on the literature, the three common DRM activities are hazard mapping, element at risk mapping and risk information that requires spatial data for analysis which is tabulated below.

Table 2-1: Spatial data requirements for DRM activities

S. No.	Activities	Data requirements	Literature
1	Hazard mapping	• DEM (Can extracted from spot height and contours) • DSM • Surface roughness (LULC) • River section • Maximum flow • Rainfall data	(World Bank, 2010) (van Westen et al., 2012)
2	Element at Risk mapping	• Hazard map • Building with degree of strength • Number of residence • Parcel • Other exposers	(World Bank, 2010) (van Westen et al., 2012)
3	Risk information	• Hazard map • Element at risk map • Value of every object • Degree of coping capacity • **Human loss cannot be measured as value**	(World Bank, 2010) (van Westen et al., 2012)

2.1.2. Land Administration and Multipurpose Cadastre (MPC)

UN-HABITAT (2010) define the land administration is *"The process of recording and disseminating information about ownership, value, and use of land and its resources when implementing land management policies"* and *"the main LA activities are land tenure, land value, land use planning and land development when implementing the land policies for sustainable development"* (Dale & McLaughlin, 1999; I. P. Williamson *et al.*, 2010; Willy, 2003).

From above, it is clear that the main LA activities are land tenure, land value, land use and land development. All the LA activities need a good land record system; therefore a cadastre plays an important role in LA activities. There are various definition of cadastre based on its type i.e. fiscal cadastre, legal cadastre and multipurpose according to the development of LA trends. A cadastre needs a strong record management system. The common definition of cadastre is *"A Cadastre is normally a parcel based, and up-to-date land information system contenting a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (e.g. valuation and equitable taxation), legal purposes (conveyancing), to assist in the management of land and land use (e.g. for planning and other administrative purposes), and enables sustainable development and environmental protection."* (FIG, 1995).

Multipurpose cadastre is defined as *"multipurpose cadastre (MPC) based on large scale spatial data layers grouped into two types of sub systems. The first group consists of components with spatial objects to which legal and administrative facts are attached (rights, restrictions and responsibilities)"* (Rahaman et al., 2011). This definition only focuses on the parcel based information and its purpose, it was not a public oriented service. The definition of MPC is *"MPC is a framework that supports continuous, readily available, and Comprehensive land-related information at the parcel level"* (Panel on a Multipurpose Cadastre, 1983). So, MPC is a broader concept in LA which covers

the overall aspects of LA activities therefore MPC is considered as sub set of LA. By using MPC, the broader concepts of LA can be fulfilled (van der Molen, 2010). The figure 2-5 gives the development of MPC concept.

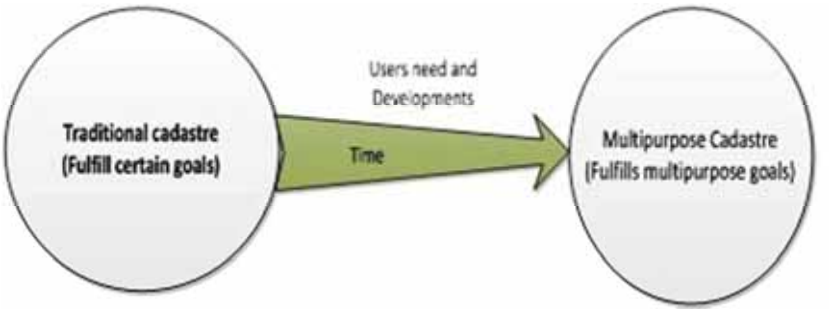

Figure 2-5: Cadastre and Multipurpose cadastre

Spatial data content in LA activities

This section discusses about spatial data requirements for the different LA activities based on the literatures. The table 2-2 describe the types of LA activities, spatial data requirements of corresponding LA activities and reviewed literatures as tabular format.

Table 2-2: Spatial data requirements for LA activities

S. No;	LA activities	Spatial data content	Literature
1	Land tenure	• People • Land (Parcel) • RRR (Rights, Restrictions and Responsibility)	(Griffith-Charles, 2011)
2	Land value	• Land type • Location • Neighbourhood • Facility • Infrastructure	(Poudyal & Hodges, 2009)
3	Land use	• Topography • Soil type • Geology • Land type • Tenure pattern • Land suitability • Land capability • Based on people need approach	(Peel & Lloyd, 2007)
4	Land development	• Land tenure pattern • Land distribution pattern • National land management policy and goal • Based on people need approach	(van der Krabben & Jacobs, 2013)

2.1.3. Disaster Risk Management and Land Administration activities

Above section discussed the concepts of DRM and LA. In this section, relationship between LA and DRM activities are identified. The figure 2-6 shows that the Land Administration activities occur in different phases of the DRM. Land use planning, RRR of land data is helpful in prevention and mitigation of DRM activities and identifies the places for infrastructure development. Preparedness planning phase involves in finding the location for building warning system. Response phase identifies the safety location and shelter. The Recovery phase consists of addressing land issues, such as the reconstruction of land ownership and relocation or resettlement. The risk assessments use cadastral information as a baseline for assessing the spatial risks which is an important task of LA in carrying out DRM activities.

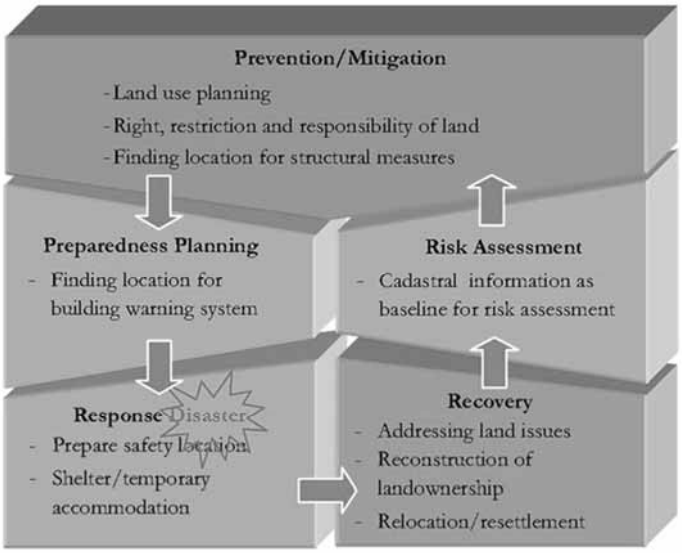

Figure 2-6: DRM and LA activities adopted from (Charoenkalunyuta, 2011)

The table2-3 gives the DRM activities and use of LA data and purpose of use of data mentioned below:

Table 2-3: DRM activities in different phase

S. No.	Activities	Phase	Purpose
1	Using Cadastral information as baseline information. That information is useful for risk analysis. Some thematic information are useful for hazard mapping	Pre-disaster/Risk assessment phase	Hazard mapping, Element at Risk mapping and guideline for early warning system
2	Using cadastre map as guideline for landuse planning, selection of structural measurements and RRR construction	Pre-disaster/Prevention/mitigation phase	Planning, mitigation process helps reduce disaster and guideline for early warning system
3	Cadastre information plays vital role for finding location for building warning system.	Pre-disaster/preparedness planning phase	Helps better warning system and selection of secure places during the disaster phase
4	Cadastre information helps to prepare safety location and selection a place for shelter or temporary accommodation	During disaster phase	For rescue operation

5	Cadastre information helps addressing land issue, reconstruction of land ownership, reconstruction parcel boundary and relocation and resettlement program	Post disaster/ Recovery phase	For reconstruction program

2.1.4. Example of DRM by using MPC data

This section describes the short summary about previous research related to LA and DRM activities. MPC is based on cost recovery concepts in Brazilian case. In Brazil, 50% of the cost was recovered in the first year (Silva *et al.*, 2012). It means that the public/ private participation to develop a MPC for good LIS is necessary. From this we can say that the usable sector of MPC is extensible. In Brazilian case they modelled the data and system which covers some descriptive and geo-information related information helpful for DRM activities (Lucas *et al.*, 2008).

In the case of Taiwan, they develop a model which was integrated to Land use planning, by using that model hazard map, and effect on hazard zonation with respect to landuse planning was prepared. They stated *"The major works includes all-hazard identification/hazards cape analysis and physical vulnerability: damage potential assessment. Practical implications this model is helpful to apply to land-use decision making for evaluating the issues concerning disasters, and avoiding the increasing loss of lives and property. As the next step, attributes of people and environments and assessment techniques from different disciplines can also be included in the model, to achieve the ultimate goal of an environment"* (Wang, 2012). For this they used MPC data as input but they use only for modelling purpose but the whole information system was not analysed.

Some research, conceptual papers and guidelines are used to collect the information related to LA and disaster management are tabulated below in table 2-4.:

Table 2-4: Literature on DRM and LA

S. No.	Literatures	Findings
1	(van der Molen, 2010)	Climate change address focus on multipurpose use Land administration system, So need to search extensive use of MPC in various use of fields
2	(Enemark, 2010)	Land Administration can use as a tools for Climate change addresses. MPC is a Multipurpose and sustainable LA system concept
3	(Fitzpatrick & Zevenbergen, 2010)	Land is a crosscut issue. So, LA helps DRM activities in property aspects.
4	(Lucas et al., 2008)	Good LIS helps DRM analysis. So, MPC is the best possible components for good LA which helps DRM analysis
5	(Hapuarachchi, 2008)	GIS technology helpful tools for DRM in Sri Lanka. It means GI technology works as a bridge between LA and DRM activities
6	(Charoenkalunyuta, 2011)	Land tenure and resilience factors in Nepalese case. This case also focused on overall land administration system.

Here the conceptual papers describe the concept on potential use of MPC in different system to make sustainable land information infrastructure and addressed climate change issue including disaster managements. In most of the cases Cadastre data are used for post disaster activities to reconstruction of ownership rights.

2.2. Conclusion

Main aim of the literature review is to find out the relation between LA and DRM activities. The gap and overlaps between LA and DRM activities are identified and tabulated in 2-3. LA can be contribute if suitable use of MPC in systematic ways. It is necessary to collect user's requirements, restrictions, analysis of need and gap in existing system and purposed system. Therefore, the user's requirements are collected by using semi structured questionnaires. To design a system, modelling tool was used. In order to test the designed system, a secondary datasets was imported in a cadastre template. The design system was validated by using an expert's opinion. This chapter derived the overlap between LA activities and DRM activities in table 2-3. The spatial data content in LA is given in table 2-2 and data requirements for DRM activities are given in table 2.1.

3. DATA COLLECTION

3.1. Introduction

This chapter addresses research question 3 based on literature study and field observation and also describes the study area, data collection methodology and data analysis methodology. In study area various settings of the study area are described such as physical, topographical, climatic conditions and other various aspects. The data collection section describe various strategy adopted in data collection phase, expected response and some limitation and bottlenecks.

3.2. Study area

Saradanagar and Mangalpur VDC area is prone to flood disaster in Chitwan district. Based on (Chhetri, 2008) and (FAO & UNDP) the table 3-1 shows the major DRM activities, involved organization and remarks are given below. Most of the organizations are involved in preparedness and risk communication. Still there is a gap in the assessment phase. Chhetri further described national mapping agency DOS for not involving in the sense of providing spatial data. National LA agency is also not involved in DRM activities. Therefore, it is not possible to address in the tenure security in post disaster situation.

Table 3-1: Involving organization in DRM activities in Chitwan district, Nepal

S. No;	DRM activities	Involved Organizations
1	Preparedness phase	"Ministry of Home Affairs, Ministry of Water Resources, Ministry Planning and Construction, Physical Ministry of Health, Ministry of Finance, , Ministry of Foreign Affairs, Ministry of Information and Communication Ministry of Forest and Soil Conservation, Ministry of Agriculture and Co-operatives, Ministry of Education and Sports, Ministry of Science and Technology, Ministry of Children, Women and Social Welfare, Ministry of Industries, Commerce and Supplies, Secretariat of the National Planning Commission , Ministry of Health, Ministry of Finance, Ministry of Foreign Affairs, Ministry of Information and Communication Ministry of Forest and Soil Conservation, Ministry of Agriculture and Co-operatives, Ministry of Education and Sports, Ministry of Science and Technology, Ministry of Children, Women and Social Welfare, Ministry of Industries, Commerce and Supplies, Secretariat of the National Planning Commission" (Chhetri, 2008)
2	Assessment and Risk calculation	"Department of Water-Induced Disaster Prevention, Department of Mines and Geology, Department of Hydrology and Meteorology and other INGOs like as Japan International Cooperation Agency (JICA), Asian Disaster Reduction Centre (ADRC), Asian Disaster Preparedness Centre (ADPC), United Nations Development Program, International Centre for Integrated Mountain Development (ICIMOD)" (FAO & UNDP, 2004) and (Chhetri, 2008)
3	During disaster phase	"Royal Nepal Army, Nepal Police Force, Nepal Red Cross Society, Nepal Scouts, Ministry of Defence" (Chhetri, 2008)
4	Post disaster phase	"International Red Cross Society (IRCS), United States Agency, for International Development Mission to Nepal (USAIDMN), United Mission to Nepal (UMN), Cooperation for American Relief Everywhere (CARE), World Food Program (WFP), Lutheran World Service (LWS), Save Children Fund (SCF), Technical Cooperation of the Federal Republic of Germany (GTZ)" (Chhetri, 2008)

Generally four LA activities i.e. land tenure, land value (Land taxation and other land value related), land use and land development are actively present in the VDCs in Chitwan. There are two land related offices one is District Revenue Office (DRO), Chitwan and other is District Survey Office (DSO), Chitwan. Land valuation, Land transaction are handled by DRO and parcel subdivisions are handle by DSO. The revenue collection responsibilities also handle by VDCs and Municipalities. DDC and town development committee also deals with land development activities such as resettlement, land pooling. Landuse project in Nepal related to planning (Nepal Government, 2001).

We can see both LA and DRM activities in the study area due to which we can say that the area is suitable for research related to LA and DRM. Tenure security is most important issue in post disaster situations. Land use planning plays vital role in disaster prevention activities. It makes earth's surface geomorphological strong against the natural hazards. Therefore the land is a crosscut issue in disaster management activities (UNHABITAT, 2010). Land use planning is a backbone of development. It needs a good land policy for all the above issues that are addressed in land use policy Nepal (Nepal Government, 2011). The main aim of this research is the alignment of land related data (same as MPC) to DRM activities in different phase of DRM.

This section further describes about the VDC wise introduction including physical settings, population, and land use, rainfall and disaster profiles. All of descriptions of VDC are collected based on the VDC profile prepared by LUP and VDC offices.

Location

Saradanagar is a Village Development Committee of Chitwan district of southern Nepal. It lies on the way to Meghauli from Bhagalpur. It is about 10 km north-west from district headquarters, Bhagalpur. It shares its border with 4 VDCs. Mangalpur lies to the north-east, Gunja nagar to the west, Dibyanagar to the south-east, Narayani River lies to the north and Fulbari VDC lies to the east. Mangalpur Village Development Committee (VDC) is one of the 36 VDCs of Chitwan District. Location map of the area is in figure 1-3.

Population

The annex 1 table shows the ward wise population distribution of Saradanagar and Mangalpur VDC of Chitwan district in Nepal. Ward number 1 of Saradanagar VDC and ward number 5 of Mangalpur VDC have highest population distribution in those VDC.

Topography

Based on the topographical datasets which is produced by DOS the range of elevation of lower and highest spots among the study area is 165m to 194 m from the mean sea level. The annex 2 describes the distribution of elevation from mean sea level of the study area.

Rainfall

Based on the DHM report, monthly rainfall of 10 years period is shown below in annex 3 average rainfall of 2007 is 228.5 mm which is the highest of 10 years period. The lowest average rainfall (144. 3 mm) is recorded in 2005. The average rainfall of 10 years period is highest (557.75 mm) in the month of July followed by August (325.8 mm) and June (313.8 mm). The highest amount of rainfall (930 mm) was recorded in the month of July, 2003.

Climate

Based on the DHM report, the climate of this VDC like other VDCs of Terai is sub-tropical monsoon type. This climate has three distinct seasons. Dry summer season begins in the month of March when the sun starts to move northward from the equator. The annex 4 shows the mean monthly temperature of ten years period. The mean minimum monthly temperature in dry summer months of May and June is above

20°C and during rainy summer months it is around 25°C. The minimum mean temperatures during winter months are below 15°C and annex 5 shows maximum mean temperature of that area.

Landuse/ Landcover

The annex 6 shows the different land cover type and corresponding area in hectares. Most of the area covered by agriculture land, forest and wet lands in both VDCs. And annex 7 shows the spatial pattern of landuse.

Main disasters in study area

On the basis of VDC profile, there is flooding due to Narayani River. Problem is created by wild animals near the community forest area in the northern part of the VDC. Wild animals damage and destroy the standing crops by grazing and trampling. Excessive use of chemical fertilizers, pesticides and insecticides has degraded the land, surface water as well as underground water. Ground water pollution appears as a serious health hazard. The following section described the DRM mechanism and LA activities in the study area from the nation's side.

3.2.1. Organizational structure of natural disaster management in Nepal

Chhetri (1999) described based on the Natural Disaster Relief Act (NDRA) of 1982, there is a provision to resolve the problem related to DRM in Nepal. The Central Natural Disaster Relief Committee (CNDRC) was established under the ministry of home as chairperson. The main responsibility of this committee is to formulate the sustainable policies and programmes for DRM activities in a whole country. CNDRC prepares norms, standards and specification for distribution of goods, cash and other materials for victim of natural hazards. So that law has also provision to establishment and functioning up to VDCs level (Chhetri, 2008). The figure 3-1 shows the organizational structure of DRM in Nepal.

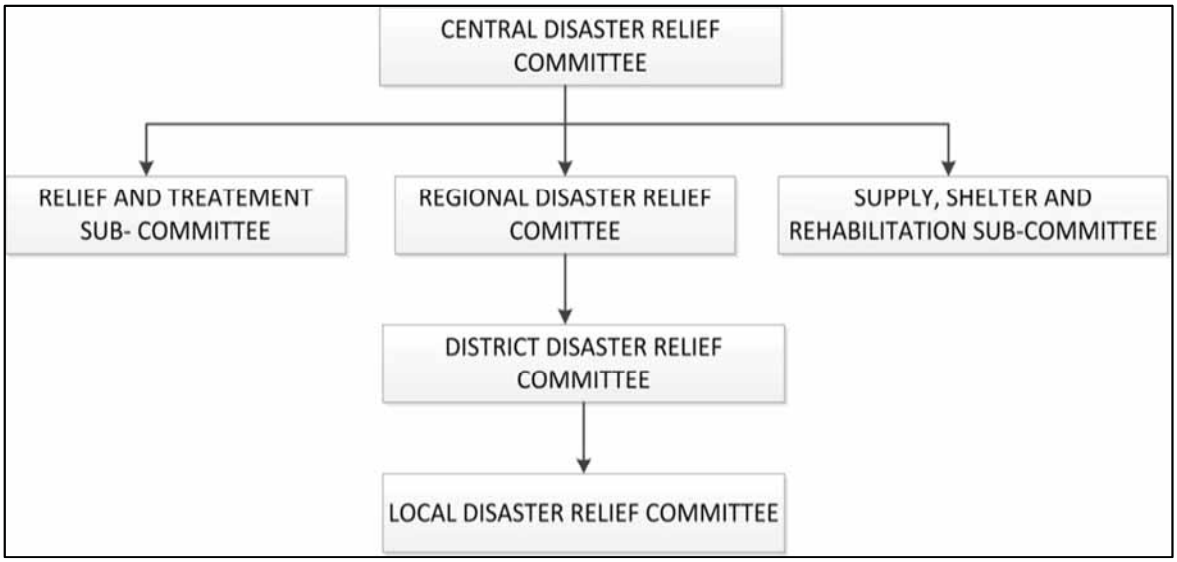

Figure 3-1: Organizational structure of DRM in Nepal adopted from (Chhetri, 1999, 2008)

Institutionally there is no any coordination mechanism between other organization, NGOs, INGOs. So, the INGOs and NGOs are haphazardly involving in DRM activities due to the sustainable rule, restriction and responsibility among organization. Due to this reasons there must be a gap or overlap in DRM activities of Nepal.

3.2.2. Current status of MPC system in Nepal

This section discusses about current status of cadastral system in the study area. Ministry of Land reform and management is responsible for the LA in Nepal. Figure 3-2 shows the organizational chart of MoLRM (MoLRM Nepal, 2012).

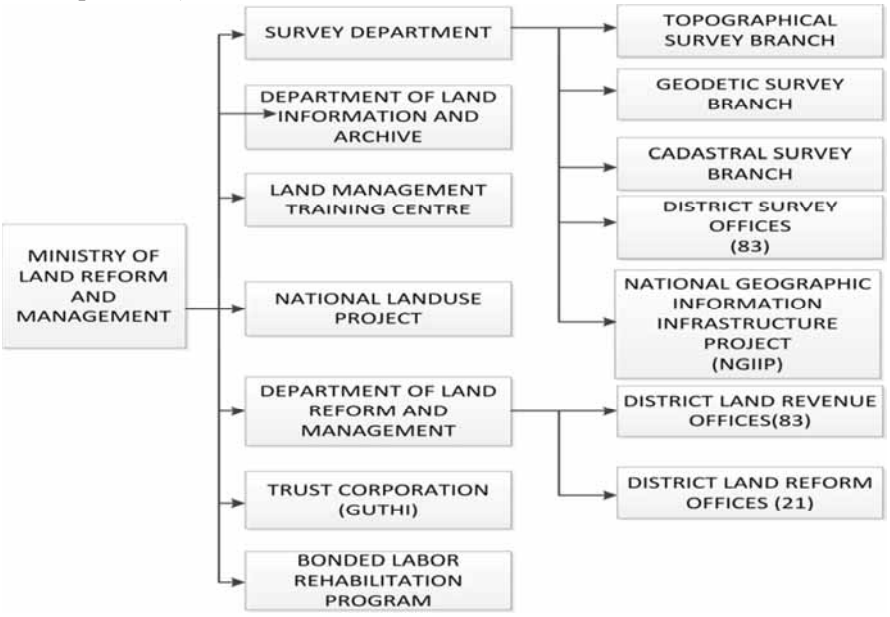

Figure 3-2: Organizational structure of MoLRM

Land registration and recording process

Based on Land measurement act and rules the processes adapted to recording the land are given below in the figure 3-3.

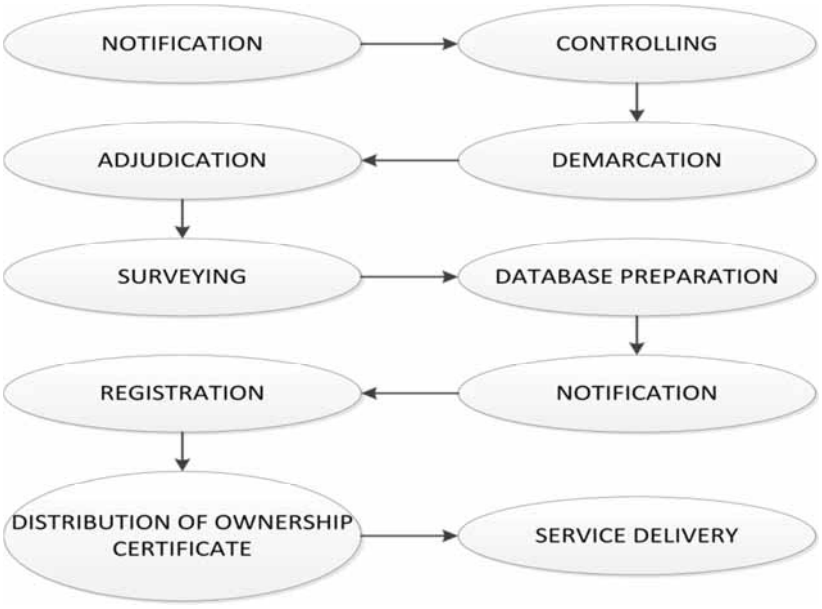

Figure 3-3: Cadastral process in Nepal adopted from (Nepal Government, 2001)

I visited to digital survey office Banepa to observe the process adopted to collect, store and share cadastral data to the user at the mean time I collected the previous photographs of the process, some sample of the steps accordingly I described below:

Notification

Notification is the legal process in cadastral mapping sector. All of the notices are published according to the law. So firstly the survey areas are declared and published at gazette. Other types of notices are in local papers, notice boards of survey offices. One of the samples of seven day notice is given in annex 8:

Controlling

Controlling is the phase to define spatial reference with respect to the national control networks. Traverses, Triangulation, GPS system are used for that purpose. In the annex 9 circled points are control points and annex 10 shows the list of control points taken from Total station.

Demarcation

Demarcation of parcel boundary is required before carrying out a survey. The process was conducted to identify the adjacent parcel owners, municipal representative and land surveyors. The activities of demarcation are in annex 11and 12.

Adjudication

Adjudication is the legal processes which minimize the land disputes. All of adjacent parcel holder sign the adjudication from in presence of lawyers, municipal representatives and other related persons. The standard adjudication form as per land measurement rule number 4 and sub rule number 1 are in annex 13.

Surveying

Surveying is the data collection phase, in this phase all of parcel corner are measured in the form of co-ordinate (Point name, Easting, Northing, Height, Remarks). The method adopted in data collection in the form of point data by using total station in annex 14. The sketch (in annex 15) of the measured points is in annex 15 and the list of downloaded coordinates is in annex 16.

Database Preparation

In this phase all coordinate data are exported based on sketch and other information collected from field in the cadastre template shown as annex 17. All of corresponding information and data vectorized in corresponding spatial layers of that template and update attribute information in the corresponding spatial attribute table. The annex 18 shows the data preparation in ArcGIS.

Registration

In this stage all of the document verified and most important thing RRR (Rights, Restrictions and Responsibilities) are noted clearly. This is the legal final stage for land recording. Official signatures are also done for authentication and acceptance signature from land owner and tenants.

Distribution of certificate

All of maps records are verified and all of the legal processes are completed then the survey office distributes the land ownership certificate to the owner and map to survey office and record to the revenue office.

Services delivery

A cadastral system is an information system of land holdings and land use. Therefore it provides excellent service related to land tenure, land valuation, land use and land development to implement the land policies. The main service from LA offices are land transaction, parcel subdivision, mortgage registration and land taxation and provide information for development activities based on by law.

Data and information sharing

The Nepalese cadastre is a decentralized system. The local level LA offices are District Survey Offices and District Revenue Offices. DSO deal spatial data collections, maintains, and edit, update and dissimilation tasks. There is no any data sharing mechanism between LA organizations. They have standalone system. Therefore, the people have to come to DSO and DRO if they need any LA services.

3.3. Primary data

The users' requirements were collected by using semi structured questionnaires. I questioned data requirement for DRM activities and MPC data contents is in structured way and data sharing mechanism and flood simulation process is in non-structured ways. The main aim was to determine the users' requirement and data sharing mechanism between MPC and DRM activities. The primary data is the source of real world. Primary data is a tool to validate the results derived from secondary data sources (Kumar, 2000). Hence, the data requirement for DRM activities by using MPC data was described in chapter 2. The semi structure interviews and field observation are the best way for validation of result derived from literature study and collection of users' requirements.

The primary data from the semi structured interview used for extraction user's requirements and restriction, system specification and other policy level data sharing issues. Secondary datasets MPC are used to run the purposed system to test the system. The figure shows the data collection methodology.

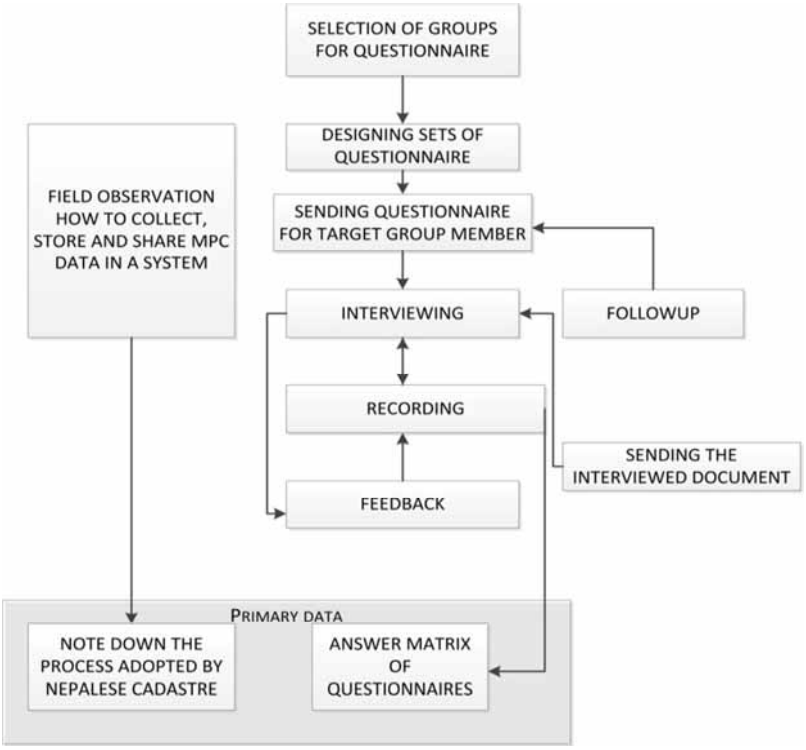

Figure 3-4: Data collection methodology

Questionnaire Design

First of all I searched the data provider for DRM activities at local level. I found most of the secondary data provided by DOS such as elevation information, landuse/Landcover, transportation from existing topographical datasets and water flow information, rainfall data and river cross section provided by DHM. My main focus on questionnaire designing phase was what information can be extracted from MPC to the DRM activities? What are the minimum data requirements for DRM activities? What must be added in existing MPC to fulfil DRM activities? And finally, what could be the data sharing mechanism of LA organization and local government. Accordingly I designed 5 set of questionnaires for LA policy makers,

IT staffs, Surveyors, Regional and local level disaster managers. Sets of designed questionnaires in annex 19, 20, 21 and 22 for different group are in table 3-2 shows the data collection overview. List of selected persons for interviews is in annex 23 and photograph taken during the interviews is in annex 25. Based on (Acharya, 1992) the interviews from key role persons is the suitable way for collection of users' requirements.

Table 3-2: Interview collection overview

S. NO;	Targeted Group	Number of targeted persons	Number of questionnaire sent	Number of collected interviews
1	LA policy makers	5	7	4
2	Land surveyors	5	8	5
3	Local level DRM managers	5	5	5
4	Regional/ Central level DRM managers	5	7	6
5	IT staffs	5	2	2 (Other 3 posts were vacant)

Strategy for selection groups

From LA policy makers the main focus were DG, DDG and directors and officer in planning section within the ministry. Due to foreign country visit of DG, DDG conducted the interviews for planning officers. From surveyors main focus on digital cadastre unit, working and implementation group of cadastral survey branch and digital cadastre and topographical survey branch. I searched overall IT staffs who are working in the organization. Two persons from IT staff were interviewed. For local level the main person at the time was VDC secretory so, collected interview 5 of 5 of them by using telephone. The DDC offices help to contact them at that movement. And regional and central level I choose flood simulation engineers to collect the methodology for hazard, elements at risk and risk information mapping.

Strategy for selection a person

Planning officers of "planning section" within the ministry always participate in all the activities regarding LA policies making process. Hence, the main focus of this group is to provide LA policy to update the datasets in the existing MPC, especially the data sharing mechanism. So I selected the branch, out of which one planning officer was interviewed. With an intention to get some answers about the methods adopted the collect, maintain, store and share the MPC data to users I choose the group of surveyors who are involved to the surveying and mapping activities. There are two people available who are working as IT officers so were interviewed. I choose 5 VDC in Chitwan district so I conducted interviews from 5 VDC secretary and some DDC officers.

Interview and follow-up

The official appointments were made with the people who were to be interviewed and the questionnaire was sent to them well in advance. They were provided information about this research by providing short description about research proposal. In some case a presentation had to be delivered in front of a small group to make them understand the proposed research. Most of interviews were recorded.

Recording

In this section all expected interviews in the phase of proposal presentation were collected. But due to the foreign visit of Director General and Deputy Director Generals of Departments within the ministry of

Land Reform and management, they could not be interviewed. To fulfil those gaps, planning officers from various branches within the ministry were interviewed. I recorded interviews from LA policy makers, DRM managers, IT staffs and land surveyors. The lists of collected interviewee and day by day activities are given in appendix 24. Some photographs are taken in the interview conducted phase are given in annex 26.

Observation

The answer of section 3.2.2 was obtained by identifying the LA procedure from legal papers. This procedure was validated from the field observations and the questionnaires. The process of collection, storage and sharing of MPC data is described in section 3.2.2.

Transcribing

By using all the recorded videos, sounds and photographs. I transcribed the interviews and prepared a summary table. See annex 26, 27, 28, 29 and 30.

3.4. Secondary data

Secondary datasets MPC are used to run the proposed system to test the system. In the data collection phase required set of secondary data are also collected. List of collected secondary data tabulated as annex 24. River data was collected from DHM.

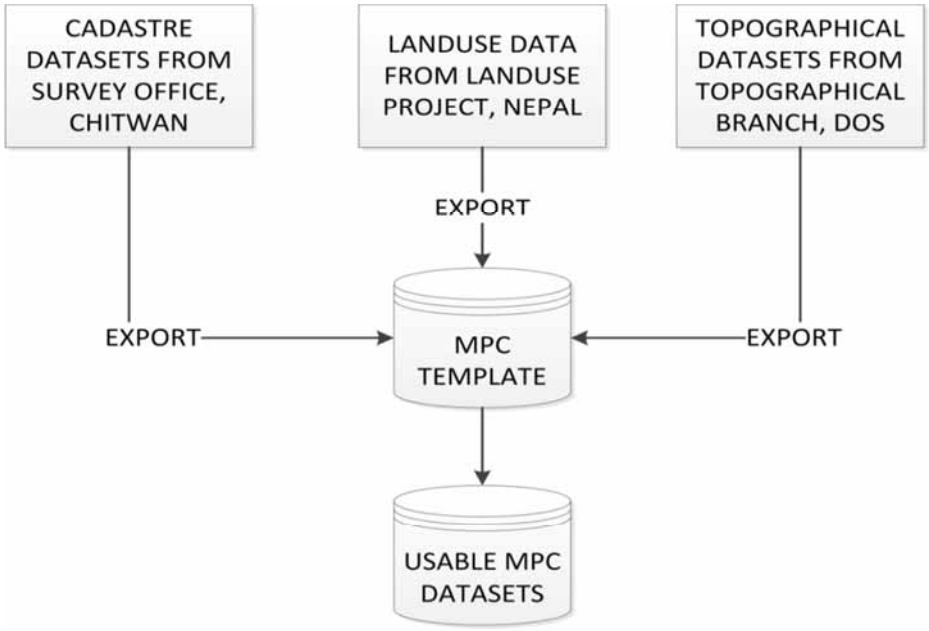

Figure 3-5: Creation MPC datasets from different data sources

DOS was having an MPC template but the Chitwan district office was not having MPC datasets in a pre-defined template. Therefore, I collected different data from different organization and exported the data in a MPC database for the purpose my research as given in figure 3-5 and annex 31 shows the components of MPC.

3.5. Lesson learnt from data collection phase

First of all I designed the questionnaire to the local level disaster practitioners those are VDC secretary. I design some technical questionnaire regarding DRM activities. 5 of 5 gave answers they don't have any idea about that simulation methods they are dependent from DDC. So my focuses became DDC engineers and collected interviews from DDC engineers.

3.6. Limitation in Data collection

Filed work time was soon before the great festival called Dashain of Hindu in Nepal. There was a long term public holidays about 10 days due to which the offices were going to be closed and I had to wait for the response after reopening of the offices. Therefore instead of visiting the offices, an alternative which I adopted was the telephonic interviews to collect response of interviews from VDC secretaries with the help of DDC engineers to finish my field work in pre-defined time. I collected interviews from officer at planning, monitoring and evaluation section within MOLRM, Due to foreign country visit of DG and DDG of DOS.

3.7. Data analysis Methodology

There are several tasks such as analysis of data requirement, analysis of system requirement carried out in this research. So, it needs to analyse gap and overlap between LA activities and DRM activities in spatial data aspects. So I used semi structured interviews, some existing reports and photographs of the activities. ATLAS-TI is a tool used which can analyse recorded sounds, transcribes, Photographs, old reports in the qualitative and qualitative way by using by coding the quotations. The idea behind use of this tool is the determination of user's requirement for system design. The figure 3-6 shows the overall data analysis methods.

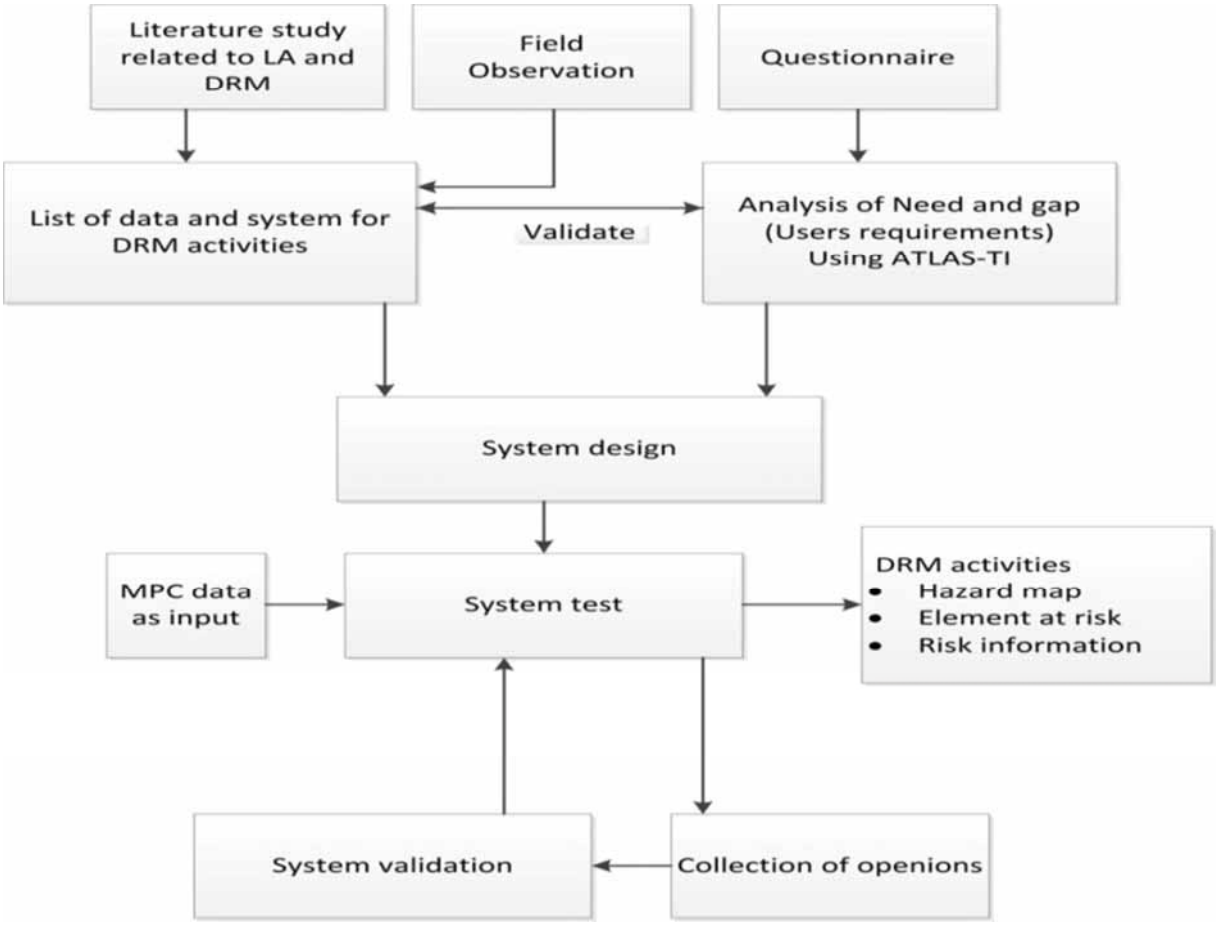

Figure 3-6: Data analysis methodology

3.8. Conclusion

The main aim of this chapter was to address research question 3. How cadastre data is collected, stored and shared? Main activities of the cadastre process in Nepalese context are notification, control point establishment, demarcation, adjudication, surveying, data preparation, registration, distribution of ownership certificate, service delivery; and data and information sharing. The surveyors' uses the predefined MPC template and creates vector layers in corresponding spatial layers based on field sketch and observed coordinate data files. The edit and maintenance parts are dealt in the ArcGIS software. The data is shared via standalone system where the user has to personally visit the land administration office and request for the required data. The following chapter combine the answer of research questions 1, 2 and 3 which are result derived from literature study by suing the analysis of semi structured interviews.

4. DATA ANALYSIS

4.1. Introduction

This chapter discuss on the data presentation for all of collected interview group wise. The main aim of this chapter is to validate results of answer of research question 1, 2 and 3 those are derived from literature study. This chapter also investigates research question 4 and 5. Main focuses are what type of information can be extracted from existing MPC data? And what type of information from existing MPC could be useful for DRM activities? The main tools to investigate are using analysis of questionnaires and existing class diagram of MPC.

4.2. Output result from interview of Land administration policy makers in Nepal

Main aim is to investigate the data produced by DOS, MPC data contents, use of MPC and its users, public privacy information in MPC and data sharing mechanism. The main controller of MPC datasets is DOS (Nepal Government, 1963) , and policy makers within LA organization providing reliable answers for it. The question number 1, 2 and 3 asked in the table below are to determine the expected production of data variety and further planning of data production on different varieties. The list of analysis of questionnaire in the table below form is based on posing the questions. The column shows the serial number of respondent, posed questions, answer from respondent and remarkable matters presented table 4-1.

Table 4-1: Analysis of interview of LA policy makers in Nepal

S. No;	Question	Response	Remarks
1	What types of data is produced by department of survey?	**Data production by DOS** • Topographical datasets • Ground control points • Ortho-photographs • Cadastral datasets 3 of 4 answered separately for topographical data sets as contours, land use, transportation line, utility line and water bodies	1 of 4 answered to refer the website of dos www.dos.gov.np
2	Who are the users of Multipurpose Cadastre (MPC)?	**MPC users** • Governments • Water boards • Electricity authority • Planners • Infrastructure developers 3 of 4 mentioned local government as users and 1 of 4 mentioned researchers and bank and irrigation board as user	4 of 4 respondent focus on government as users. Individual only concern on their single property.
3	What are the use of Multipurpose Cadastre (MPC)?	**Use of MPC** • Planning • Taxation • Infrastructure development 2 of 4 explain use of MPC to DRM and food security	2 of 4 are not focused on multiple use of MPC such as food security and DRM
4	How many spatial layers are contented in Nepalese	**The layers and attribute information of MPC** 1 of 4 referred the parcel editor report	Analysis based on class diagram

	Multipurpose cadastre (MPC)?	published by DOS.	
5	What are the most people's privacy information in Nepalese Multipurpose Cadastre (MPC)?	**Most people's privacy information** Owner information, valuation and parcel boundary	1 of 4 said restriction (mortgage) also public privacy
6	How can MPC data be easy accessed by the users?	**Existing data sharing system** All of them replied as standalone system	1 of 4 replied in the data preparation phase he used local area networks
7	How can easily access MPC data for local government?	Purposed web based system, 3 tires system	1of 4 mentioned the users as per their responsibility. 2 of 4 mentioned security.

4.3. Output result from interview of Land surveyors in Nepal

The main aim is to investigate how surveyors' collects, stores and shares the MPC datasets to the users and what are the process adopted for field data collection and its management. What is the content of MPC data sets? The table 4-2 shows the analysis of the answer of the questionnaire among the surveyors within MoLRM is given below. The column shows the serial number of respondent, posed questions, answer from respondent and remarkable matters presented in the table.

Table 4-2: Analysis of interview of surveyors within LA organization in Nepal

S. No;	Question	Response	Remarks
1	What type of data do you work with?	**Working data type (5 of 5 response)** • They used vectors • Mainly parcel and building data in vector forms • Large scale topographical data • Owner and tenant table	5of 5 replied they work with cadastral and topographical datasets
2	How do you collect data from field observation?	**How surveyors collects the MPC data (5 of 5 response)** • Collect survey points by using total station in a coordinate form • Preparation of field sketch • Entry in a dataset based on points and sketch	2 of 5 focused on point data format. The process adopted to collect , stores and share and first registration process explained in 3.2.2 what I observed in the field
3	How do you edit, update and maintain MPC datasets?	**How do surveyors edit, update, store MPC data (5 of 5 response)** • Data preparation in a corresponding spatial layers based on field sketch and point datasets	1 of 5 who working topographical survey branch replied he don't have any idea about data update and maintain

		• For edit and update they are using Arc GIS software by using general GIS operation • For store used MPC standard template designed by DOS	
4	How many spatial layers and non-spatial tables contents in Nepalese Multipurpose Cadastre (MPC)	**What are the MPC contents (5 of 5 response)** • Cadastral datasets • Topographical datasets • Owner and tenant tables	2 of 5 referred for parcel editor report and 2 of 5 did not respond on these questions. This question only designed for digital cadastre working and implementation group
5	What is the current data sharing system for MPC to users?	**Existing data sharing system (5 of 5 response)** • All of them replied they are using Standalone system	

Based on parcel editor report and existance MPC datasets a class daigram was extracted using MS Access and was analyzed in ATLAS-TI. The annex 31 shows the spatial layers in MPC. I also extracted the cadastre process which tell how the data is collected, stored and shared in MPC. From this I validated how surveyors collects, store and share MPC datasets which is the answer of research question 3, From section 3.2.2 , I derived that the MPC data contents only partial answer of research question 4.1.

4.4. Output result from interview of IT related staffs within LA organization in Nepal

The main aim was investigation of existing data sharing mechanism among users, what could be purposed sharing mechanism and how to control data security for LA organization form this group. The table shows the analysis of interview among IT staffs within LA organization in Nepal. The column shows the serial number of respondent, posed questions, answer from respondent and remarkable matters presented in the table.

Table 4-3: Analysis of interview among IT staffs within LA organization in Nepal

S. No;	Question	Response	Remarks
1	Which data sharing system do you work with?	**Working data sharing mechanism** • 1 of 2 replied standalone system • 1 of 2 replied standalone system for public but using LAN within organization	1 of 2 provided the possibilities to data sharing in a network
2	In your opinion what could be the suitable MPC data sharing system for local government?	**Purposed data sharing mechanism among users** • 2 of 2 purposed 3 tire system • Client server approach among district land administration offices • Internet based system	2 of 2 did not mentioned data sharing mechanism within individual users and local governments
3	How to maintain data security for sharing MPC to users?	**Data security** • Define user based on their rights, restrictions and responsibility • Providing strong firewall • Highly defined security and users	2 of 2 focused on same issues

The main output of this section is the future data sharing mechanism for well define users. This will help to define users' responsibilities, rights and restrictions in a system designing phase.

4.5. Output result from interview of Local level disaster managers in Nepal

The main aim to investigate from this group was how to create a hazard mapping, element at risk mapping and risk information at local level, the main data sources. To identify whether MPC data will fulfil the minimum required for DRM activities or not. The table 4-4 shows the analysis of interview of flood disaster practitioners at local level in Nepal. The column shows the serial number of respondent, posed questions, answer from respondent and remarkable matters presented in the table.

Table 4-4: Analysis of interview of flood disaster practitioners at local level in Nepal

S. No;	Question	Response	Remarks
1	Do you do Hazard/ Element are Risk and Risk mapping?	**DRM activities mapping** • People's perception approach • Participatory approach for flood extent mapping • DDC and other donors provided descriptive risk information ward wise.	5 of 5 they do not do hazard, element at risk and risk information mapping. They are dependent on DDC and donors. (See annex 42)
2	What types of data requires for flood DRM activities?	**Data required for DRM activities** • They do not have idea about DRM activities • Need to ask their Headquarters DDC (So I referred to ask those question to DDC simulation engineers)	2 of 5 explain existing descriptive information also helpful for information but those are not accurate and not in micro level.
3	What are the current data sources for flood DRM activities?	**Current data sources** • DDC, DWDIP and international donors (So I referred to ask those question to DDC simulation engineers)	5 of 5 mentioned only readymade document prepared by DDC. They did not mentioned data producer
4	Can you get recently updated data for flood DRM activities?	**Updated data** • They are using old data what provided DDC before 5 years	2 of 5 mentioned descriptive reports
5	Department of Survey (DOS), Nepal provides MPC data, what do you think whether it fulfills your needs for flood DRM activities?	**Does MPC fulfil DRM activities?** • No other data sources also needed	5 of 5 focused on depend upon purpose. Collect idea from DDC
6	Is it possible to conduct flood DRM activities in client server approach?	**Possible data sharing mechanism** • Web based technology	2 of 5 respond as they don't have core knowledge about IT but they know internet.

This section also helps about system testing phase. How can system use for DRM activities by using MPC datasets.

4.6. Output result from interview of Regional and central level disaster managers in Nepal

The main focus on this group was data requirement for DRM activities, Method adopted for mapping, current data sources, MPC data and its use in DRM activities and data sharing mechanism for DRM activities. The table shows the interview of Regional and central level disaster managers in Nepal below. The column shows the serial number of respondent, posed questions, answer from respondent and remarkable matters presented in the table.

Table 4-5: Analysis of interview of regional and central level disaster managers in Nepal

S. No;	Question	Response	Remarks
1	What data do you use for DRM mapping?	**Data requirement for DRM activities** • For **hazard** Landuse, DSM, River flow data, Rainfall data and River section data • For **element at risk** hazard information, building, parcels and other physical property • For **Risk information** hazard information, element at risk information, values and coping capacity	All of them replied same element according to the purpose.
2	What process and method do you adopt for DRM mapping?	**Method adopted for DRM mapping** • For **hazard** flood simulation method adopted • For **element at risk** GIS overlay operation • For **risk information** GIS overlay operation	All of them explain same methods
3	What are the current data sources for flood DRM activities	**Current data sources** • Topographical datasets from DOS • River data from DHM • Simulation results from DWDIP	All of them explain INGO ICIMOD also provides data but they are not data producer.
4	What types of MPC data requires for flood hazard mapping?	**MPC data and its use in DRM activities** • Topographical datasets(contours, landuse, hydrography) for hazard mapping • Cadastral datasets(parcel and building) for element at risk mapping • Combination of both for risk mapping with value and coping capacity	3 of 6 mentioned coping capacity Carrying capacity refers the degree of strengthens of the physical or people's perceptions in a during disaster phase. This is very difficult to measure in this research so addressed only element at risk.

5	Is it possible to conduct flood DRM activities in client server approach?	**Data sharing mechanism for DRM activities** • Client server approach • Web based application	All of them referred after simulation

The table validates the answer of research question 1.What is the data requirement for DRM activities that derived from the table 2.1.

4.7. Additional findings in data collection phase

Most of DRM practitioners said that they do not have information regarding MPC. Most of LA policy makers said they do not have knowledge DRM activities. The surveyors and IT staffs were not having sufficient knowledge about the DRM activities. Therefore, it became difficulties to explain about the research to these people. It means that there is a gap between LA organization and DRM organizations. The newly designed system can help bridge to reduce the gap between LA and DRM organizations.

4.8. Class diagram of existing MPC

The main aim of creating a class diagram is to determine MPC contents. A class diagram helps to extract the information and determines its usefulness for DRM activities. Based on existing MPC data extracted class diagram by using MS Access software and analyse the questionnaires in ATLAS-TI software the contents of MPC are determined and its attribute information also extracted in the class diagram of topographical and cadastre dataset respectively given in annex 31 and 33. Annex 32 shows the cadastre class diagram of existing MPC by using MS Access, annex 33 shows the component diagram of cadastre dataset of existing MPC datasets, annex 34 shows the topographical datasets of existing MPC data by using MS Access and annex 35 shows the topographical dataset component diagram of existing MPC by using ATLAS-TI.

4.9. Need and gap analysis of MPC for DRM

These sections describe what type of data is required for hazard mapping, element at risk mapping and risk information. The analysis is based on the transcribed semi structure interviews by using ATLAS-TI. I created quotations' from the transcribed document collected from field interviews. I coded the quotations and created a family based on their relationship. I used existing MPC class diagram which I made by using MS Access software and converted it into JPEG format. I imported that class diagram and coded it in ATLAS TI. Annex 37 shows the main data requirement for hazard mapping; annex 38 shows the data requirement of element at risk and annex 39 shows the data requirement of risk information. From these diagrams I validated the research question 2 which type of MPC data is required for Flood DRM activities? What I derived from literature in table 2.3.

From the above mentioned analysis of annex 36, 37 and 38 explains about data requirement for DRM activities. Annex 32, 33, 34 and 35 explains about the data can be extracted from existing MPC. By using those diagram and analysis by using transcribed interviews and ATLAS-TI software the annex 39 shows the information can be extracted from existing MPC datasets and annex 40 shows the need to add in the existing MPC datasets for flood DRM activities.

4.10. System requirement analysis in terms of users requirements

This system will be designed on the basis of the use requirements identified from the interviews, literature study and the information collected from the various sources.

4.10.1. Defining the users based on restriction and responsibility

The table shows the prospected users' responsibility and restriction on the use on MPC data handling.

Table 4-6: Defining the users

S. No;	Role	Responsibility and restriction	Remarks
1	Administration (Role-1)	• Creating users' role (Users management) • Database update • Deleting and modifying the users role • Database edit and view • Data download	Administrator belongs to LA organizations
2	Editors (Role-2)	• Data view • Spatial edit by using Q GIS • Attribute edit by web based system • Data download	Editors belongs to LA organizations
3	Central level DRM managers (Role-3)	• Data view • Data download (Sending updated hazard information to administrator using drop box)	Central level DRM managers belongs to DDC or DWDIP
4	Local level DRM managers (Role-3)	• Data view • Data download (Sending updated hazard information to administration using drop box)	Local level DRM managers belongs to VDC offices

4.10.2. Defining the data sharing system

From the output results of question number 7 from table 4.1, question number 5 from table 4.2, question number 3 from table 4.3 and question number 6 from table 4.4 described the data sharing mechanism. LA policy makers, IT staffs and DRM managers are focused on web based system to share data among the governments. The disaster managers also focused on web application for sharing mechanism. So, this research focuses on the web based application for MPC sharing.

4.11. Conclusion

Based on the need and gap analysis I validate the result of research question 1, 2 and 3.

- For research question 1 which type of data is required for Flood DRM activities? I derived the answer of that question from the literature as table 2-1 and validated from table 4-5.
- For research question 2 which type of MPC data is required for Flood DRM activities? I derived the answer from the literature as in table 2-4 and I validated the result from table 4-9.
- For research question 3 what is the process followed by Nepalese cadastre in order to collect, stores and shares MPC data? I derived the answer of the question based on current land laws and the direct field observation and I validate the result from 4-2 process and method adopted by cadastre office in Nepal.
- Answer of research question 4 what type of information can be extracted from existing MPC data? And what type of information from existing MPC could be useful for DRM activities? Answers are extracted by using class diagram of existing MPC datasets and data requirement for DRM activities by using annex 36, 37 and 38. So, annex 39, 32 and 34 is the answer of research question 4 must be added for DRM activities in MPC template.
- Answer of research question 5 which additional attributes in MPC would be beneficial for DRM purpose? Those derived from need and gap analysis of MPC for DRM activities in section 4.9 and annex 40.

The users' needs are derived only from the limited sets of interviews. Therefore they may not represent the entire or most accurate pictures. Due to time frame I could not collect interviews from many people involved in the LA activities, DRM managers and IT experts. But, the people interviewed were key persons amongst the selected groups. The semi structured interviews are one of the suitable ways to determine the users' requirements for designing a LA system (Acharya, 1992).

To identify the ways of data sharing system, I collected the opinions of the central, regional and local level DRM managers and LA policy makers including IT staffs. Most of them suggested the web based system for data sharing purpose. Therefore, I am developing a web based system, its requirement and the system components in next chapter including prototyping, testing and validating the system. I am studying the online LA systems of different countries from the literature for the guideline when implementing the system design.

5. SYSTEM DESIGNING AND PROTOTYPING

5.1. Introduction

This chapter discusses the MPC system requirements for LA and DRM practitioners. The main aim of this chapter is to develop a system which is based on practice used in the international LA organizations. This chapter explains the steps followed to create web enabled MPC system. It explores the practice used by the system for storing, maintenance and sharing MPC data by the DRM practitioners. The main focus is to identify how to create a flexible and extensible system as the MPC data extensible used in various sectors for e.g. food security, climate change etc. Therefore, the open sources software would be possibly used. This chapter addresses answer of research question 6.1.

5.2. Open sources softwares and system development

A free open source software (FOSS) is heading for easier entry of developing countries to the era of IT system-managed LA. The main advantages of the FOSS is easy maintenance, wide range of international developer and active user communities, problem solution without external support with no threats of licensing and vendor locks (Christl, 2008). The Solution for Open Land Administration (SOLA) project and community is working on LA system in Nepal. The High security organizations like US Department of Defence (DOD) invented and sponsored the Geospatial open source. The open source software was expanded and was later named as GRASS (Geographic Resource and Analysis Support System) by DOD (Kennedy, 2011).

Open sources development model

The open source software aims at solving the problems. The figure 5-1 explains about the steps and cycle of open sources development model. The main steps are problem identification, software developments, finding errors based on participatory approach, solving the errors and publishing the new code in the internet to get the updated version. Open source GIS software QGIS has a plugin with capabilities to handle all types of data i.e. points, line and polygons; all types of land rights and all types of subjects based on Social Tenure Domain Model (STDM) concepts. STDM is a powerful tool for LA system. This model can be used as per requirements of national LA organizations (Lemmen *et al.*, 2009). As it can prepare a document from a pre-defined template of the required documents i.e. land ownership certificate, deeds, and revenue paid receipts free of cost.

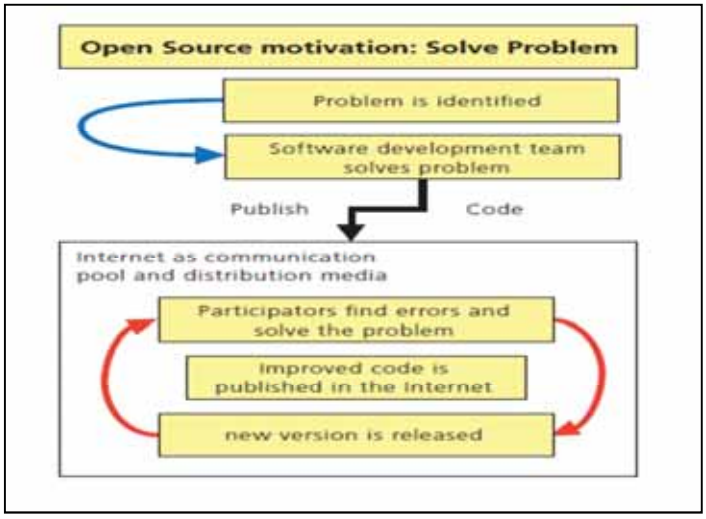

Figure 5-1: Open-source development models (Christl, 2008)

System design and development

After designing the conceptual database, there is need to design a system in order concentrate on the service delivery,. The major steps for designing a system is mentioned in figure 5-2. The steps are initial planning, analysis of requirements, analysis and design, implementation and testing and evolution (Tsai *et al.*, 1997). These steps are the main system designing steps in this research.

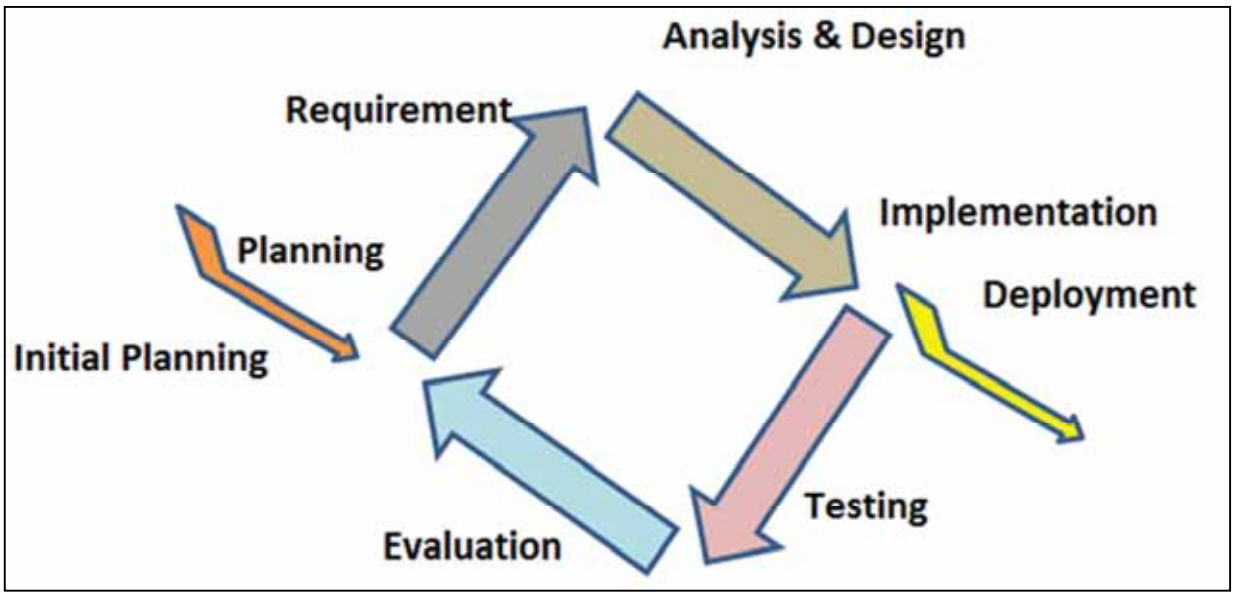

Figure 5-2: Iterative Software development model adopted from (Tsai et al., 1997)

5.3. Online LA system of different countries

This section explores the LA system of different countries based on literature. This helps to explore users' requirements and system requirements in an international standard. I searched online LA system of different countries and among them I selected Indian Bhoomi online system, Turkish LA system and Dutch cadastre system. The main features of that cadastre are given below:

Bhoomi online system

Thomas (2009) and P. V. Rajasekhar (2006) explains 'Bhoomi' (Land in Hindi language) is an Indian project based on online delivery and management of Land records. The Bhoomi project established for keep millions of parcel records to facilitate the farmer in the state of Karnataka. The main activities carried out to create this system and its features are given below.

- The digital maps are created using free sheet hard copy maps and dense national level ground control points (GCP) to geo-reference the maps by digitization methods.
- This data is stored in a database which was predefined as per national standards such as data standards, specifications and data sharing arrangements, data model and infrastructures to reduce redundancy.
- The key requirements are well defined for the security of e-documents against damage, loss, and also save from corruption and misuse by any person using biometric login facility.
- The main feature of this system is users friendly for the farmers.

Turkish LA system

Akıncı *et al.* (2012) and Bank and Mataraci (2004) explains Turkish Land Registry and Cadastral Information System (TLRCIS) is a parcel based system. The cadastral and registry systems are integrated and co-operated in Turkey. The main features of TLRICS are given below:

- The spatial part of the data from cadastre side managed by using ArcSDE/SQL server and land registry (attribute part) managed by SQL/database server.
- The system is centrally designed. Four servers are used such as SQL Server, Domain Controller Server, Backup Domain Server and Proxy Server.
- Cadastral data is handled by ArcSDE in a geodatabase format, which stores its data on SQL Server. Title Deed tables are on the SQL Server. All o integrated in the system.
- The system is based on variety of GIS standards and IT standards like as ISO and XML web services which supported various kind of data format.
- During the development of TLRCIS the major priority was given on data security, data integrity, data consistency, data efficiency and data currency.
- This system is capable to handle Cadastral part by cadastre office and registry part by registry office simultaneously and concurrently.

Dutch cadastre system

Hess and de Vries (2006) explain the web enabled parcel based system. The cadastre and registry parts are integrated. The main features of Dutch cadastre are given below.

- Web enabled LA system.
- Pre modelled database ISO standard.
- Capable to handle spatial and attribute in a web browsers.
- Web based query facility.
- Login facility for data security.
- Deed submission and automated deed verification system by using XML codes.
- Online verification facility

The above mentioned points are useful for the system design as a guideline. Toroi (2009) also explains about the system requirements for web based computer system. Her main focus was users' friendly interface, data access capabilities, data security and users' management and basic working principle.

5.4. System and user requirement analysis

After study of the international LA system and AS-IS system of Nepalese LA, the major requirements of the system are tabulated in table 5-1 and based on the computer system design principle by (Toroi, 2009) are given below:

Table 5-1: Users requirements analysis

S.NO;	Requirements	Implementation/Design
1	A simple and user friendly interface	Design a web based system
2	Remote data access capability	Design and implement client server approach database, data server, data view, edit function and download facility.
3	Simultaneous data access and query from both DRO, DSO and DRM offices	Data view, edit function and download facility
4	Capabilities of handling both spatial and attribute data concurrently	Spatial part handled by QGIS and attribute edit facility in web based system
5	Data security and user management	Password protection and role management (table 4-6)
6	Basic working principles should match the existing land administration practices, with some modifications and improvements	Matching with basic LA practice and process

5.5. System designing steps

This section describes the major steps followed during the system designing phase. The collection of users requirements are extracted from the analysis of transcribed interviews from all pre-defined 5 groups and the system requirements are extracted from the international LA practices. This section describes about the system components and system requirement. The major task is the users requirement analysis, maintain and reengineering the existing database and searching suitable sharing mechanism. Accordingly, a class diagram, use case diagram, system architect diagram and activity diagram design are described below. The major steps are given below:

5.5.1. Collection of users requirements

The user requirements are extracted based on the existing MPC database. Needs assessment carried out from interviews. The data sharing mechanism also extracted from analysis of interviews from all 5 pre-defined groups. The system requirements are extracted from literatures describing the international LA organizations.

5.5.2. Modification of existing MPC template and create a new MPC template (prototype output as a Class diagram)

Modification of existing MPC database is done in ArcGIS software. I prepared modified MPC datasets based on users' requirements for the newly designed system. The existing database system used Nepali Romanised Unicode because Arc GIS does not support Nepalese fonts in a database. Therefore some of field value in the database shows as "?????_???". The Postgre does not support Unicode due to which the system used English fonts and ignored Unicode and Nepalese fonts. The figure 5-3 and 5-4 shows the modified MPC for newly designed system. Watershed class added on the basis of natural resources management and spatial hierarchy concepts from (Tuladhar et al., 2004).

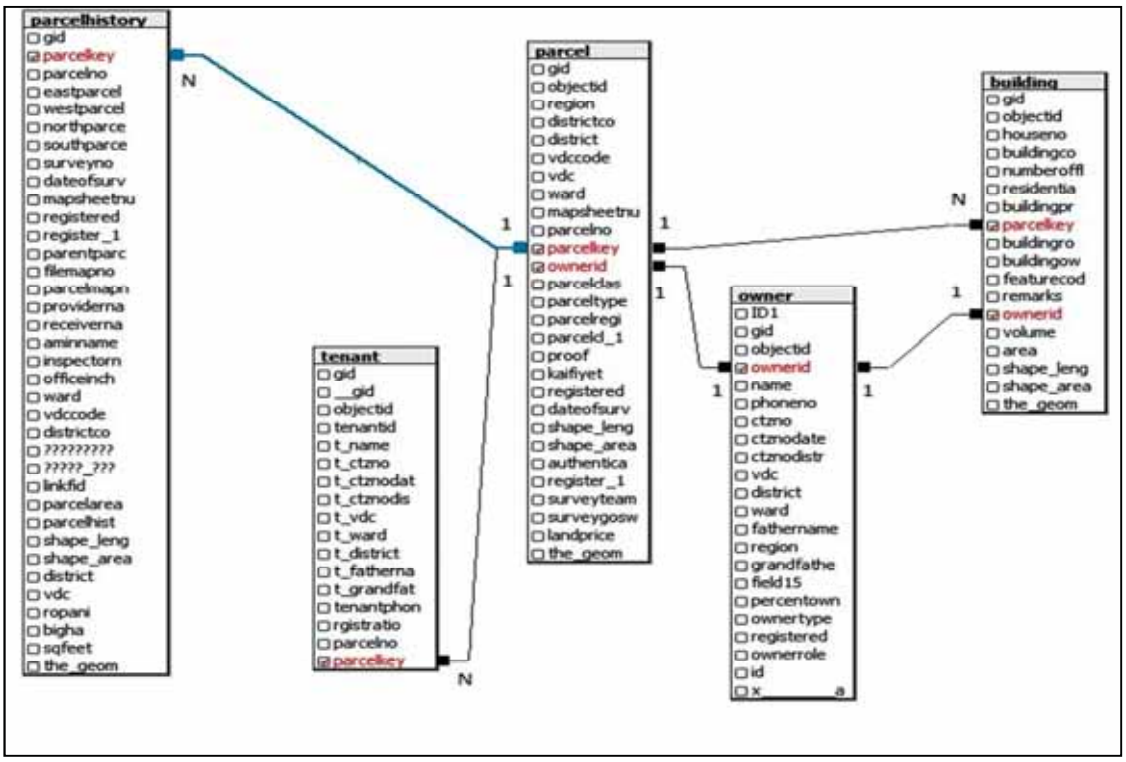

Figure 5-3: Modified cadastre class diagram of MPC

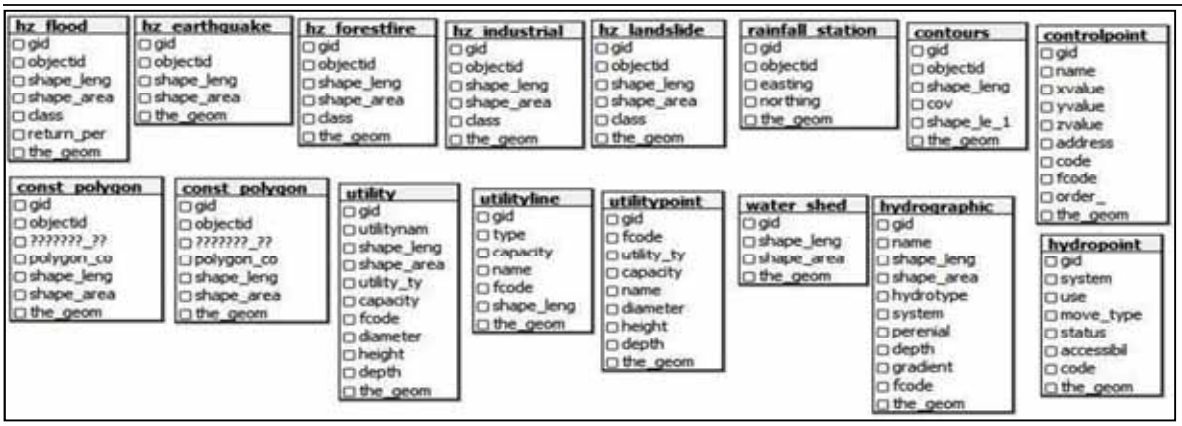

Figure 5-4: Modified topographic class diagram of MPC

5.5.3. Based on AS-IS LA usecase and activities searching TO-BE usecase and activities (prototype output as a Usecase diagram and activity diagram)

The existing data sharing mechanism is standalone system which I extracted from the field interviews. If anyone needs the MPC data they can collect the data from LA office. Therefore, AS-IS activities are standalone system. Land transaction, mortgage registration and parcel subdivision are also done in front desk approach. The TO-BE activities and use case for this research are given below:

The main users of the system are administrator, editors, local DRM managers as well as regional and central level DRM managers. The main tasks and activities are users' management, data upload, view, edit, delete, data download, flood simulation, mapping and visualizations. Administrator plays most important role for overall management in the system except flood simulation. The regional and central level DRM managers are responsible for downloading the contours to make a DEM. By using other datasets like hydrographical information from DHM, they perform flood simulation activities in SOBEK software. Hazard zoning classes are generated by multi criteria evolution based on water depth and velocity in the form of raster based simulation results. After generating the hazard zoning map manager responsible for share that data to the administrator.

Other LA activities like full parcel transactions are performed by using web based system. Parcel subdivision tasks are performed using the QGIS. These tasks are responsible for the editors. Map printing and other information can be easily printed by the editors using this system. The figure 5-5 shows the usecase diagram.

The figure 5-6 shows the TO-BE activity diagram for involved four users group is given below:

Administrators (belongs to LA organization):

- Users and role of user define as table 4-6.
- Data upload to the system
- Data download, data delete and data modification for monitoring and evolution purpose.

Editors (Belongs to DRO and DSO):

- Data view
- Data edit/ delete for transactions (Regular task within LA organizations)
- Map and information printing
- Spatial edit by using Postgre database and QGIS.

Central level DRM managers (Belongs to DDC or DWDIP):

- Data view and download from the system
- Flood simulation
- Multi-criteria evolution and hazarding mapping
- Share the result to the administrator

Local level DRM managers (Belongs to VDCs offices):

- Data view
- Data download

- Information printing
- Risk identification
- Risk communication
- Other regular works

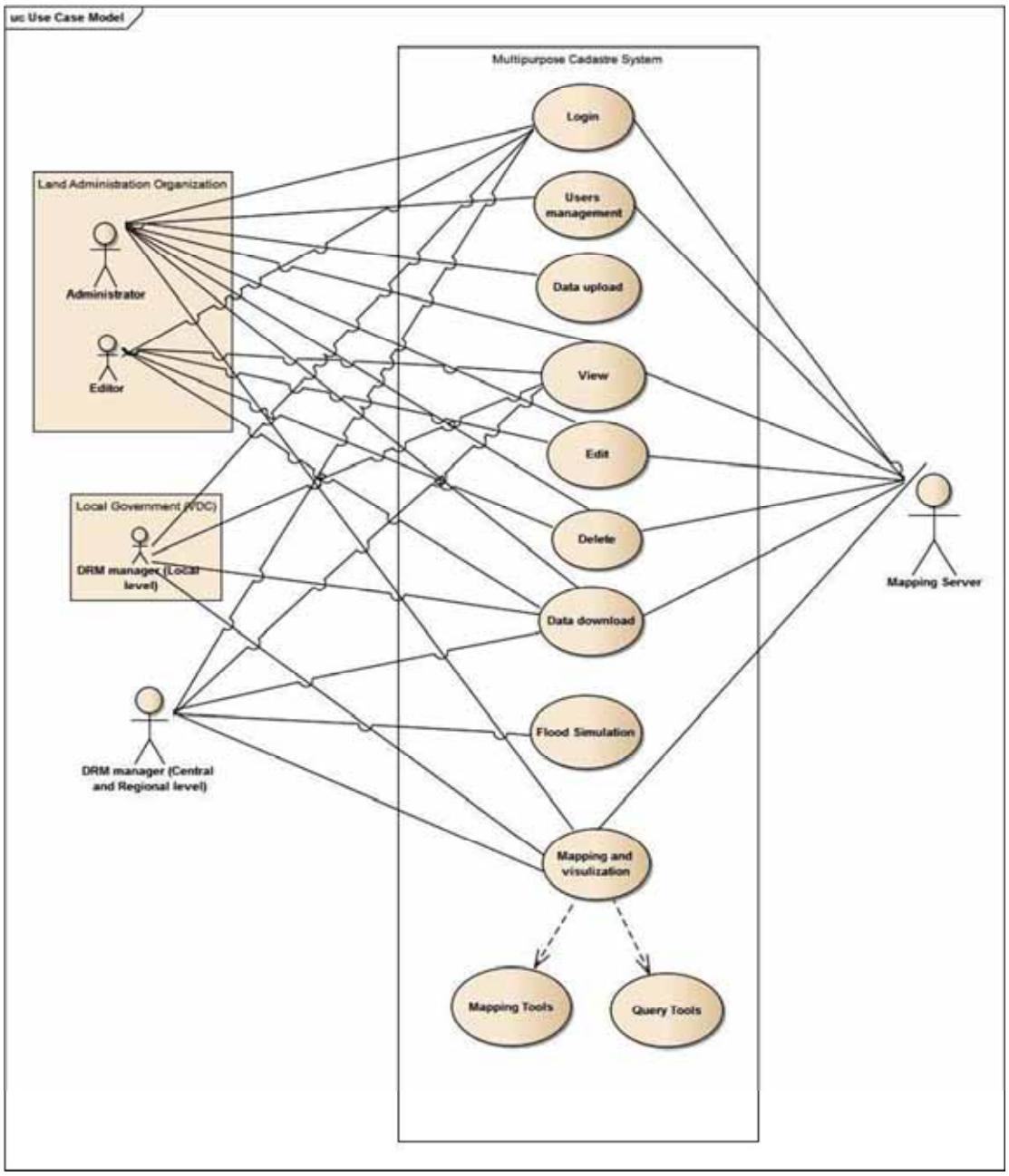

Figure 5-5: TO-BE use case diagram for use of MPC for DRM managers

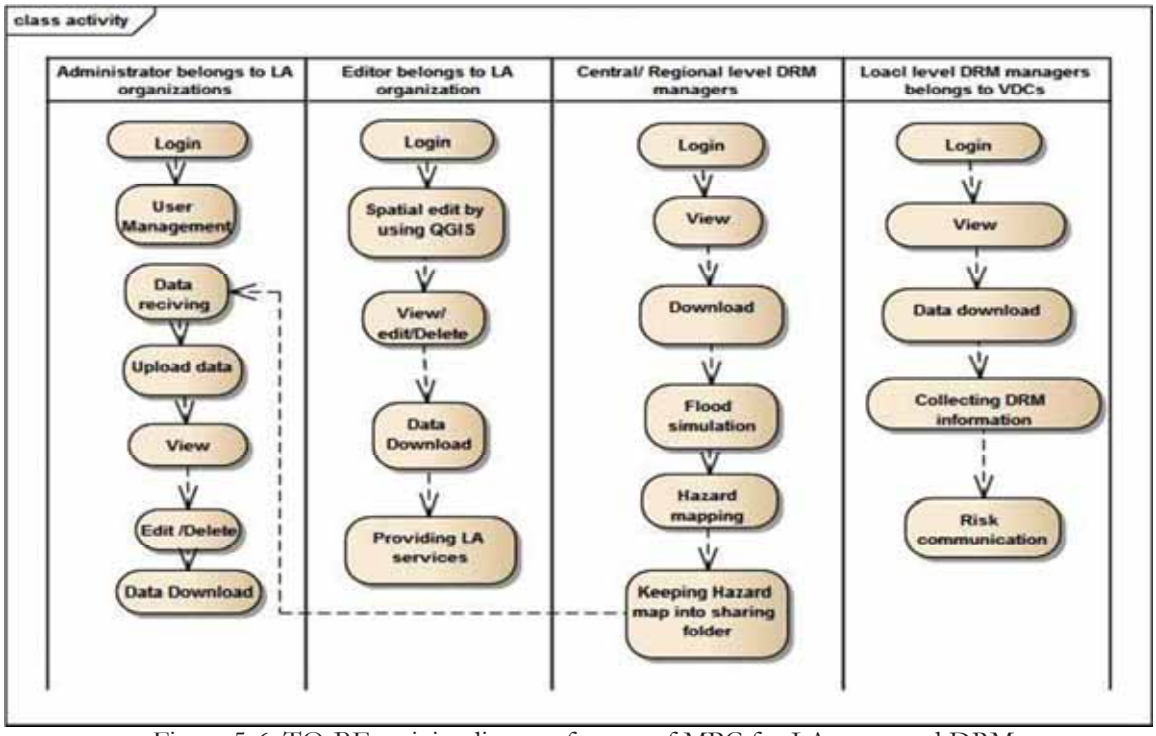

Figure 5-6: TO-BE activity diagram for use of MPC for LA users and DRM managers

5.5.4. Based on users requirements and international LA system designing system architect (prototype output as a System architects)

Now after revising and finalizing the use case diagram, class diagram and activity diagram the feedback from the user's requirement analysis the system architecture has been developed which is shown in the figure 5-7 below:

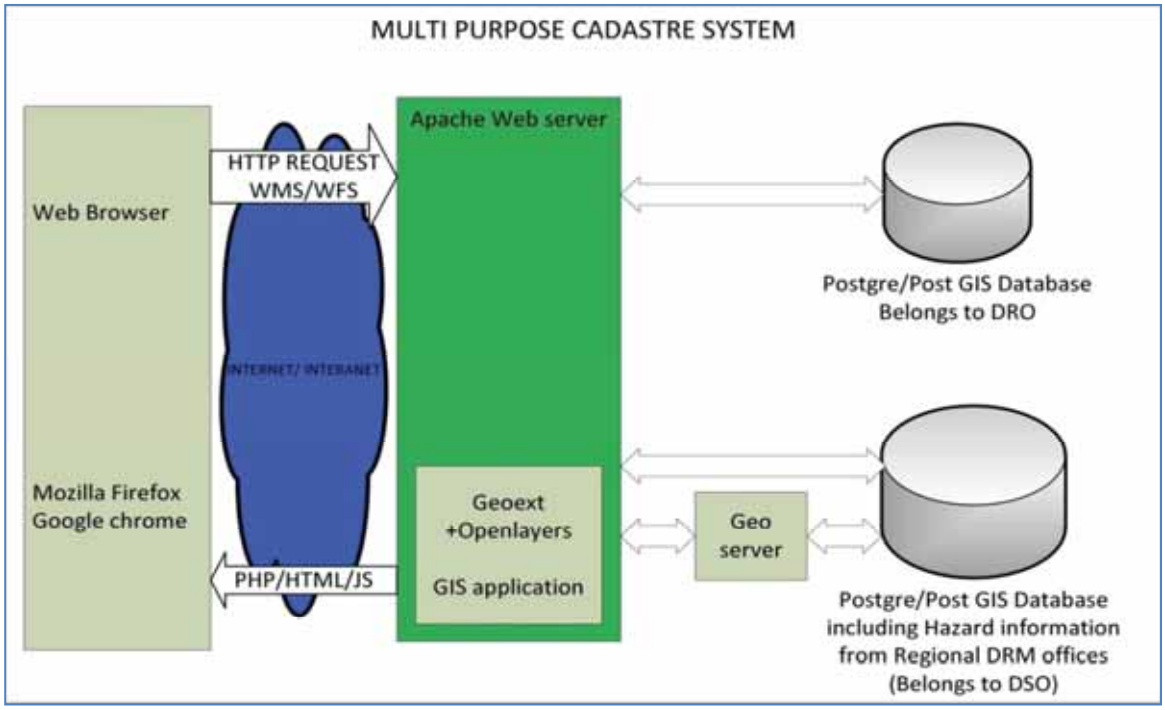

Figure 5-7: System architect

The detailed description of each of the component along with their need is as follows:

Databases: Existing database is in MS Access as a geodatabase. The template of MPC was also a Geodatabase in *.MDB format. The required outputs of LA activities were also developed in parcel editor application as an extension of ArcGIS which had a facility to print the required document in a pre-designed template. Therefore the suitable way is to choose the database server from the open sources category. This case used Postgre database as a data server having spatial tools handling capabilities.

Mapping Server (Geoserver): Rautenbach *et al.* (2013) mentioned the web based thematic map visualization system. The system can handle the spatial part by using Geoserver. The HTTP/WFS request sent via web browser and Geoserver handled mapping part, PHP handled data server and the other management. I adopted this system in my research.

Apache Web server

- GIS Application using OpenLayers, Geoext and ExtJS: A complete GIS solution developed using the OpenLayers, Geoext and ExtJS libraries is served using the Apache web server. The server allows the user to interact with the page and responds to their inputs. The map part is basically a combination of PHP, HTML and JS. The controls are built on top of the OpenLayers and Geoext using JavaScript coding. This client is capable of proving the users with easy to use map and a lot of tools and controls to interact with it.

- Database Application using PHP, JS and HTML: The database application is also served using the Apache web server. Most of the contents/pages are written in the PHP with supplements from HTML and JS. All the user requests are handled by the PHP served using Apache.

- Internet: This is the bridge that connects the web server to the clients. All the requests and responses are sent via the Internet. Internet could either be global providing World Wide Web (WWW) services or a local intranet service. I used local hosting system.

Client: Anyone connected to the internet/intranet and having an OGC WWW specification complaint browser is a client in our case. The clients that we have targeted our system are local and central governments. The client sends the requests to the Apache web server and receives and displays the responses from it. The requests could be in the form of HTTP request, WFS or WMS requests. The responses are in the form of PHP, HTML and JavaScript codes which the browser parses and displays user understandable output.

5.6. Description of system components

This section describes about the system components and interface and tools adopted for the system.

Login page

This page is the login page of the system. Username, password, role and department are stored in the Postgre database. PHP handled users table for query and verification. The figure 5-8 shows the login window. A person entering a predefined username and password in login page can have an access to the corresponding users' group page.

Figure 5-8: Login window

Home page

Home page contents login menu and information about this system. A snapshot of the menu is in figure 5-9 below.

Figure 5-9: Home page snapshot

Admin page

The admin page consist 6 menus such as home, cadastre, map visualization, download, hazard and users' managements menu. The figure 5-10 shows the snapshot of admin page.

Figure 5-10: A snap shot of admin page

User management

This menu contents two pop down menus such as users list with id, name, role, address department. The functional tools are view, edit and delete for individual users. And other menu contents create users function. After using any one of functional key updated in a Postgre database. The figure 5-11 shows the screen dump of the windows.

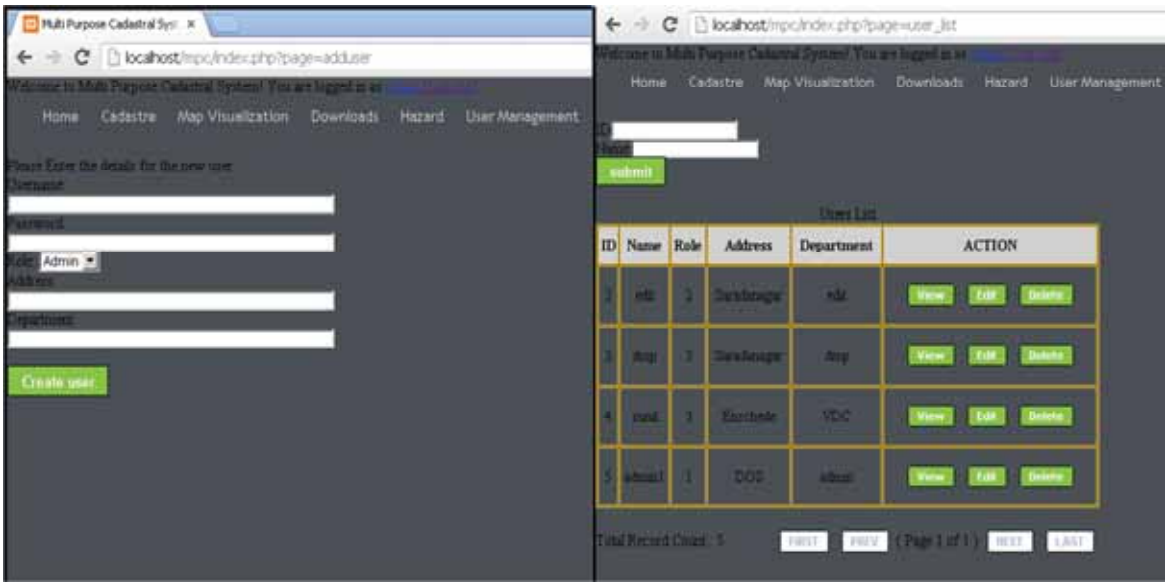

Figure 5-11: Screen dump of users' management menu

Editor page

This menu contents all of the facilities excluding the users' management menu of the admin users. Cadastre menu is useful for view, edit and download even printing facility for LA activities. The figure 5-12 shows the sample of edit page.

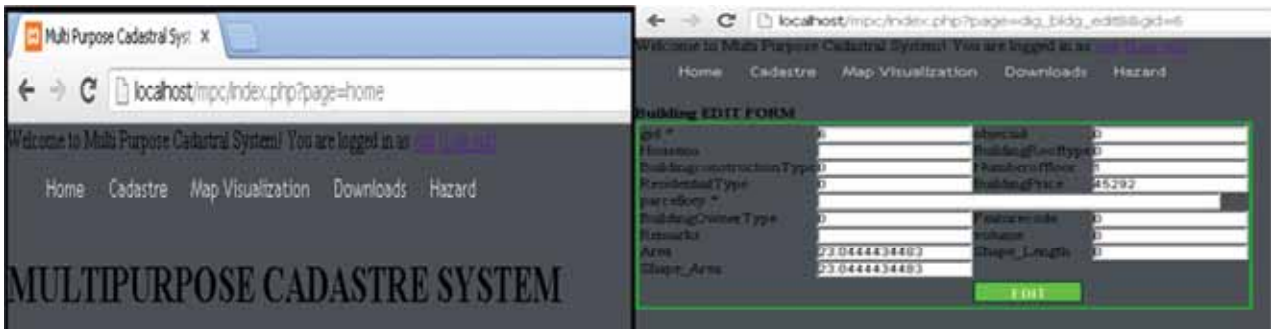

Figure 5-12: Sample of editors' page

DMP page

This page contents home, download and hazard menu. The main idea is downloading the required datasets and using those data for flood simulation task. Applying multi-criteria evaluation gives the flood hazard zoning mapping. Share this information to the admin to upload in the system. The figure 5-13 gives the snapshot of DMP page.

Figure 5-13: Snapshot of DMP page

Cadastre

The cadastre menu contented parcel list and building list pop down menu for several function on parcel and building in the system.

Parcel list

The parcel list menu has the query function to search any parcel by using parcel number, owner id and parcel key. The page contents 5 functional tools i.e. map view of single parcel attribute, map view of single parcel, edit attribute of single parcel, delete, owner view and download the parcel in a SHAPE-ZIP format. The figure 5-14 shows the screen of parcel list windows.

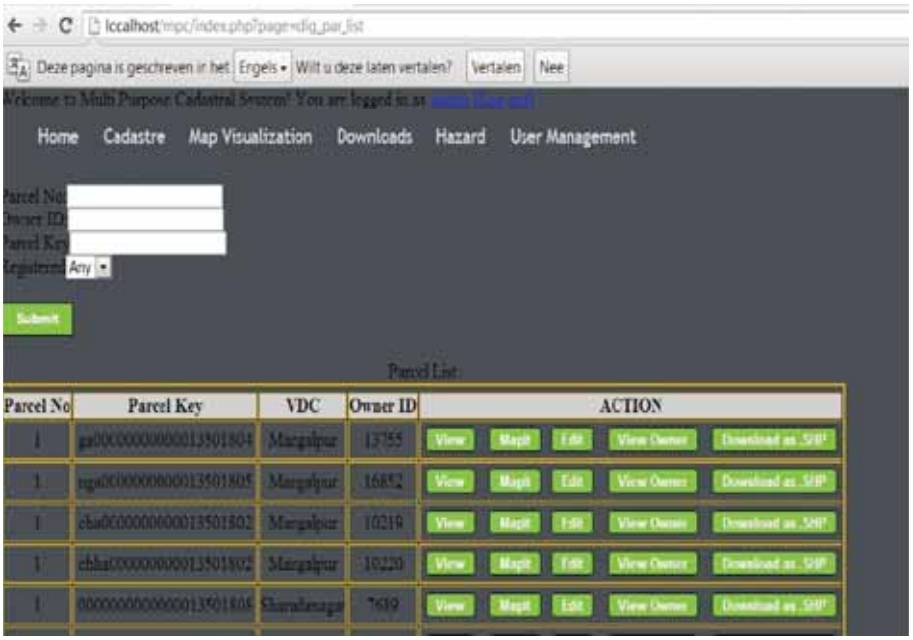

Figure 5-14: Parcel list windows

Building list

The page contents searching facility by using building type and GID. There is also a 5 functional tools such as view, edit, remove, map view, owner view and download as SHP format. The figure 5-15 shows the snap shot of building windows.

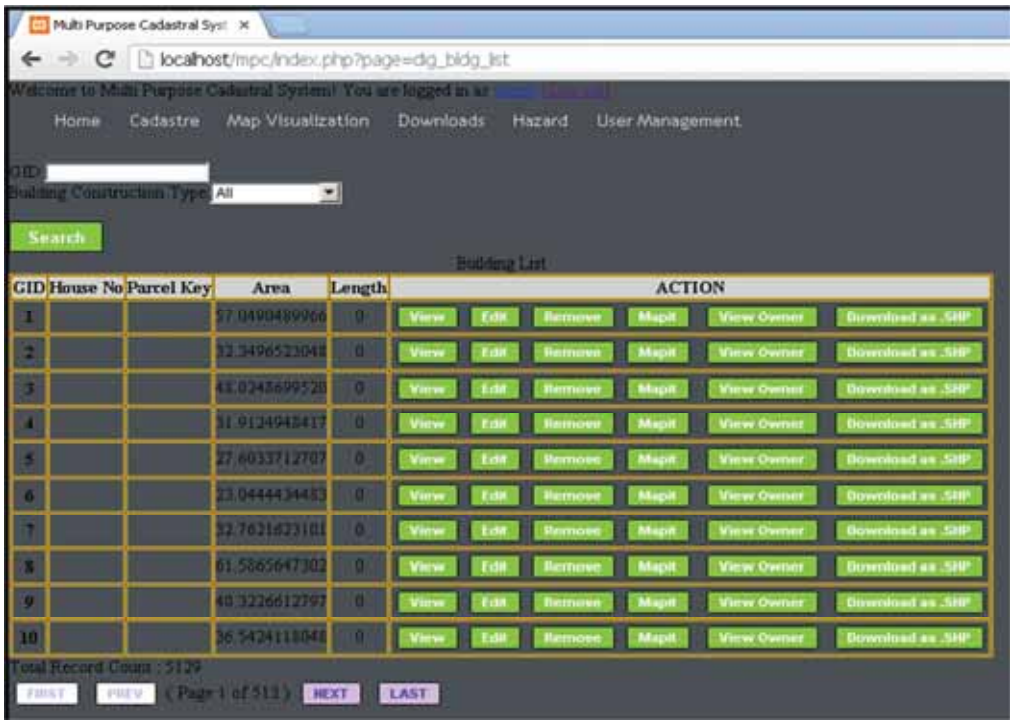

Figure 5-15: Building windows

Downloads

Download menu contents the pop down menu for selection a VDC from the postgres database. Other pop down menu for is for selection a spatial layer which is downloaded in a SHP-ZIP format which contents SHP file and other file supporting SHP. The figure 5-16 shows the download window.

Figure 5-16: Download window

Map visualization

Map visualization menu contents the map views of the several spatial layers in the database. Geo server plays important role to handle spatial layers in a web browsers. There is a option switch on and off facility and zoom, identify and printing facility. Map visualization part is further described in hazard and element at risk part.

Other designed tools

S. No;	Tools	Descriptions
1	Zoom to Maximum Extent [ ]	This tool is useful for the zoom to maximum extent in a designed mapping window for all spatial layers.
2	Pan [ ]	This tool is useful for move to the feature layers to view particular fixed location without distorting the spatial references
3	Zoom to Previous Extent [ ]	This tool is useful to show the last recent position of map viewer only one time this is not undo view bottom.
4	Zoom to Next Extent [ ]	This tool helps to restore the last position of map viewer once used zoom to previous extent bottom
5	Identify [ ]	This tool helps to identify the feature in a map viewer including attribute information of the spatial layers
6	Zoom In [ ]	This tool helps to magnify the features in the viewer. The magnification limit was fixed in a certain scale of views.
7	Zoom Out [ ]	This tool helps to reduce to the magnification of the features in a viewers
8	Measure Length [ ]	This tool designed for measurement of the linear distance in a view between any two points.
9	Measure Area [ ]	This tool designed for measurement of area in a view of any polygon or prospect polygon
10	Print Map [ ]	This tool is designed for map and information print such as parcel map and other forms.
11	Query	The web based pop down menu also developed for selection a VDC and spatial layers what have to download. The value entry query also developed.

5.7. Conclusion

Web based system is chosen because it is easy to use. System designing performed based on users' requirements and system requirements. This chapter derived the system requirement analysis, users' requirement analysis and system components. The main focus was to identifying the suitable data sharing mechanism and designing a prototype of the system. The system designed by using PHP, HTML and JS and server used Postgres, apache, post GIS and geo-server for organizing the system. PHP, HTML and JS have capabilities to handle spatial database and mapping in a web application. The PGADMIN can be used as a data server and PGCLIENT can be used as client in the networks in this case. But I did not use this system because it needs very high skilled human resources to create users need SQL. The system will be useful as a bridge between MPC and DRM. The outputs prototype will helps to establish the system in the country context. The use case diagram will help to establish the coordination among the DRM offices and LA organisations. The TO-BE activity diagram will help to distribute the roles and responsibilities to the staffs among the LA and DRM organisations. The class diagram will be guideline to additional attribute information should be added for DRM activities in the existing MPC datasets. And System architect diagram will be the system component and overall structure for collect, store and share data within the users' group. Thus, all of the prototype product will be guideline document to DRM activity by using MPC datasets. The following chapter will be focused on the disaster management activities from the designed system, testing and validation of the system.

6. SYSTEM OUTPUTS, GIS OPERATION AND VALIDATION

6.1. Introduction

The main focus of this chapter is to study the system outputs. I used hazard class map from DWDIP, Nepal. Therefore I am explaining the method adopted for hazard map preparation followed by DWDIP. This chapter also deals with the answer of research questions 6 regarding the system validation. The main output of the system is Hazard mapping, Element at risk mapping and Risk information. The following section describes the DRM activities.

6.2. DRM activities

The main outputs from the system are hazard zoning map, elements at risk map and risk information besides the regular LA activities. I used hazard zoning map from DWDIP and identified the methods adopted for preparation of hazard map. I prepared a list of the data which can be/cannot be generated by system to input for flood simulation, based on DWDIP adopted for preparation of Hazard zoning map. The following section described the method adopted for flood simulation by DWDIP.

6.2.1. Hazard mapping

The figure 6-1 shows the flow chart of flood simulation process. The river sections and river discharge data from DHM and contours from DOS to generate DEM for flood simulation. Flood simulation process done in Geo_Ras software.

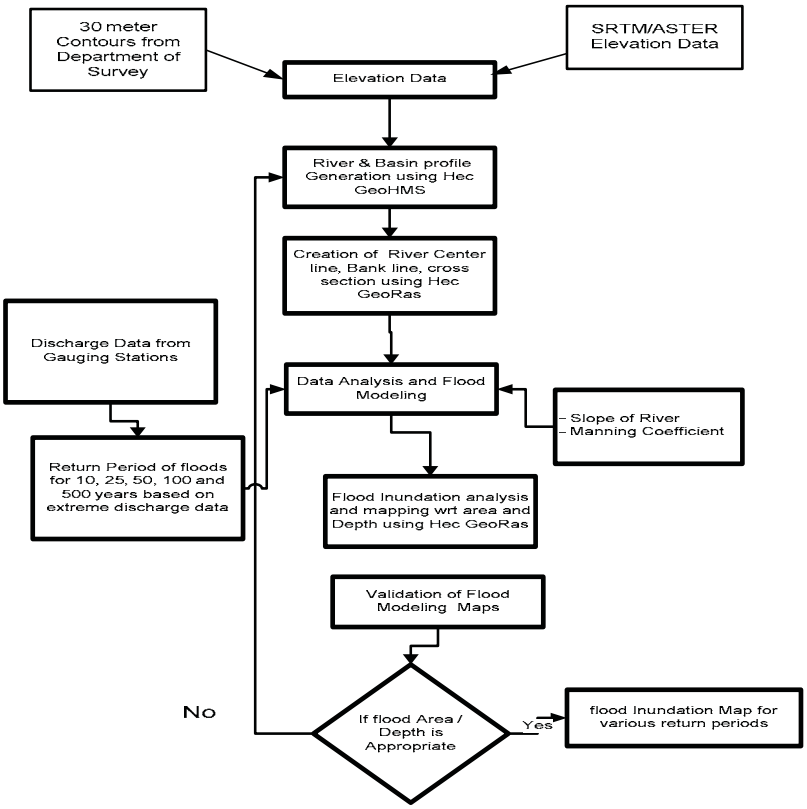

Figure 6-1: Flood simulation process adopted from (ADPC *et al.*, 2010)

Data Requirements for Hazard mapping

From the above mentioned figure 6-1, some data requirements for flood simulation are listed below. The main exploration is what can be extracted from the system and what cannot be extracted. The table 6-1 shows the data requirements for flood simulation, extraction methods from MPC. After simulation, the results are flood depth, flood velocity, flood duration, flood impulse and sedimentation information produced in the form of a raster based map. I could not collect raster based data from DWDIP. After simulation process multi criteria evaluation is adopted.

Table 6-1: Data requirements for flood simulation

S. No;	Data required for Hazard mapping	Can be Extracted from the MPC system
1	Digital Elevation Model (DEM)	Can prepare from contours and spot heights and control points. Data can be download from web based system
2	Manning coefficients or friction value (Surface roughness data)	Can be extracted from land use map (Abdul Rahman, 2006)
3	Rainfall data (Calculation for return period)	Cannot extract from the system. DHM or DWDIP can provide the information
4	River discharge	
5	River section	

Multi-criteria assessment adopted for hazard zoning

The figure 6-3 shows the flood simulation for different return periods. It gives information related to flood extent and water depth. Based on water depth, the multi criteria evaluation process was adopted as described in the table 6-2 and hazard classified map were prepared. The Hazard classified map was collected from DWDIP figure 6-2 and method adopted for flood simulation. I did not perform flood simulation process in this research.

Table 6-2: Criteria adopted for hazard class preparation Adopted from (Abdul Rahman, 2006) and (Alkema *et al.*, 2007)

S. No;	Hazard Zone	Water depth from ground
1	High Risk Zone	Greater than 1.6 meters
2	Medium Risk Zone	0.30 metres to 1.6
3	Low Risk Zone	Less than 0.3 metres

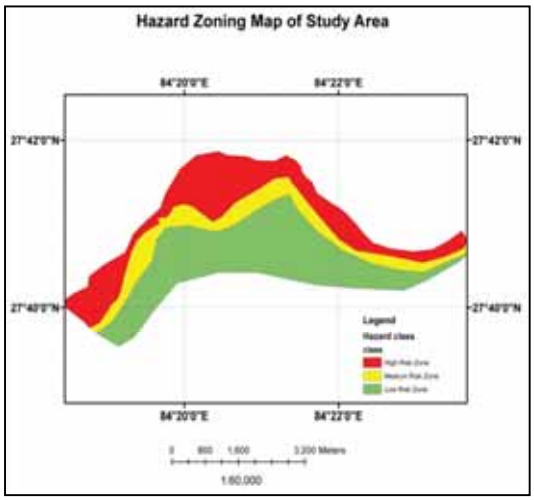

Figure 6-2: Hazard classified map adopted from DWDIP, Nepal (2012)

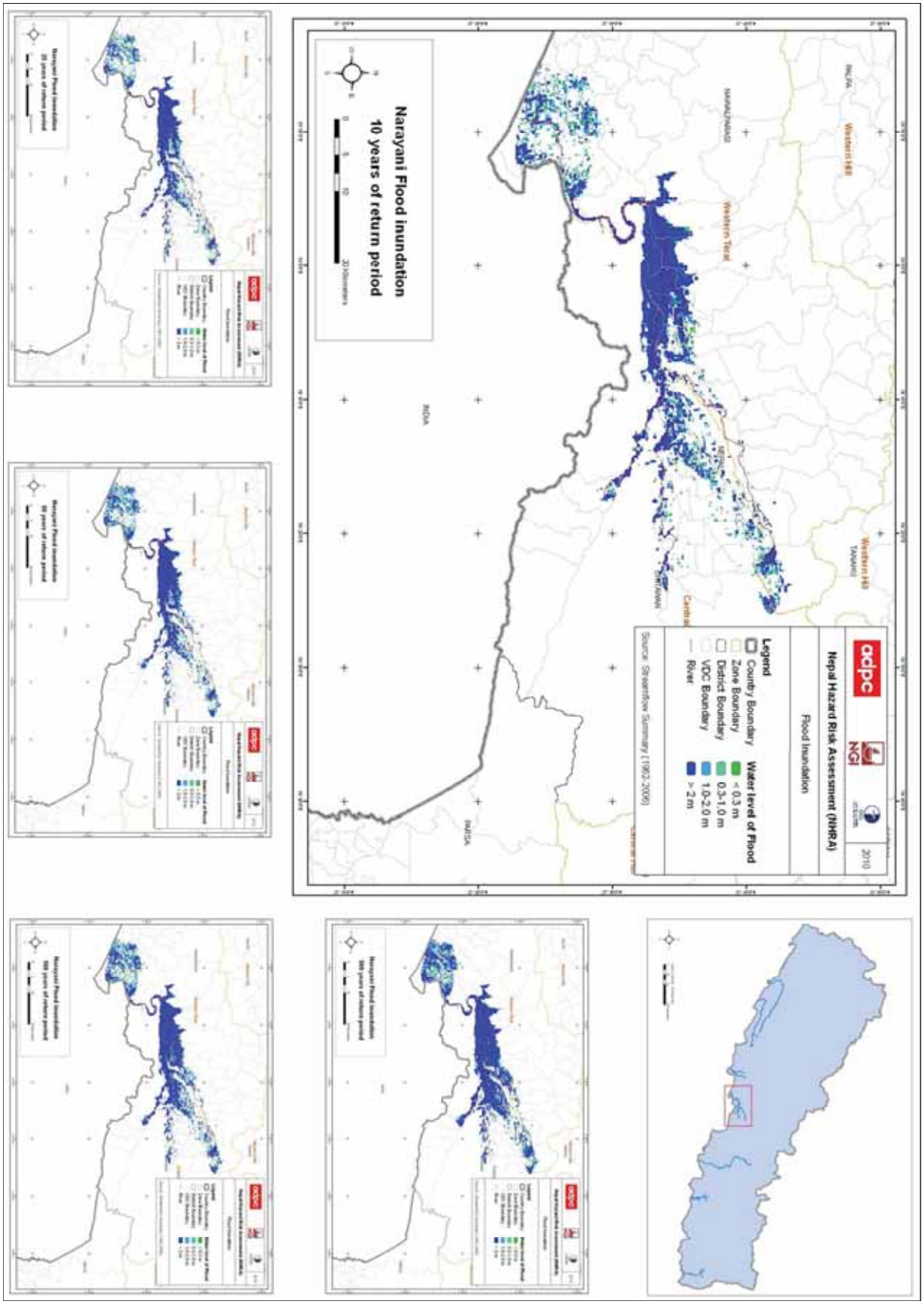

Figure 6-3: Flood simulation map adopted from (ADPC et al., 2010)

6.2.2. Element at risk mapping and Risk information

Administrator uploads the hazard class data from sharing folder. This hazard class data is obtained from flood simulation engineers working in regional or central level DRM organizations. The system perform the overlay function to the building, parcels and landuse and summarized the number of buildings, parcels and total number of people suffered and price in the particular risk zone. The figure 6-4 shows the element at risk and risk information as output from the system.

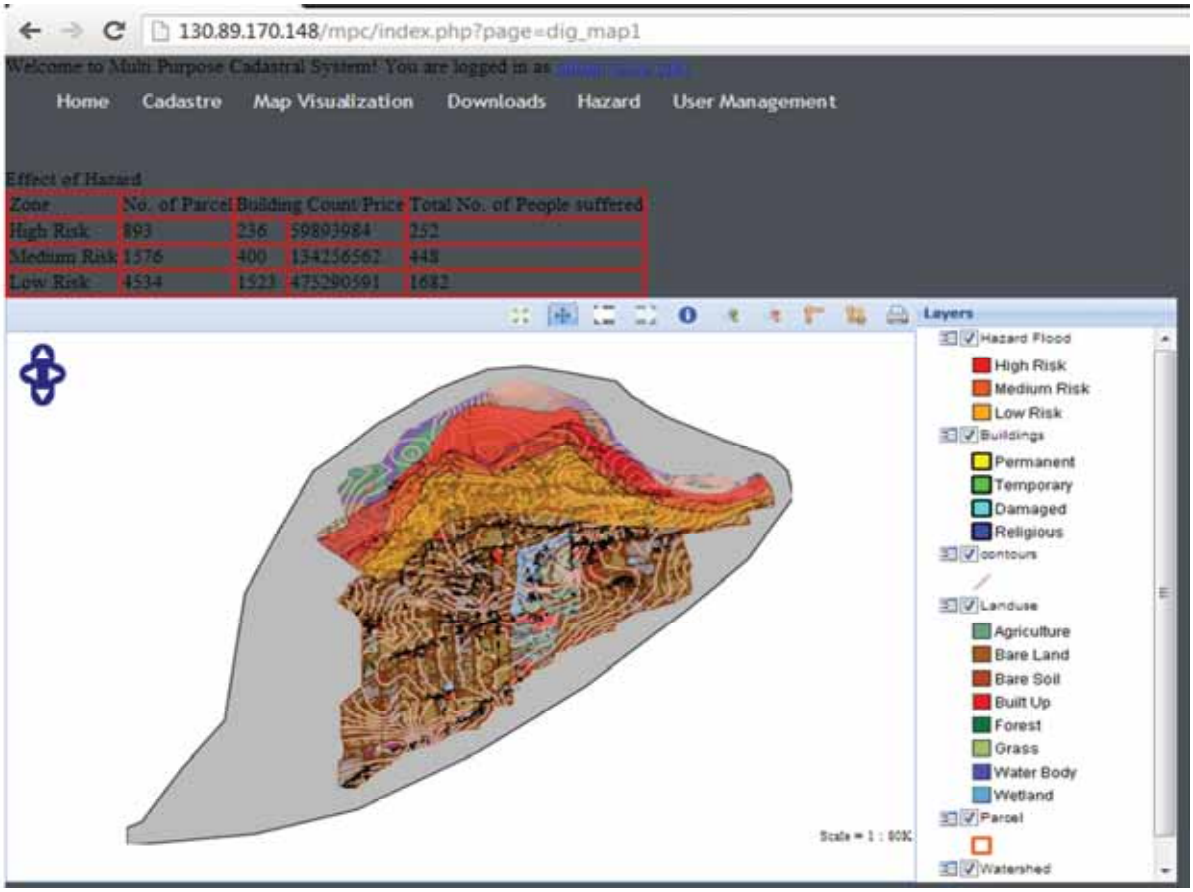

Figure 6-4: Element at risk and risk information

6.3. System validation

The system validation model (V- Model) contains four qualifications (4Q) i.e. design qualifications, installation qualifications, operational qualifications and performance qualifications (Huber, 2009). This research also adopted (V-model) with 4Q approach. Four experts are selected for the validation purpose, two from LA organization and two from DRM managers. I selected the experts from each pre-defined group which I defined for the primary data collection phase. The chief of DSO, Chitwan was chosen to represent the view of local level LA organization, Survey officer from cadastral survey branch was chosen to represent the view of policy makers, and Engineers from DWDIP and DDC, Chitwan represents the DRM side; name list in the annex 43. Due to energy problem in Nepal and network security of ITC, it is difficulty to share local host internet protocol publicly. I got the support from Er. Bishrant Adhikari the student from Kathmandu University, who installed the system in Nepal. I used Skype software and mobile phone to communicate with the experts to collect their views in percentage. The qualifications such as Design Qualification (DQ), Installation Qualification (IQ), Operational Qualification (OQ) and Performance Qualification (PQ) with descriptions, where each qualification have their corresponding

sectors called description of the qualification. The Quality of system are classified in four classes for each Qualifications such as very bad, bad, good and very good system. The qualitative approach is adopted for this research with some modification (Huber, 2009) . I used quantitative approach to validate the system because "quantitative results also emphasise the qualitative results" (Kumar, 2000). Every qualification considered as 100% marks and distributed among their corresponding descriptions. The marks are distributed as below 70 very bad, 70-80 bad, 80-90 good and above 90 very good for the system. Average percentile marks are generated from the average of marks from each description. Average marks for each qualification is the average of average marks for every description. The table 6-3 shows the 4Q description, distributed marks and average marks.

Table 6-3: Validation process

Qualifications	Descriptions	Marks	Marks from experts				Average marks for every description	Average marks for each Q
			Expert-1 (LA)	Expert-2 (LA)	Expert-3 (DRM)	Expert-4 (DRM)		
Design Qualifications	User requirement specification	25%	20	22	19	23	21	
	Functional specifications	25%	22	18	23	17	20	
	Operational specifications	25%	21	20	21	22	21	
	Vendor qualification	25%	20	23	19	19	20.25	82.25
Installation Qualifications	Check arrival as purchased	50%	42	40	37	41	40	
	Check installation of hardware and software	50%	41	42	45	46	43.5	83.5
Operational Qualifications	Test of key operational functions	50%	42	41	43	44	42.5	
	Test of securiety functions	50%	39	37	40	38	38.5	81
Performance Qualifications	Test for specified application	33.3%	30	29	28	26	28.25	
	Preventive maintenance	33.3%	32	29	31	30	30.5	
	On-going performance test	33.3%	27	30	31	29	29.25	88

The design qualification scored 82.25 which are good in design aspect. Installation qualification scored 83.5 which are good in system installation aspects. Operational qualification scored 81 indicated good in operational aspects and performance qualification scored 88 shows well in performance aspects. The overall score of the system derived from the mean score from all of 4Q is equal to 83.6875 which is good system from validation results.

The principle of system validation plan contents time period to check installation the system, operational standards and system performance in long-term basis. Therefore, the time frame for validation was the limitation of the validation approach. The limited persons were chosen in the system validation process due to the time frame and difficult to communicate the remote place in Nepal from Enschede.

6.4. Conclusion

The system outputs are visualized as the product from designed prototyping. The results are hazard zoning map in a web based system, elements at risk map as overlay between hazard map and parcel, building, landuse and summary table as risk information. Identifying tools also helps us to know individual house information from corresponding attribute information. Validation process was done on the basis of (V-Model) and 4Q methods. The validation result is satisfactory because overall score is 83.6875. The overall exploration result from qualitative analysis is also difficult to determine from district classes such as very bad, bad, good and very good. Thus I thought quantitative method was the suitable method to validate the system. I got the suggestion to deal with quantitative method to validate the system from Mr. Damodar Wagle, Chief, District survey office, Chitwan. The following chapter deals with the conclusion and recommendation for each user groups in LA and DRM organizations of the research.

7. CONCLUSION AND RECOMMENDATION

7.1. Introduction

This chapter focus on the 4 objectives of the research. What are the answers of research questions to illustrate the main objective for alignment of MPC data for flood DRM activities in Nepalese context, the summary of the answer of every objective is given below:

Objective 1: To evaluate the main data requirements for flood DRM activities

From the literature studied and validation from field work, the main data requirements of flood simulation are follows. DEM (elevation information) can be extracted from contours and spot heights. The surface roughness value (Friction value or mining constant), river discharge and river section can be collected from DHM in Nepalese case. Multi-criteria evaluation can be adopted from DWDIP standard. For element at risk and risk information is extracted from overlay GIS operations. The attribute information is also summarized for each spatial layer. Parcel, building and number of people were the elements at risk in this research. So, parcel and building with number of residence and price is the important element as exposer. I could not consider the coping capacity in this research to calculate absolute risk value therefore calculated risk information was only relative.

Objective 2: To evaluate the existing MPC data, whether it will fulfil the minimum requirements for flood DRM or not

The MPC could not fulfil the minimum data requirements for the DRM activities. The rainfall data, river section and the river discharge data depends upon the DHM. The elevation data can be extracted from MPC datasets. Hazard zoning map is created after flood simulation and multi-criteria evaluation. The main use of MPC data are element at risk and risk information. Parcel and building layers are used as element at risk analysis. The numbers of effected persons are calculated from the number of residence in a building from building layer.

Objective 3: To search the possibilities for value added information by adding additional attributes to the existing MPC data which are useful for flood DRM

By using the need assessment, I analysed the existing MPC data and data requirement for DRM activities. I concluded that the number of residence, price and building strength (for vulnerable study not included in this research) must be added. Hazard class are added based on the literature. After adding this attribute information, the system gave value added information regarding risk information in terms of expected loss or damage.

Objective 4: To investigate how to improve the data sharing between the LA organizational system and DRM practitioners

The web based system designed is based on users' requirement in terms of rights, responsibilities and restrictions from the government side. Postgres as a database server, Apache as a web server, post GIS and Geoserver for spatial visualization are used in the system. PHP commands are used to link and perform several tasks in the system. The web based DRM information extracted as system outputs. The system is validated in (V-Model) and 4Q approaches fully based on having experts opinions.

7.2. Recommendation

This research only concentrated on user's requirements based on table 5-1. The users of this system are defined based on analysis of answers of questionnaires from the field table 4-6. The study did not focus on national data sharing policy. I designed this system only as an example. This system designed for the partial fulfilments for M. Sc. in Land Administration at ITC. Some part of hosting system is the task of computer engineers. The simulation is the task of simulation engineers in Nepalese context. Some recommendations are made based on experience gained during research.

7.2.1. Recommendation for LA policy makers

LA policy makers must establish an efficient and effective data sharing policy between LA organization and local government. This is important for local level decision support system. This also helps to collect revenue in effective and efficient way. The inconsistencies in data specifications are still identified. Therefore, a need to formulate standard policy is necessary to achieve the national cadastral mapping goal of Nepal. After formulation of the policy the designed prototypes will be the guideline to implement the use of MPC datasets to DRM activities with the coordination among the local and central governments.

7.2.2. Recommendation for surveyors

The MPC templates already have several fields in the spatial layers. When the data is implemented in the data collection phase, the surveyors keep the attributes such as number of floors, building type, roof type, building construction type and number of residence for building layer and parcel value, landuse for a parcel in parcel layer and utilities information in utility layer blank. They think that this information is purposeless. To prepare the cadastre data as MPC, it is necessary to fulfil multiple goals. Therefore, data should be complete and accurate. So, surveyors must fill each and every attribute for every feature of MPC.

7.2.3. Recommendation for DRM managers

Local DRM managers in the local government need awareness about DRM activities and MPC data security. They have a right to data download facility because if they require they can use it for further analysis. It helps in the post disaster situations like re-construction the land rights and parcel boundary by using MPC datasets.

7.3. Recommendation for further research

Some points to be noted for further research from the experience gained are given below:

- This research is conducted only for the partial fulfilment of M. Sc. In Land Administration at ITC. The time was too short, so weak and strong points of the system could not be collected. Therefore the performance should be examined in a long term basis.
- I used limited set of interviews when collecting the users' requirement. Potential users of MPC are numerous. It is necessary to collect the potential users' requirements for the system. The limited number of interviews may not represent the significance numbers of user group. Thus, the users group must be determined among potential users and interviews must collect significant number of persons, which would give more accurate result for users' requirements collections. Future research should be focus on potential use and users of MPC datasets.
- The additional LA activities requirements might be required. The template of ownership certificate, parcel subdivision reports and field book reports are not designed yet due to time frame. Future system must content the template of LA documents.
- QGIS is used to handle spatial part of LA activities such as parcel sub division. Web based parcel sub division system must be developed for the further research.
- In future, users might be extended up to the citizen level and the payment process should be e-banking for LA services.

- The biometric login facility may be developed for system login.
- During the validation of the system by land administrator, they proposed more facilities than designed. They expect parcel subdivision and other spatial operation in the web applications. Therefore, the parcel subdivision and spatial operation handling capabilities in the system need further research.
- During the validation of the system by central and regional disaster managers, they also recommended few facilities. They expect to automate flood simulation system. Therefore, parcel flood simulation handling capabilities system can be added in future research.

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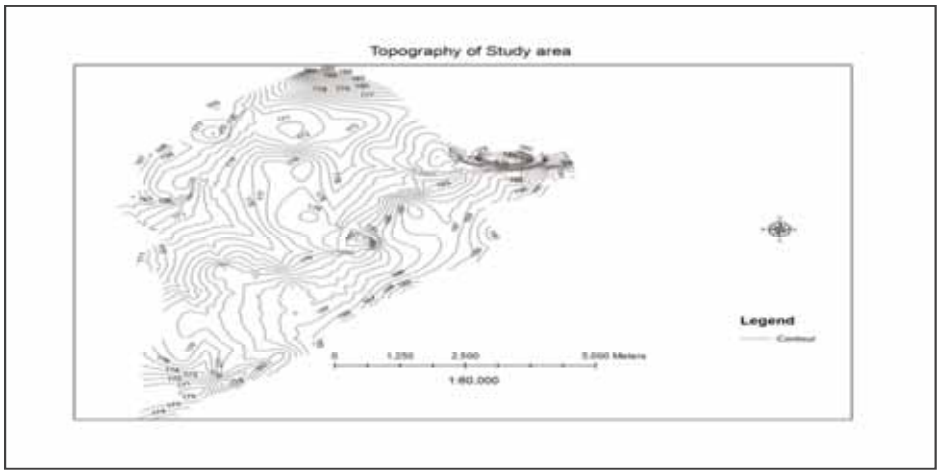
LIST OF ANNEXES

ANNEX 1: Population distributions of Saradanagar and Mangalpur VDC in Chitwan district

Ward Number	Sharadanagar				Mangalpur			
	Male	Female	Total	%	Male	Female	Total	%
1	1182	1155	2337	19.19	929	855	1784	10.26
2	688	756	1444	11.86	863	811	1674	9.63
3	481	482	963	7.91	582	578	1160	6.67
4	439	443	882	7.24	973	916	1889	10.86
5	1110	1035	2145	17.61	1555	1566	3121	17.95
6	222	223	445	3.65	1242	1219	2461	14.15
7	530	541	1071	8.79	611	616	1227	7.06
8	614	626	1240	10.18	1156	1112	2268	13.04
9	844	809	1653	13.57	925	879	1804	10.37
Grant total	**6110**	**6070**	**12180**	**100.00**	**8836**	**8552**	**17388**	**100.00**

Data sources: Saradanagar and Mangalpur VDC, 2010

ANNEX 2: Topography of study area



Data sources: Topographical survey branch, DOS, Nepal, 1990

ANNEX 3: Rainfalls (in mm) for Rampur

Year/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean Rainfall
2000	0.8	9.8	24.9	73	315.8	520.8	558.3	333.2	206.9	6.4	0	0	170.83
2001	1.6	18.6	0.8	67.4	349.9	386.3	644.8	548.2	376.8	28.3	20.4	0	203.59
2002	31.9	28.3	45.6	57.7	391.9	600.9	853.3	303.3	263.7	22.7	44.6	0	220.33
2003	35.1	59.4	62	101	99.9	473.2	930	548.9	292.2	81.1	0	10.7	224.46
2004	62.7	0	0	180.2	111.4	472.5	495.5	214.3	417.7	75.7	12	0	170.17
2005	32.1	6.4	38.9	28.8	133.5	139.9	349.2	671.1	148.6	183.5	0	0	144.33
2006	0	0.1	3	125.9	279.7	387.1	352.3	405.4	362	60.6	2.1	19	166.43
2007	0	80.3	47.6	100.9	131	406.7	497.2	427.4	926.7	120.2	4.6	0	228.55
2008	17.1	1.7	33.8	40.4	118.9	378.6	431.4	458.1	218.7	87.3	0	0	148.83

Source: Department of Hydrology and Meteorology

ANNEX 4: Minimum Temperature in 0C (Rampur Average from 10 years, 2000-2009)

Month/Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
Jan	8.2	7	8.4	7.9	9	9.1	8	7.8	8.5	10	8.39
Feb	8.1	9.9	10.9	10.5	10.3	10.6	14	11.5	7.6	10.1	10.35
Mar	12.1	12.3	14.5	14.2	15.8	15.3	12.8	13.4	14.7	13.3	13.84
Apr	18.4	18.1	19.6	19.6	20.2	17.4	18.5	19.8	18.9	19.2	18.97
May	23.3	23	22.9	21.2	22.6	21.6	23.2	23.1	22.3	22.1	22.53
Jun	25	24.9	24.7	24.3	24.4	24.9	24.6	24.7	25.1	24.8	24.74
Jul	25.4	25.6	25.1	25.4	25.3	25.5	26.2	25.4	25.7	26.4	25.60
Aug	25.5	25.3	25.3	25.6	25.9	25.5	25.5	25.5	25.5	25.7	25.53
Sep	24.1	24.1	23.4	24.8	24.4	25.1	24	24.3	24.3	24.7	24.32
Oct	20.2	20.4	19.3	20.9	18.8	19.9	19.9	21.3	19.7	20.3	20.07
Nov	15.9	14.6	13.9	15.1	13	13	14.6	13.9	13.8	14.2	14.20
Dec	8.1	9.8	9.8	9.2	9.7	8.8	10.5	8.9	12	10.2	9.70

Source: Department of Hydrology and Meteorology.

ANNEX 5: Maximum Temperature in 0C (Rampur, Average from 10 years, 2000-2009)

Month/Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
Jan	22.1	23.2	23.6	20.5	21.3	23.2	23	22.3	22.3	23.4	22.49
Feb	24.6	27.2	27.4	26	26.4	26.3	28.5	24.4	24.3	27.8	26.29
Mar	31.3	33	32	29.6	33.2	32.4	32.4	30	31.4	32.5	31.78
Apr	35.4	36.7	34.3	34.8	33.4	36.2	34.8	35.4	35.8	37.4	35.42
May	34.1	34.6	33.9	35.5	34.9	35.9	35.1	36.4	35.5	35.4	35.13
June	34.2	34.2	35.2	34.2	34.6	36.6	34.7	34.7	33.2	35.1	34.67
July	33.6	33.9	33.4	33.7	33	33.1	34.3	32.5	33.2	33.9	33.46
Aug	33.3	34.4	34.3	33.9	34.5	33	34.7	33.9	32.5	32.6	33.71
Sep	32.9	33	33.4	33.2	33.3	34.5	33.4	32.5	33.1	33.6	33.29
Oct	33.5	32.8	32.4	32.8	31.5	31.5	32.9	32.3	31.3	31.2	32.22
Nov	28.8	29	29.6	29	28.1	28.2	28.5	29.7	28.1	26.9	28.59
Dec	25.3	23.7	24.5	24.7	24.7	25	24.3	24.4	24	23.3	24.39

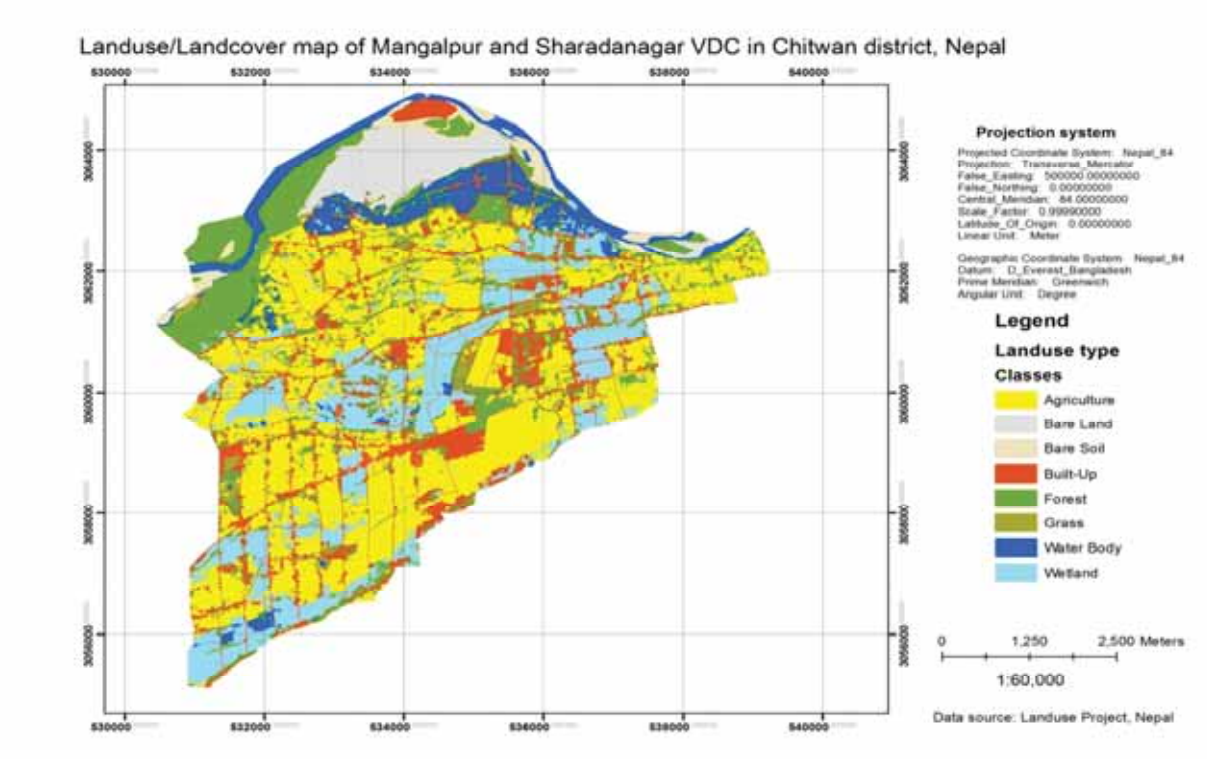
Source: Department of Hydrology and Meteorology.

ANNEX 6: Landuse/ Landover distribution of Saradanagar and Mangalpur VDC

		Saradanagar		Mangalpur	
S. No;	Land cover type	Area (Ha)	%	Area (Ha)	%
1	Agriculture	631.35	44.35	1229.92	42.28
2	Bare Soil	6.65	0.47	103.57	3.56
3	Built-Up	183.12	12.86	346.32	11.90
4	Forest	136.96	9.62	649.5	22.33
5	Grass	17.24	1.21	16.71	0.57
6	Water Body	23.05	1.62	133.21	4.58
7	Wetland	425.31	29.87	429.8	14.77

Data source: Landuse project, Nepal

ANNEX 7: Landuse distribution of study area

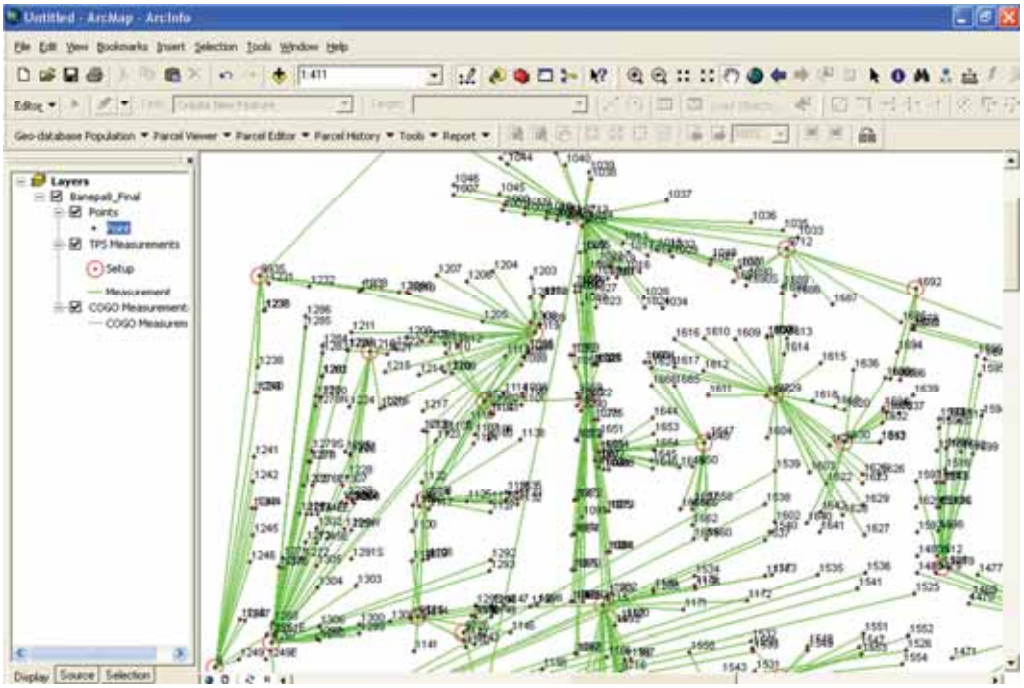


Data source: National Landuse project, Nepal, 2010

ANNEX 8 Notices

Data source: Cadastre office Banepa, 2012

ANNEX 9: Visualization of control points and other details



Data source: Cadastre office Banepa, 2012

ANNEX 10: List of control points from traverse survey

Point ID	Easting	Northing	Height	Remarks
TP7	354182.891	3058250.767	1478.862	Control Point
TP6	354178.226	3058213.968	1476.534	Control Point
TP5	354177.266	3058186.354	1472.294	Control Point
TP4	354175.796	3058154.213	1467.459	Control Point
TP3	354119.966	3058159.577	1465.892	Control Point
TP2	354094.458	3058169.015	1465.401	Control Point
TP1	354078.623	3058198.907	1467.938	Control Point

Data source: Cadastre office Banepa, 2012

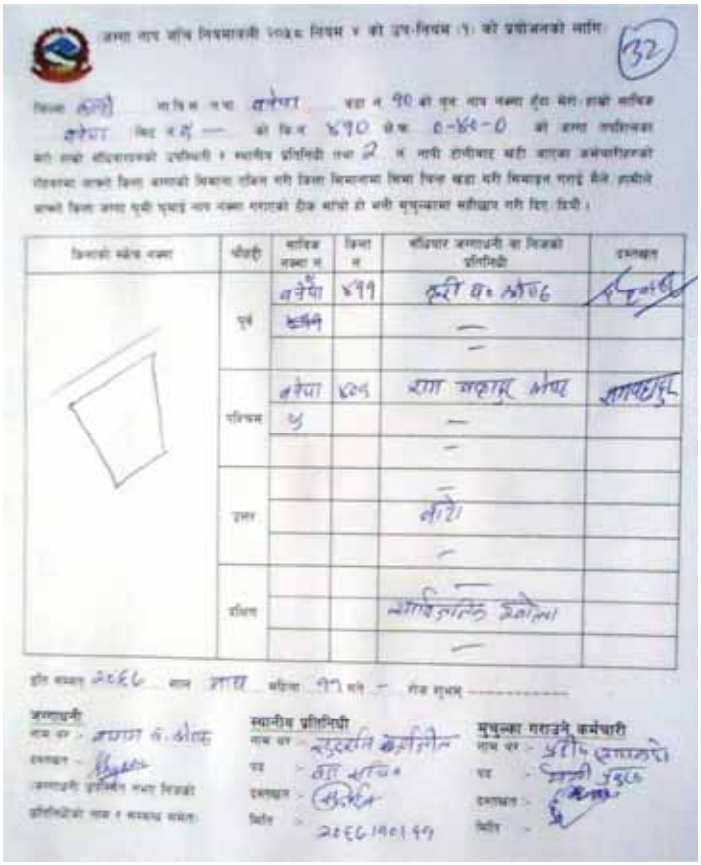
ANNEX 11: Demarcation process photo 1

Data source: Cadastre office Banepa, 2006

ANNEX 12: Demarcation process photos

Data source: Cadastre office Banepa, 2006

ANNEX 13: Adjudication form

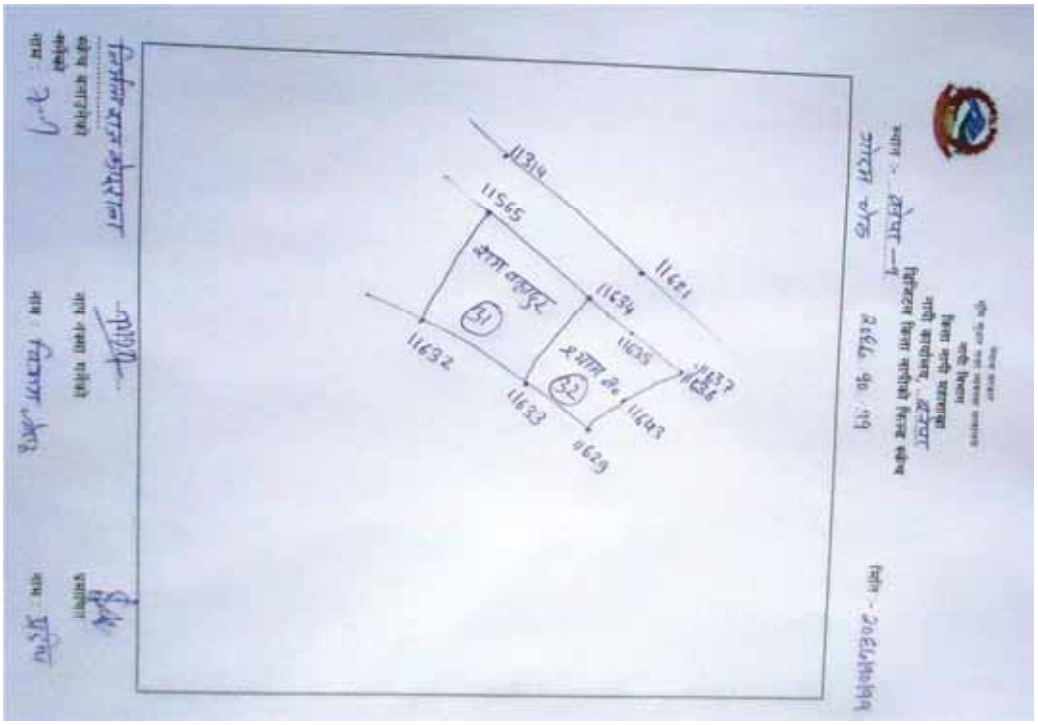


Data source: Cadastre office Banepa, 2012

ANNEX 14: Data acquisition by using Total station

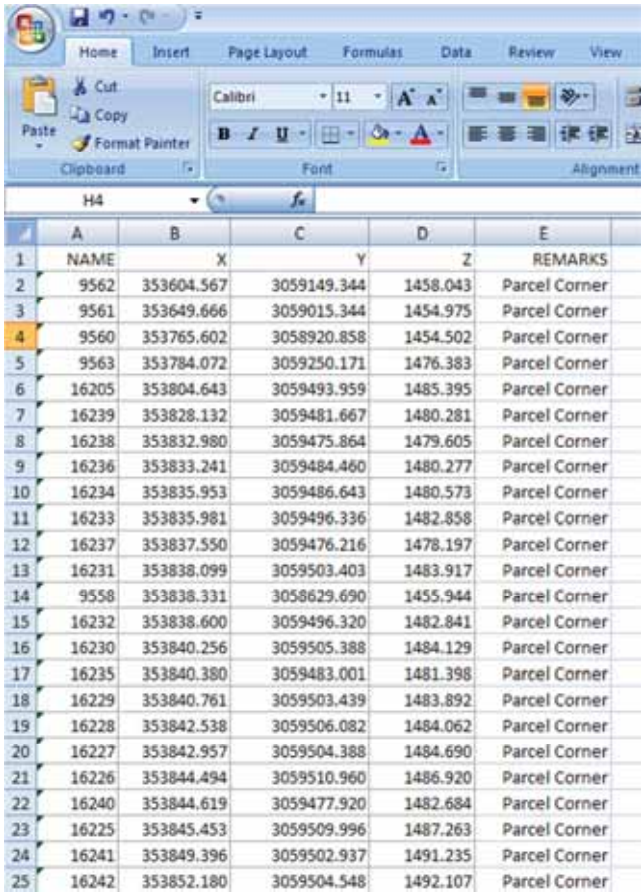
Data source: Cadastre office Banepa, 2006

ANNEX 15: Sketch pad



Data source: Cadastre office Banepa, 2012

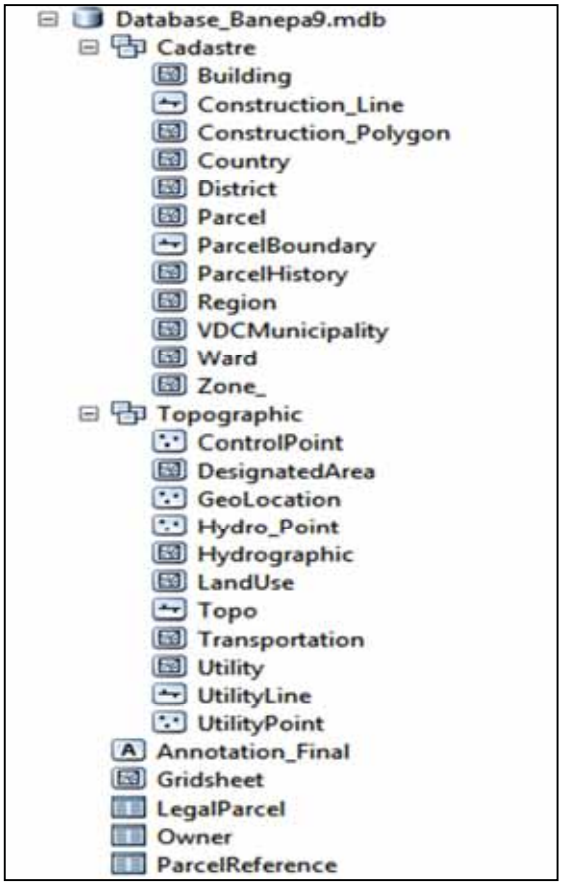
ANNEX 16: Downloaded coordinate list



	A	B	C	D	E
1	NAME	X	Y	Z	REMARKS
2	9562	353604.567	3059149.344	1458.043	Parcel Corner
3	9561	353649.666	3059015.344	1454.975	Parcel Corner
4	9560	353765.602	3058920.858	1454.502	Parcel Corner
5	9563	353784.072	3059250.171	1476.383	Parcel Corner
6	16205	353804.643	3059493.959	1485.395	Parcel Corner
7	16239	353828.132	3059481.667	1480.281	Parcel Corner
8	16238	353832.980	3059475.864	1479.605	Parcel Corner
9	16236	353833.241	3059484.460	1480.277	Parcel Corner
10	16234	353835.953	3059486.643	1480.573	Parcel Corner
11	16233	353835.981	3059496.336	1482.858	Parcel Corner
12	16237	353837.550	3059476.216	1478.197	Parcel Corner
13	16231	353838.099	3059503.403	1483.917	Parcel Corner
14	9558	353838.331	3058629.690	1455.944	Parcel Corner
15	16232	353838.600	3059496.320	1482.841	Parcel Corner
16	16230	353840.256	3059505.388	1484.129	Parcel Corner
17	16235	353840.380	3059483.001	1481.398	Parcel Corner
18	16229	353840.761	3059503.439	1483.892	Parcel Corner
19	16228	353842.538	3059506.082	1484.062	Parcel Corner
20	16227	353842.957	3059504.388	1484.690	Parcel Corner
21	16226	353844.494	3059510.960	1486.920	Parcel Corner
22	16240	353844.619	3059477.920	1482.684	Parcel Corner
23	16225	353845.453	3059509.996	1487.263	Parcel Corner
24	16241	353849.396	3059502.937	1491.235	Parcel Corner
25	16242	353852.180	3059504.548	1492.107	Parcel Corner

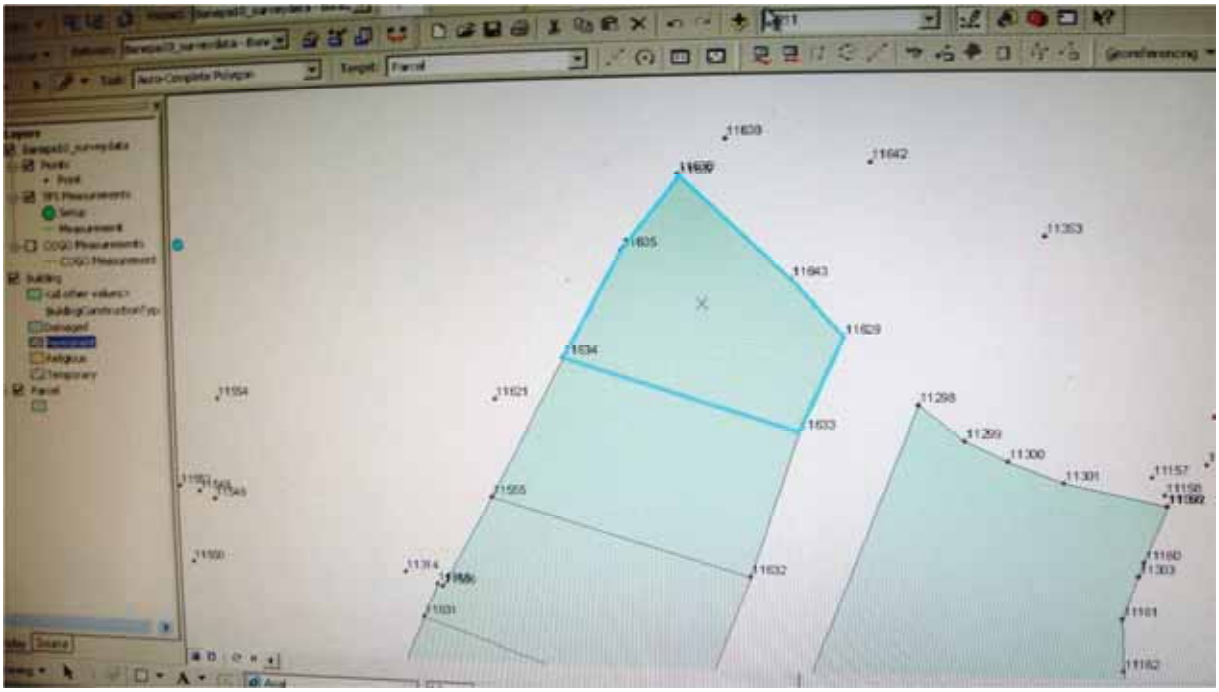
Data source: Cadastre office Banepa, 2012

ANNEX 17: Spatial layers contents in cadastre template



Data source: Cadastre office Banepa, 2012

ANNEX 18: Data preparation



Data source: Cadastre office Banepa, 2012

ANNEX 19: Questionnaire for Land Administration policy makers in Nepal

(Semi structured interview)

Name: Designation:

Organization: □Ministry of Land Reform and management
□Department of Survey Branch
□Topographical Survey Branch
□Geodetic Survey Branch
□Cadastral Survey Branch
□Digital cadastre design and implementation group
□LMTC

Experience in this post:

Questions	Expected results
Q1) What types of data is producing by your organization?	List of data
Q2) Who are the users of Multipurpose Cadastre (MPC)?	List of MPC data users
Q3) What are the use of Multipurpose Cadastre (MPC)?	List of uses of MPC in different sectors
Q4) How many spatial layers are contented in Nepalese Multipurpose Cadastre (MPC)? *(Only for Digital cadastre design and implementation group)*	List of layers
Q5) What types of information can be extracted from Nepalese Multipurpose Cadastre (MPC)? *(Only for Digital cadastre design and implementation group)*	List of attribute information and its uses
Q6) What are the most people's privacy information in Nepalese Multipurpose Cadastre (MPC)?	List of sensitive information
Q7) How can MPC data be easy accessed by the users?	Idea for data sharing mechanism
Q8) How can easily access MPC data for local government?	Idea for data sharing mechanism

ANNEX 20: Questionnaire for Land surveyors in Nepal

(Semi structured interview)

Name: Designation:

Organization: □MPC design and implement working group
□Department of Survey Branch
□Survey office Chitwan
□Geodetic Survey Branch
□Cadastral Survey Branch

Experience in this post:

Questions	Expected results
Q1) What type of data do you work with?	Data type and specifications
Q2) How do you collect data from field observation?	List of methods and process adopted
Q3) What are the steps of data processing to import field data into MPC data sets?	List of methods and process adopted
Q4) How do you store the data in MPC datasets?	List of methods and process adopted
Q5) How do you edit, update and maintain MPC datasets?	List of methods and process adopted
Q6) How many spatial layers and non-spatial tables contents in Nepalese Multipurpose Cadastre (MPC) *(For MPC design and implement working group only)*	List of Layers and tables and its use
Q7) What are the attribute information contents in Nepalese MPC? *(For MPC design and implement working group only)*	List of attribute information
Q8) What are the most people's privacy information in Nepalese Multipurpose Cadastre (MPC)?	List of sensitive information
Q9) What is the current data sharing system for MPC to users?	Idea about system requirements

ANNEX 21: Questionnaire for flood DRM practitioner local and central level

(Semi structured interview)

Name: Designation:

Organization: □Department of Water Induced Disaster Prevention
□Department of Hydrology and Meteorology
□……. VDC, Chitwan
□District Development committee, Chitwan
□Private flood DRM practitioners

Experience in this post:

Questions	Expected results
Q1) Do you do Hazard/ Element are Risk and Risk mapping?	Yes or No
Q2) What data do you use Hazard/ Element are Risk and Risk mapping?	Different data type and sources
Q3) What types of data requires for flood hazard mapping?	List of data and its formats
Q4) What process and method do you adopt for Hazard/ Element are Risk and Risk mapping?	Method and process to preparation of Hazard/ Element are Risk and Risk mapping
Q5) What types Data requires for elements at risk mapping?	List of data and its formats
Q6) What types Data requires for flood disaster risk assessment?	List of data and its formats
Q7) What are the current data sources for flood DRM activities?	List of data sources (Name of data producers)
Q8) Can you get recently updated data for flood DRM activities?	List of Updated data and list of non-updated data sources
Q9) Did you /your organization use Nepalese Multipurpose Cadastre (MPC) data for flood DRM activities?	(Yes/no)
Q10) If Department of Survey (DOS), Nepal provides MPC data, what do you think whether it fulfills your needs for flood DRM activities?	List of data requirements and data available in MPC
Q11) Is it possible to conduct flood DRM activities in client server approach?	Idea for data sharing mechanism

ANNEX 22: Questionnaire for Information Technology related staff
(Semi structured interview)

Name: Designation:

Organization: □Department of Water Induced Disaster Prevention
□Department of Hydrology and Meteorology
□Ministry of Land Reform and Management
□IT section Department of Survey (DOS), Nepal

Experience in this post:

Questions	Expected results
Q1) Which data sharing system do you work with?	Idea about system
Q2) How can DOS share MPC data to users?	Idea about data sharing mechanism
Q3) How can DOS share MPC data to local government?	Idea about data sharing mechanism
Q4) How to maintain data security for sharing MPC to users?	Idea about security and privacy control
Q5) In your opinion what could be the suitable MPC data sharing system for local government?	Idea about system design

ANNEX 23: List of collected interviews

S. No	Name	Post	Organization	Date of Interview	Remarks
1	Khilaraj Chauhan	Survey Officer (Policy Maker) Section chief digital cadastre	Cadastral Survey Branch (Digital Cadastre working group)	1/10/2012	Policy Maker
2	Sanjib Kumar Sah	Survey Officer	Cadastral Survey Branch (Digital Cadastre working group)	1/10/2012	Surveyor
3	Madhav Uprety	Engineer (District level Disaster Manager)	District Development office, Chitwan	3/10/2012	District level Disaster Manager
4	Krishna Jayantee	Engineer (District level Disaster Manager)	District Development office, Chitwan	3/10/2012	District level Disaster Manager
5	Balaram Luitel	Information and communication officer (District level Disaster Manager, Risk communication)	District Development office, Chitwan	3/10/2012	District level Disaster Manager
6	Buddhi prasad Gautam	Secretary (Local level disaster manager)	V.D. C. Office, Mangalpur	4/10/2012	Local level disaster manager
7	Kambhu prasad chaudhary	Secretary (Local level disaster manager)	V.D. C. Office, Meghauli	4/10/2012	Local level disaster manager
8	Kalika prasad ghimire	Secretary (Local level disaster manager)	V.D. C. Office, Saradanagar	5/10/2012	Local level disaster manager
9	Padam prasad dhakal	Secretary (Local level disaster manager)	V.D. C. Office, Gunja nagar	5/10/2012	Local level disaster manager
10	Ram prasad sapkota	Secretary (Local level disaster manager)	V.D. C. Office, Dibyanagar	5/10/2012	Local level disaster manager
11	Janak Raj Joshi	Director (Policy maker)	Ministry of Land Reform and Management	8/10/2012	Policy Maker
12	Lekhnath Dahal	Survey officer	Ministry of Land Reform and Management	8/10/2012	Surveyor
13	Er. Prasant Ghimire	Survey officer	Ministry of Land Reform and Management	8/10/2012	Surveyor
14	Shanti Basnet	Survey officer	Department of Survey, Nepal (Planning section)	9/10/2012	Policy Maker
15	Dwarika Nath Dhital	Survey officer	Topographical Survey Branch (Planning section)	9/10/2012	Policy Maker
16	Nirmal Raj Koirala	Survey officer	Topographical Survey Branch	9/10/2012	Surveyor
17	Tanka Prasad Dahal	Survey officer	Cadastral Survey Branch (Digital Cadastre working group)	10/10/2012	Surveyor
18	Proposal Presentation at LMTC			10/10/2012	
19	Er. Krishna Bahadur Pandey	Engineer (Flood simulation officer)	Department of Water Induce disaster prevention	12/10/2012	Central level disaster manager
20	Sudip Shrestha	Survey officer (Flood Simulation Specialist)	Topographical Survey Branch	12/10/2012	Flood Simulation Specialist
21	Er. Prem Lasiwa	Engineer (Flood simulation and information officer)	Department of Water Induce disaster prevention	14/10/2012	Central level disaster manager
22	Om Mani Pokhrel	Information Technology Officer	Ministry of Land Reform and Management	15/10/2012	IT Professional
23	Ramkumar Sapkota	Survey Officer (IT Section DoLIA)	Ministry of Land Reform and Management	16/10/2012	IT Professional
24	Prof. Dr. Jibraj Pokhrel	Professor	Institute of Engineering, Centre for Disaster Risk management TU, Nepal	19/10/2012	Professor

ANNEX 24: List of secondary data collected

S. No;	Data name	Data source	Date of collection	Status
1	District Disaster Profile of Chitwan	DDC, Chitwan	3/10/2012	Collected
2	Cadastre data	District Survey office, Chitwan	5/10/2012	Collected
3	Land use Data	Land use project, Nepal	17/10/2012	Collected
4	Topographical datasets	Topographical survey branch, Nepal	18/10/2012	Collected
5	Multipurpose Cadastre Template	Survey office, Banepa	19/10/2012	Collected
6	River section, Maximum discharge and Rainfall data	Department of Hydrology and Meteorology, Nepal	21/10/2012	Collected

ANNEX 25Photographs

DRM practitioner



LAND ADMINISTRATOR AND SURVEYOR







ANNEX 26: Summary of semi structured interviews of IT staff within LA organization in Nepal

Summary of semi structured interviews of Information Technology related staff within Land Administration organization in Nepal

S. No.	Name	Post/Role	Address/Organization	Q1) Which data sharing system do you work with?	Q2) How can DOS share MPC data to users?	Q3) How can DOS share MPC data to local government ?	Q4) How to maintain data security for sharing MPC to users?	Q5) In your opinion what could be the suitable MPC data sharing system for local government ?
1	Om Mani Pokhrel	Information Technology Officer	Ministry of Land Reform and Management	Now standalone	Planning to develop 3 tire system	Planning internet based sharing system	Providing strong firewall and defining users	Client sever approach
2	Ramkumar Sapkota	Survey Officer (IT Section DoLIA)	Ministry of Land Reform and Management	Within organization using LAN	Planning central server and district office as client	Planning internet based sharing system	Highly defined security with users	Client sever approach

ANNEX 27: Summary of semi structured interviews of Land surveyors' in Nepal

Summary of semi structured interviews of Land surveyors' in Nepal

S. No.	Name	Post/Role	Address/Organization	Q1) What type of data do you work with?	Q2) How do you collect data from field observation?	Q3) What are the steps of data processing to import field data into MPC data sets?	Q4) How do you store the data in MPC datasets?	Q5) How do you edit, update and maintain MPC datasets?	Q6) How many spatial layers and non-spatial tables contains in Nepalese Multipurpose Cadastre (MPC) *(For MPC design and implement working group only)*	Q7) What are the attribute information contains in Nepalese MPC? *(For MPC design and implement working group only)*	Q8) What are the most people's privacy information in Nepalese Multipurpose Cadastre (MPC)?	Q9) What is the current data sharing system for MPC to users?
1	Sanjib Kumar Sah	Survey Officer	Cadastral Survey Branch (Digital Cadastre working group)	All are vector based related to land owner, rights and parcel mainly. As second task we prepare topographical large scale datasets	First we collect points data by using total station from field with good drawing sketch in the field and entry to database	First surveyor collect point data and sketch from the field and surveyor entry information in attribute table of corresponding feature class in a readymade cadastral database template.	DOS have a standard database template surveyor store data in the template database for maintain quality and standard of DOS service	Data entry persons uses Arc GIS software in a LAN so responsible persons can edit from them after all Survey office use standalone system	See parcel editor reports of DOS. Basically topographical and cadastre data sets and non-spatial tables owner and tenants are in that datasets. In topographical datasets it contains contours, spot heights, Land use, utility line, points and area, hydro line and area, cadastre data sets contains building and parcel.	See the parcel editor report of DOS for more information. At designing phase all of possible field were added but in real practice parcel and building data are created even that land value put blanks and in building layer surveyors did not fill all attribute like structure type, number of story etc. In real practice surveyors cannot get all topographical information from MPC but according to the design survey office must do it.	Boundary and owner information	Standalone
2	Lakhnath Dahal	Survey officer	Ministry of Land Reform and Management	All data are vector format basically survey offices focus on parcel and building	Points, sketch and other information collected from field by using Total station and output as ENZ point format	From point data and sketch surveyors prepare features in corresponding spatial layers in MPC template	Dos designed a MPC data template surveyors uses that to store in a personal geodatabase having 2 data sets and some no spatial attribute tables	By using Arc GIS software and performing ordinary operation	Topographical datasets, cadastre datasets and non-spatial tables as per standard cadastre template	If you want to see more information please See the parcel editor report of DOS.	Boundary of parcel	Standalone
3	Er. Prasant Ghimire	Survey officer	Ministry of Land Reform and Management	Parcel, building and other topographical datasets	Point coordinate with field sketch	Digitization features from point coordinate and sketch in cadastral template	Store in a standard personal geodatabase MPC template designed by DOS	By using Arc GIS software and parcel editor application for DOS	N/A	N/A	Owner information	Standalone
4	Nirmal Raj Koirala	Survey officer	Topographical Survey Branch	Parcel, building and other topographical datasets	First surveyors collects points from field with good drawing sketch and entry those data to MPC database template	First surveyors collect point data and sketch and we entry information in attribute table of corresponding feature class in a readymade cadastral database template.	Store in a standard personal geodatabase template designed by DOS	I don't have edit and maintenance idea *(This person only deal with topographic data.)*	N/A	N/A	Boundary and owner information	Standalone
5	Tanka Prasad Dahal	Survey officer	Cadastral Survey Branch (Digital Cadastre working group)	Parcel, building and other topographical datasets	Points, sketch and other information collected from field by using Total station with XYZ point coordinate format	First surveyors collects point data and sketch and data entry person entry information in attribute table of corresponding feature class in a readymade cadastral database template.	In a standard database template	By using Arc GIS and parcel editor application for DOS	See parcel editor reports of DOS. Basically topographical and cadastre data sets and non-spatial tables owner and tenants are there. In topographical datasets it contains contours, spot heights, Land use, utility line, points and area, hydro line and area, cadastre data sets contains building and parcel.	At designing phase all of possible field were added but in real practice parcel and building data are created even that land value kept blanks and in building layer surveyors didnot fill all attribute like structure type, number of story etc. In data preparation phase in real practice survey offices cannot get all topographical information from MPC but according to the design survey office must do it.	Boundary and owner information	Standalone

ANNEX 28: Summary of semi structured interviews of Land Administration Policy makers in Nepal

Summary of semi structured interviews of Land Administration Policy makers in Nepal

S. No	Name	Post/Role	Address/Organization	Q1) What types of data is producing by your organization?	Q2) Who are the users of Multipurpose Cadastre (MPC)?	Q3) What are the use of Multipurpose Cadastre (MPC)?	Q4) How many spatial layers are contained in Nepalese Multipurpose Cadastre (MPC)? *(Only for Digital cadastre design and implementation group)*	Q5) What types of information can be extracted from Nepalese Multipurpose Cadastre (MPC)? *(Only for Digital cadastre design and implementation group)*	Q6) What are the most people's privacy information in Nepalese Multipurpose Cadastre (MPC)?	Q7) How can MPC data be easy accessed by the users?	Q8) How can easily access MPC data for local government?
1	Khilaraj Chauhan	Survey Officer (Policy Maker) Section chief digital cadastre unit	Cadastral Survey Branch (Digital Cadastre working group)	Topographical base map, control points, Ortho photographs, cadastral data sets, land use maps and other thematic data sets	Planners, Water board, Electricity authority, Local government, (Maximum participation are useful for cost sharing)	Planning purpose, taxation, Infrastructure construction and development, other development activities	See parcel editor reports of DOS. Basically topographical and cadastre data sets and non-spatial tables owner and tenants are there. In topographical datasets it contains contours, spot heights, Land use, utility line, points and area, hydro line and area, cadastre data sets contains building and parcel.	At designing phase all of possible field were added but in real practice parcel and building data are created even that land value kept blanks and in building layer surveyors didnot fill all attribute like structure type, number of stay etc. In real practice survey office cannot provide all topographical information from MPC but according to the design survey office must do it.	Land owner and mortgage information and sometime parcel boundary may play sensitive case in Nepalese case	Nowadays survey office, have standalone system people have to come to office and made a request what they want.	Nowadays we have standalone system so they have to come to office and made a request what they want. Near future survey office planning to upgrade system in to three tire system as client server approach.
2	Janak Raj Joshi	Director (Policy maker)	Ministry of Land Reform and Management	Land related data, cadastre data, land tenure related data, Land use data in VDC level, and other thematic data sets	DoR, Peoples, water board, irrigation board, Bank, Local government and planners and researchers	Disaster management, Planning, food security, spatial planning and management and other development activities	N/A	N/A	Sometime parcel boundary may play sensitive case in Nepalese case. May solve in digital system depends upon security of system. Admin : overall interfere Edit: Edit spatial and non-spatial part Others : depends upon purpose	Due to energy problem planning offline update at end of the day and online may also sustainable system. Nowadays standalone system	Web based three tire system payment systems planning to design with collaboration with financial organization. Need to define the users for security purpose
3	Shanti Basnet	Survey officer	Department of Survey, Nepal (Planning section)	Topographic map, Digital layers of topographical sets. Control points, cadastre data sets	Public, Local government, planners and managers of different geo related sectors	development activities, taxation, etc.;	N/A	N/A	Owners, valuation and boundary	Now standalone system. Need client server application	Web based application required Users must be define as their purpose and responsibility
4	Dwarika Nath Dhital	Survey officer	Topographical Survey Branch (Planning section)	You can get information from our web site www.dos.gov.np you will get there. More about digital data go to web site of NGIIP http://www.ngiip.gov.np/publications/topographical.php and its price. "Geodetic Control Data, Aerial Photographs, Topographical Base Maps, Terai and Middle Mountain at the scale of 1:25000, High hills and Himalayas at the scale of 1:50000, Land Resources Maps, Administrative and Physiological Maps, Maps of VDC/Municipalities, District, Zone & Developement region, Digital Topographic Data, Cadastral Plans, Ortho photo Maps, Soil Data and Cadastre datasets in district survey offices"	Ministries, Central and regional government, Local governments and publics, Financials and development related organizations	Disaster management, Planning, food security, spatial planning and management and other development activities and much more in engineering and designing works.	N/A	N/A	Owner information and parcel boundary	Networks with full security. 3 Tire system required	Networks with full security. 3 Tire system required

ANNEX 29: Summarized interviews of flood DRM practitioner at central level in Nepal

Summary of semi structured interviews of flood DRM practitioner at regional and central level in Nepal

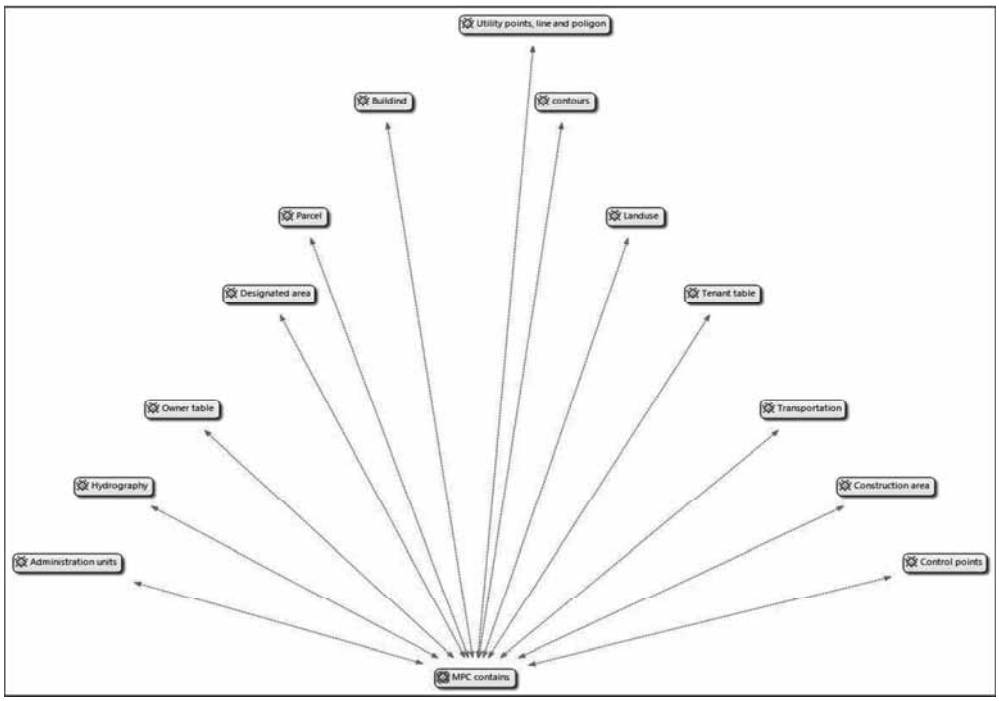
S.No.	Name	Post/Role	Address/Organization	Q1) Do you do Hazard/ Element are Risk and Risk mapping?	Q2) What data do you use Hazard/ Element are Risk and Risk mapping?	Q3) What types of data requires for flood hazard mapping?	Q4) What process and method do you adopt for Hazard/ Element are Risk and Risk mapping?	Q5) What types Data requires for elements at risk mapping?	Q6) What types Data requires for flood disaster risk assessment?	Q7) What are the current data sources for flood DRM activities?	Q8) Can you get recently updated data for flood DRM activities?	Q9) Did you /your organization use Nepalese Multipurpose Cadastre (MPC) data for flood DRM activities?	Q10) If Department of Survey (DOS), Nepal provides MPC data, what do you think whether it fulfills your needs for flood DRM activities?	Q11) Is it possible to conduct flood DRM activities in client server approach?
1	Madhav Uprety	Engineer (District level Disaster Manager)	District Development office, Chitwan	Yes, I started flood simulation process with technical support of DWDIP.	DDC collected topographic data from DOS and river data from DHM	DEM, DSM, (Elevation information), river discharge, Rainfall data, river section, Land use for surface roughness for simulation for any flood modeling	For hazard by running the flood simulation model and for others overlay operation of GIS function with hazard	Hazard information and Parcel and building	Hazard, Vulnerability mapping if possible otherwise element at hazardous zone and its worth (value)	ICIMOD, DWDIP, DHM and DOS	DOS don't have updated topographical datasets	No	Partially yes, river discharge data, rainfall data cannot provide DOS	Need to simulate for hazard zoning map so possible after simulation
2	Krishna Jayantee	Engineer (District level Disaster Manager)	District Development office, Chitwan	Yes, DDC started flood simulation process with collaboration with DWDIP	Topographic data set from DOS and river data from DHM	DSM, Land use and river maximum discharge and section and surface roughness mining value by using land use	For hazard simulation model running and for others overlay operation of GIS function	Hazard information and exposer Elements	Hazard, element at hazardous zone and its worth	ICIMOD, DWDIP, DHM and DOS	DOS don't have updated topographical datasets but DHM have updated information	No, Partially fulfill. Except rainfall data, river discharge data.	Partially yes. Needs some information from DWDIP and DHM	yes
3	Balaram Luitel	Information and communication officer (District level Disaster Manager, Risk communication)	District Development office, Chitwan	Yes, I started flood simulation process with collaboration with DWDIP and data support from DOS	Topographic data set from dos and river data from DHM	Contours, roads, , river discharge, Rainfall data, river section, Land use for surface roughness to simulation for any flood model	For flood simulation model running and for others overlay operation of GIS function	Hazard and exposer	Hazard, Vulnerability mapping if possible otherwise element at hazardous zone and price of every element	ICIMOD, DWDIP, DHM and DOS	DOS have 1980 topographical datasets	No, may be updated and useful	Partially, From DOS DDC can get topographical datasets but remaining required data have to depend on DHM	Yes with simulation result
4	Er. Krishna Bahadur Pandey	Engineer (Flood simulation officer)	Department of Water Induce disaster prevention	Yes technical supported by DWDIP and data support from DOS	DDC collected topographic data from DOS and river data from DHM	DEM, DSM, (Elevation information), river discharge, Rainfall data, river section, Land use for surface roughness for simulation for any flood model	For hazard simulation model running and for others overlay operation of GIS function	Parcel, building with number of residence and hazard zoning map	Hazard, Vulnerability mapping if possible otherwise element at hazardous zone and its worth and coping capacity	ICIMOD, DWDIP, DHM and DOS	DOS don't have updated topographical datasets	No, may be updated and useful	Partially, From DOS DDC can get topographical datasets but remaining required data have to depend on DHM	Yes after flood simulation
5	Sudip Shrestha	Survey officer (Flood Simulation Specialist)	Topographical Survey Branch	DOS provide technical support for central, regional and local government	We only support and development for simulation process and I use data from DOS and river data from DHM	DSM, Land use and river maximum discharge and section and surface roughness mining value by using land use	For hazard simulation model running and for others overlay operation of GIS function	Hazard and Elements	Hazard, Vulnerability mapping if possible otherwise element at hazardous zone and its worth, coping capacity details element characters means strength of building	ICIMOD, DWDIP, DHM and DOS	We are using 1980s topographical datasets for any types of analysis	No, may be updated and useful and there exist parcel and building information that are also useful for Ear and Risk assessments	No needs more additional data from other organization	Yes web based application with classified hazard zone
6	Er. Prem Lamsal	Engineer (Flood simulation and information officer)	Department of Water Induce disaster prevention	Yes we do	We use data from DOS and DHM	Height information, Land use, River conditions and section data and maximum water flow	For hazard simulation model running and for others overlay operation of GIS function	Hazard and exposer information	Hazard, Vulnerability mapping if possible otherwise element at hazardous zone and its worth and coping capacity	ICIMOD, DWDIP, DHM and DOS	No we are using old data	No, may be updated and useful	It depends upon the collaboration between organization	Yes of course

ANNEX 30: Summary of semi structured interviews of flood DRM practitioner at local level in Nepal

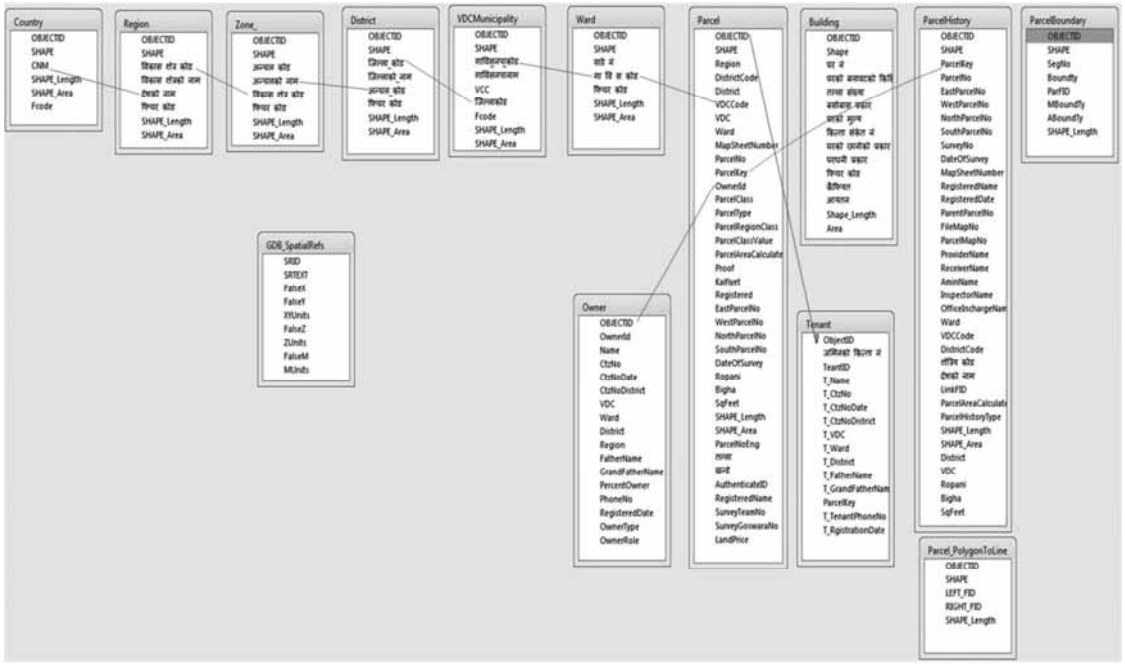
Summary of semi structured interviews of flood DRM practitioner at local level in Nepal

S.No.	Name	Post/Role	Address/Organization	Q1) Do you do Hazard/ Element are Risk and Risk mapping?	Q2) What data do you use Hazard/ Element are Risk and Risk mapping?	Q3) What types of data requires for flood hazard mapping?	Q4) What process and method do you adopt for Hazard/ Element are Risk and Risk mapping?	Q5) What types Data requires for elements at risk mapping?	Q6) What types Data requires for flood disaster risk assessment?	Q7) What are the current data sources for flood DRM activities?	Q8) Can you get recently updated data for flood DRM activities?	Q9) Did you /your organization use Nepalese Multipurpose Cadastre (MPC) data for flood DRM activities?	Q10) If Department of Survey (DOS), Nepal provides MPC data, what do you think whether it fulfills your needs for flood DRM activities?	Q11) Is it possible to conduct flood DRM activities in client server approach?
1	Buddhi prasad Gautam	Secretary (Local level disaster manager)	V.D.C. Office, Manglapur	No, VDC doesn't do it. DWIDP prepare it. DDC prepare some information by collaboration with international donor. VDC prepare some risk zoning map by using peoples participatory approach in real practice VDC office are using it.	People's perception approach. No more accurate but useable in to get tentative information about risk	VDC don't prepare map. We have prepared descriptive version of hazard information in different wards of VDC. Need scientific way of flood simulation map. Need to ask Engineers in DDC.	VDC uses some information what collected from DDC. Need to ask Engineers in DDC.	VDC have descriptive information at ward level. It is the intersection of risk zone and elements say house.	Need to ask DDC Engineers but we have participatory approach of hazard map.	DDC, International donor, DWIDP They provided readymade information.	No, VDC using 5 years old information	No	It depends upon the DDC Engineers	No idea about core knowledge about information technology, but I can suffer in internet
2	Kambhu prasad chaudhary	Secretary (Local level disaster manager)	V.D.C. Office, Meghauli	DDC prepare some information by collaboration with international donor.	Public perception on flood map (participatory GIS method) using nowadays	VDC don't have simulation result but we have some sketch about flood. Need to ask Engineers in DDC.	Need to ask Flood simulation specialist at DDC	VDC have descriptive version of element at ward level which is prepared by DDC before 5 years	DDC provided information. Other part no idea	DDC	No, VDC using 5 years old information	May be from DDC side	Depends upon map makers in DDC level	Yes, most of the country using web based application
3	Kalika prasad ghimire	Secretary (Local level disaster manager)	V.D.C. Office, Sarodanagar	No we don't do it. DWIDP prepare it for our information.	No more accurate maps what DDC have.	Need to ask Engineers in DDC.	No idea. Simulation engineers do that	Peoples are using descriptive version of element at ward level which is prepared by DDC before 5 years	Need to ask DDC Engineers but we have participatory approach of hazard map.	DWIDP provides to DDC	No VDC using 5 years old VDC report	No	Depends upon requirement for mapping purpose in DDC	No idea about core IT system. I know email and internets
4	Padam prasad dhakal	Secretary (Local level disaster manager)	V.D.C. Office, Genja nagar	We have descriptive risk information from DDC	We use simple people's perception on flood survey at VDC level and make a VDC disaster profile with collaboration with DDC	No idea	I don't have idea but I am using some information prepared by DDC.	We have district disaster profile at VDC level DDC did it	No idea	Donor and DWIDP made that before 5 yrs.	No, I am using 5 years old information	No	It depends upon purpose	Web GIS may useful
5	Ram prasad sapkota	Secretary (Local level disaster manager)	V.D.C. Office, Dibyanagar	I am using old reports and district disaster profile for VDC level	No idea	No idea	No idea	No idea	No idea	No idea	No, VDC office have 5 years old profile	May be Donor using	No idea	Internet based system may useful

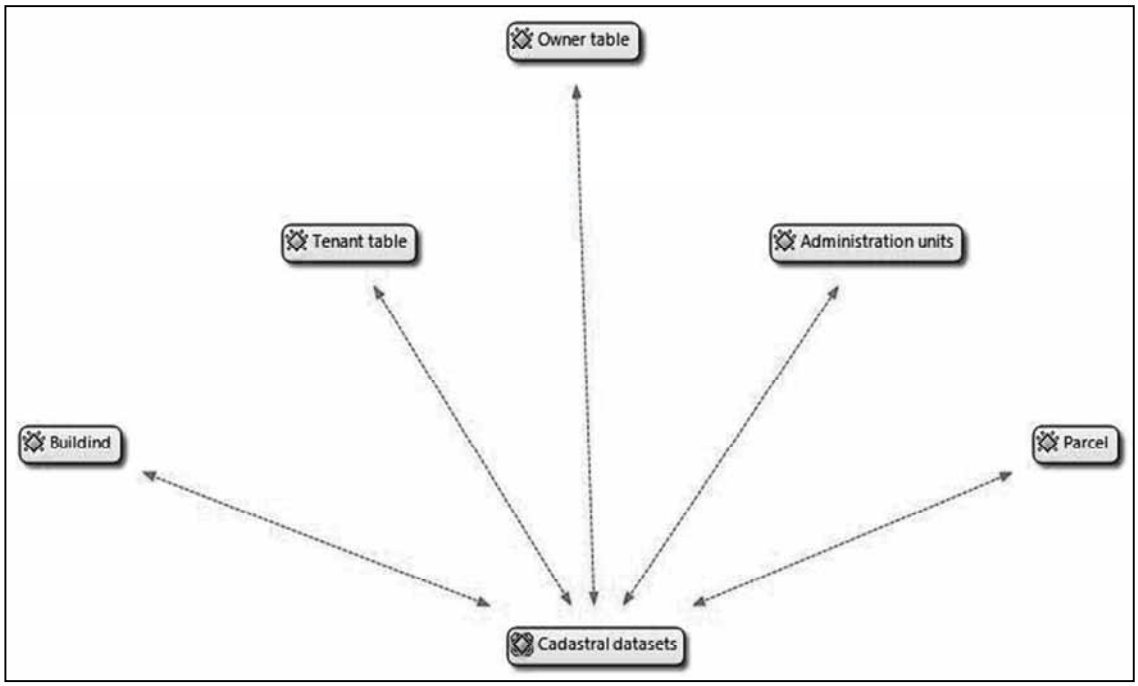
ANNEX: 31 MPC data contents



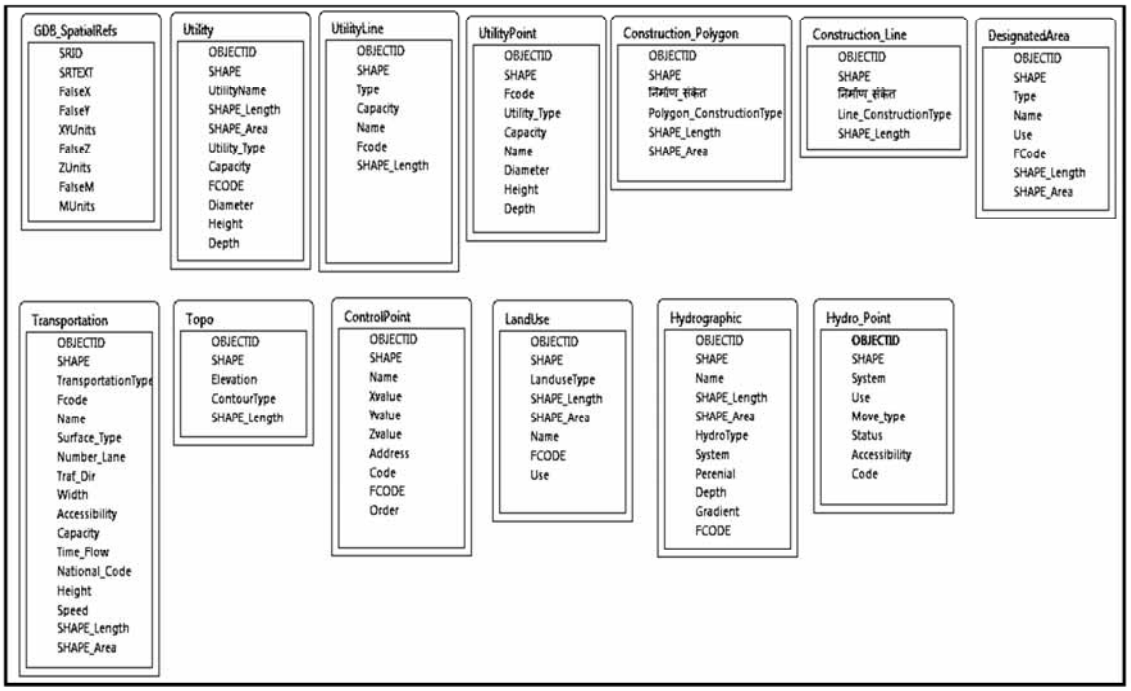
ANNEX 32: Class-diagram of cadastre datasets of existing MPC extracted by using MS Access



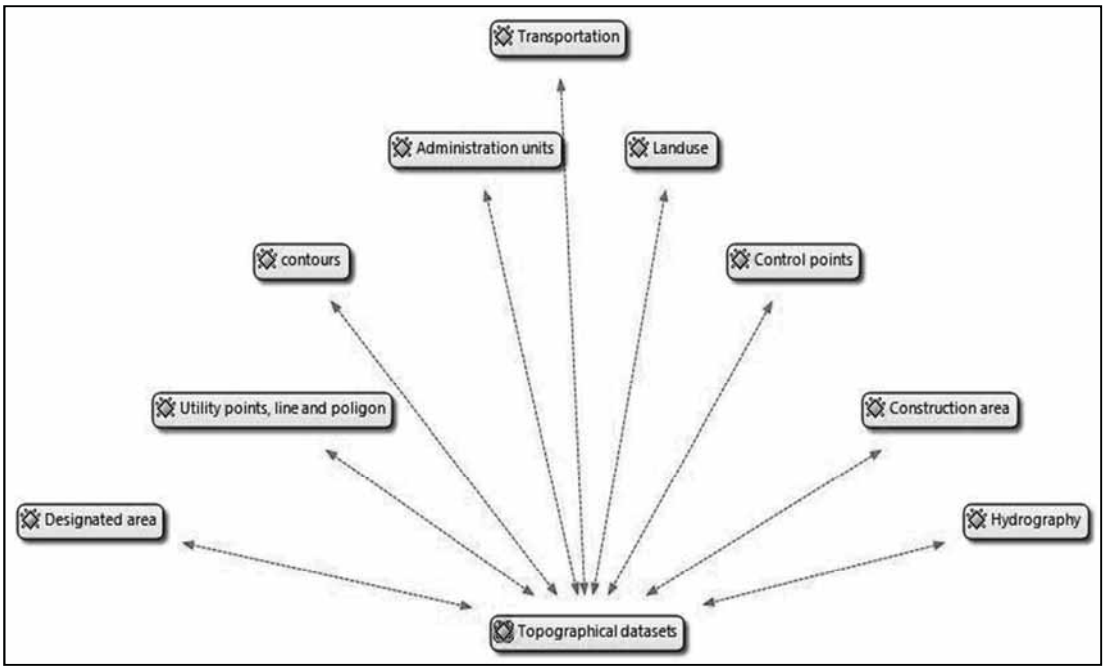
ANNEX 33: MPC cadastre dataset component diagram by using ATLAS-TI



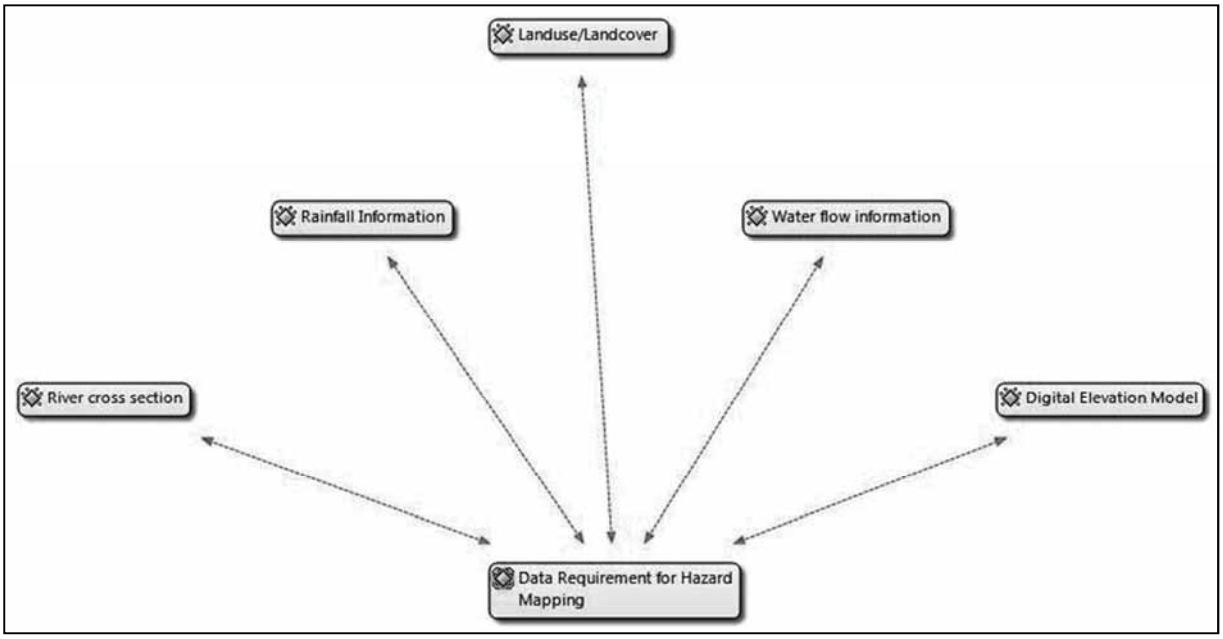
ANNEX 34: Existing MPC class diagram for topographical datasets extracted by using MS Access



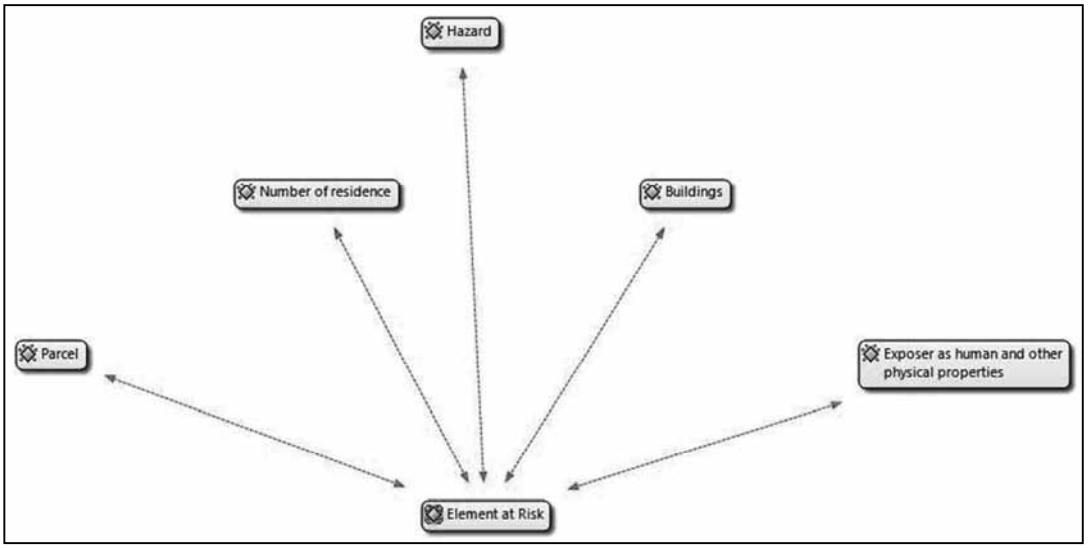
ANNEX 35: MPC topographical datasets component diagram by using ATLAS-TI



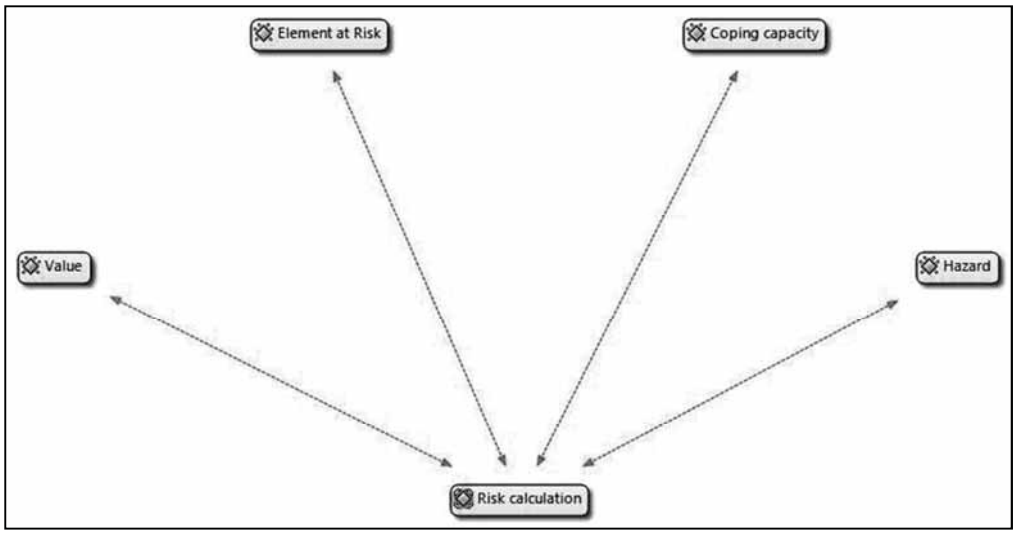
ANNEX 36: Data requirements for hazard mapping



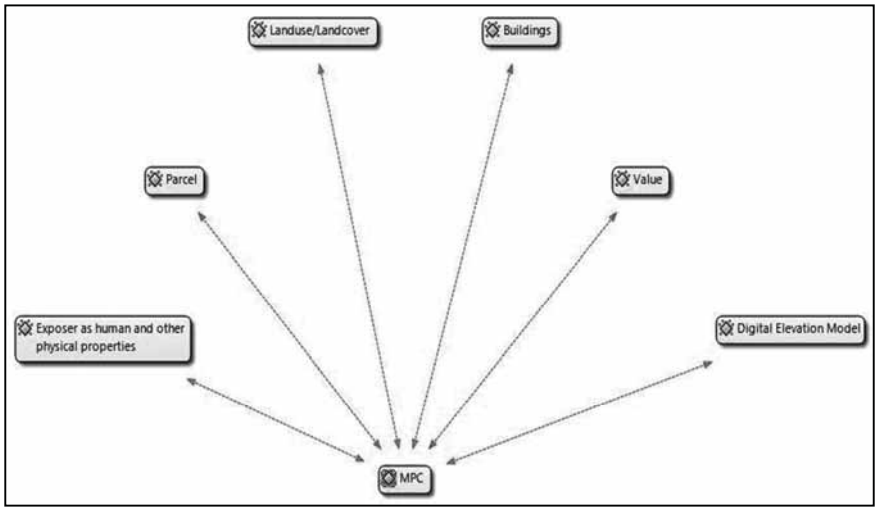
ANNEX 37: Data requirements for element at risk mapping



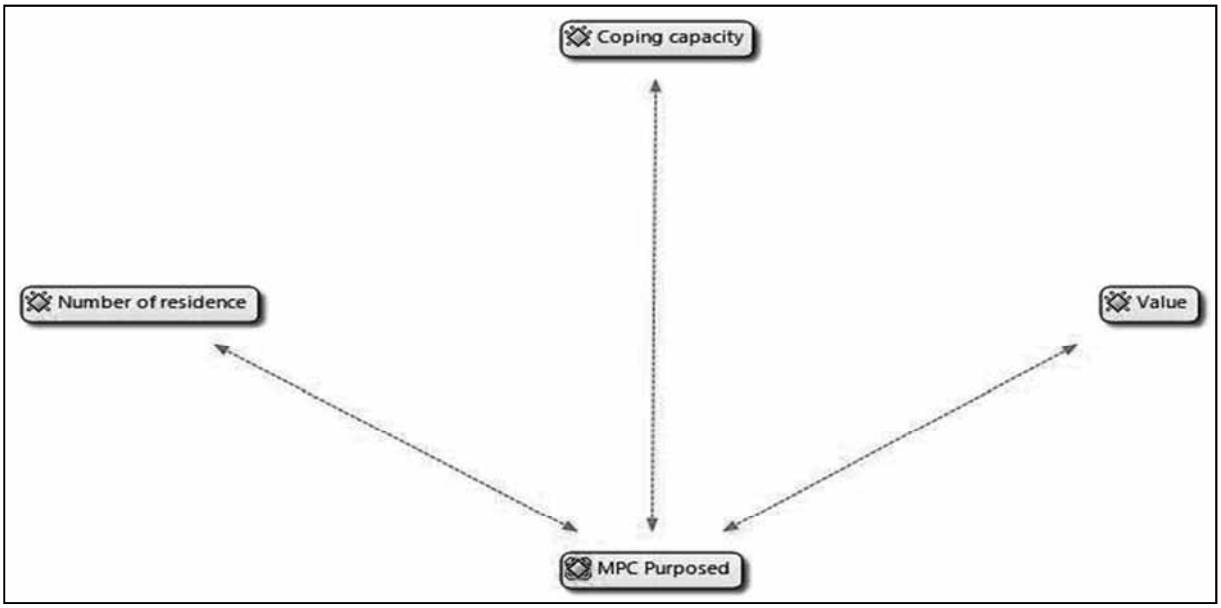
ANNEX 38: Data requirements for risk information



ANNEX 39: Data can be extracted from existing MPC for data requirement for DRM activities



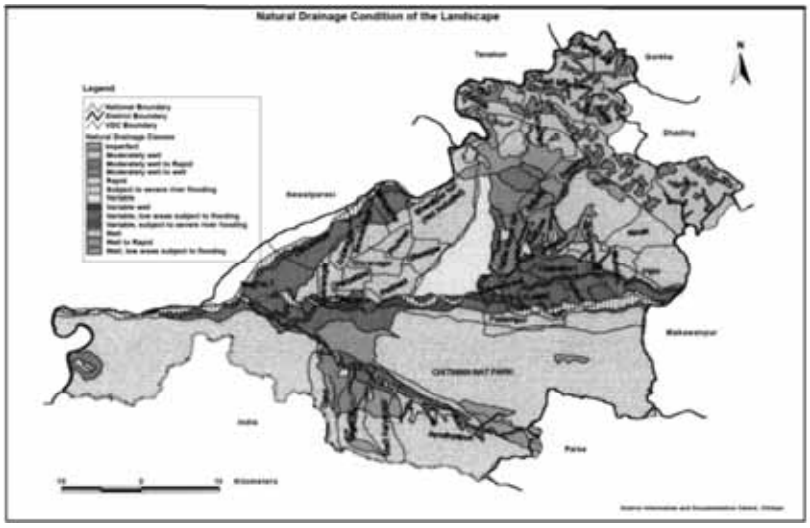
ANNEX 40: Need to add in existing MPC for DRM activities



ANNEX 41: List of experts for validation purpose

S. No;	Name	Organization
1.	Mr. Damodar Wagle	District survey office, Chitwan Survey officer (Chief)
2.	Mr. Khil Raj Chauhan	Cadastral survey Branch, DOS Survey officer
3.	Er. Prem Lasiwa	Engineer, Department of Water Induce disaster prevention Flood simulation and information officer
4.	Er. Madhav Uprety	DDC, Chitwan

ANNEX 42: Hazard map used in VDC



Data source: DDC, Chitwan