The Usage of Geo-information and Technology in Disaster Management by Sub National Level Organizations Case Study - Ratnapura in Sri Lanka

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by

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This document describes work undertaken as part of a programme of study at the International Institute for Geo-information Science and Earth Observation. All views and opinions expressed therein remain the sole responsibility of the author, and do not necessarily represent those of the institute.
Dedication

To

My parents with love and gratitude

“Who encourage me to knowledge”
Abstract

Sri Lanka is exposed to risk by various natural hazards such as Tsunamis, floods, landslides, droughts, wind storms, soil erosion and land degradation. Ratnapura is one of the most vulnerable cities in the Sri Lanka, and frequently suffers from landslides and flood hazards. Although government has taken several initiatives to reduce vulnerability of the city, the problems still persist to continue.

This research is focused on the extent of geo-information and technology usage by sub national level organizations in disaster management. Further more, it explores the adoption of geo-information technology from past Sri Lanka Urban Multi Hazard Disaster Management Project (SLUMDMP).

The study is also concerned on factors that limit the usage of geo-information and technology in these organizations. The actual usage of geo-information and technology is influenced by theses factors. The current situation of geo-information and technology usage seemed to be very limited and local knowledge is highly valued than technology.

Through the analysis and interpretation the number of factors could be identified which creates the gap between actual and potential usage. And also SLUMDMP project efforts seemed to be unpopular. The recommendations are generated for better balance between technical and social requirements.
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1. Introduction

1.1. Background

Natural disasters are inevitable. Although the intensity and magnitude change, almost all countries in the world face with natural disasters (Mohanty, 2006). The threats of natural disasters have presented disruption of human lives, properties, infrastructure, economy, capital investment and development process. Different nations in the world have been paying necessary attention to avoid impacts of natural disasters (Abdulharis et al., 2005). The success of the disaster management depends to great extent on decision taken on information at the right time, right place in right format (Kohler, 2005).

The geo-information and technology can play a vital role in decision making and also important to increase transparency of decisions and it contribute to better governance (Montoya, 2002). “About 80% of daily decisions on national level, either in economy, finances/taxation, demography, spatial planning, environment, hazard areas, infrastructure, housing, cultural heritage, etc are spatially or geo-referenced”(FIG, 2006). That demonstrates clearly, geo-information (location) is central pillar of each country and economy.

The use of Geo information and technology has increased rapidly in strengthening the disaster management. According to (Kohler, 2005), geo-information provide an enormous variety of information that can be used in the context of disaster management. Geo-information products such as thematic maps, GIS based hazard maps (Mansourian et al., 2004), land use maps, satellite images (Montoya, 2002; Peiris N and Free, 2005; Stoimenov et al., 2005), aerial photographs (Frantzova et al., 2005; Stoimenov et al., 2005) play a role in all phases in disaster management. GIS is used as a tool to integrate thematic maps in computer background. With the development of the information technology increase of storage and processing capacity, increasing net working actors and resources via internet and effective communication channels facilitate better performance in disaster management (Kohler, 2005). GIS has become underpinning technology for spatial data infrastructure (SDI) and role in facilitating decision making based on spatial data processing and analysis. Web based GIS has high interaction between decision makers in disaster management communities (Abdulharis et al., 2005).

Kohler (2005) notes “Embedding in effective organization, coordination structures, application-oriented methods, data, information and technologies are required for decision making in operational disaster management (mitigation, preparedness, response, recovery)”. If the geo-information and technology play an effective role in disaster management, advantages gained from that depends upon how far organizations make use of geo-information of technology on the context of disaster management. According to the literature, the usage is depend upon factors relevant to organizational, data, man power, technology, political, financial and sustenance approach.

1.2. Disaster Management in Sri Lanka

Sri Lanka is often faced with natural disasters such as flood, land slides, cyclones, droughts and storms during passed few decades. Prior to the Tsunami in Dec 2004, the ministry of Women’s Empowerment and Social Welfare was the national level ministry for Disaster Risk Management
(ADPC, 2000). Sri Lanka Disaster Management Act no.13 of 2005 was enacted in May 2005. The National Council for Disaster Management (NCDM) under the President and Disaster Management Centre (DMC) was established with the Act as the leading agencies for Disaster Management.

With the establishment of responsible agencies and acts, the Sri Lankan government has begun to pay more attention on Disaster Management. As a result of that, more geo-information and technology such as multi hazard base maps creating, data base creations, web maps and disaster resource network have been incorporated in the proactive to use in disaster management by the DMC. DMC has prepared road map which includes more than 100 projects to implement in next 10 years (MDMHR, 2006). As other less developed countries, Sri Lanka is in the initial stage of adoption geo-information for in disaster management although new world trends to web GIS, real time warning system, satellite earth observations for rapid damage assessment, data standard, data quality, data management systems and highly advanced technologies that could be used for disaster management activities.

Although the Government of Sri Lanka has taken initiatives to minimize damages from natural disasters, but still mitigation is not at a satisfactory level (Jayawardane, 2007). In general disaster management efforts were mostly limited to relief and rescue phases rather than mitigation.

1.3. Disaster Management in Ratnapura

Ratnapura is one of the two administrative districts in the Sabaragamuwa Province in Sri Lanka. The town of Ratnapura is an urban growth centre subject to landslides, frequent flooding, soil erosion, pollution and contamination of water supplies, land subsidence, and other hazards. Geographical situation affects Ratnapura to face with frequent natural hazards and this cause high potential of using geo information in disaster management. In the past years, Ratnapura faced with flood and landslides series and caused loss of lives and property. Unplanned development, improper land use, lack of implementation of regulations and unplanned depletion of forest cover are caused to increase natural disasters (Jayawardane, 2007).

Sri Lankan government has taken several initiatives to develop disaster management in the Ratnapura area. Sri Lanka Urban Multi Hazard Mitigation Project (SLUMDMP) was implemented in Ratnapura as pilot project from 1997 to 2000. SLUMDMP demonstrated a methodology for identifying hazards and for selecting appropriate strategies to avoid or reduce hazard related losses.

1.4. Research Problem

Geo-information can play an effective role to support in addressing disaster management activities (Farruggia, 2003; Montoya and Masser, 2003; Poona et al., 2006; Yaakup et al., 1997). Most of the developing countries introduce GI by project oriented task and rarely use GI after project is completed. It’s a common problem in developing countries in adoption of the geo-information is stand alone with limited benefits (Sherstha, 2007).

Although Ratnapura municipality has been introduced geo-information and technology by the SLUMDMP, the area is still vulnerable. Lots of people faced with severe damages to their properties and lives in 2003 huge flood event. The responsible authorities were not able to manage that flood event (Divitura, 2005). The statement of “Ratnapura local authorities are not sufficiently aware of nationally available geo-information” is in Divitura’s (2005) thesis implies that local authorities are not good geo-information users and disaster management activities can partly be contributed by poor geo-information.
The problems regarding effective use of geo-information are sometimes beyond technicalities (de Man and van den Toorn, 2002). Optimal use of geo information can be related to users and management context which include organizational and institutional conditions (de Man and van den Toorn, 2002). Unsatisfactory levels of geo-information and technology applications in Ratnapura can be assumed due to organizational factors. Accordingly, there is a gap between the actual usage and potential usage of geo-information and technology in disaster management. Then the research problem is “Is there any gap between actual usage and potential usage? If there is how can bridge the gap? ”.

1.5. Motivation

The disaster management is new concept to Sri Lanka. As result of DMC establishment, most of projects will come up with road map that can be benefited by proper utilization of geo-information and technology. Therefore strengthening of organizations in geo-information and technology application for disaster management has become a national mandatory. “Road map covers the area of policy, Institutional Mandates & Institutional Development, Hazard, Vulnerability & Risk assessment, Disaster Mitigation and Integration in to Development Planning, Integration of Disaster Risk reduction in to development planning” (MDMHR, 2006).

SLUMDMP had been applying geo-information technology in disaster management to reduce the impact of natural disasters (Jayawardane, 2007). Thus SLUMDMP has an experience in geo-information and technology in disaster management. Since this concept (disaster management) is new in Sri Lanka, literatures indicates that a few researches have been done in this area. Hence, this has inspired me to undertake this study how geo-information and technology is used in Ratnapura and SLUMDMP has been in relation to geo-information application in disasters management. With the hope, that results of this study can be replicated in other areas with the same problem.

1.6. Objectives of the Research

Main Objective: To identify critical factors in the usage of geo-information and technology for disaster management.

Sub Objectives:
1. To review the current usage of geo-information and geo-information technology of disaster management in Ratnapura.
2. To use Sri Lanka Urban Multi Hazard Mitigation Project (SLUMDMP) as a case study to analyze how geo information was used in Ratnapura municipal council level.
3. To find to what extent geo-information can be used in Ratnapura in the future.

1.7. Research Questions

1. How is current usage of geo-information and technology in Disaster Management in Ratnapura?
2. What factors affect to usage of geo-information and technology in disaster management in Ratnapura?
3. What can we learn from Sri Lanka Urban Multi Hazard Project (SLUMDMP)?
4. What is the potential usage of geo-information and technology in disaster management?
5. What recommendations can be made to strengthen usage of GI and technology?
1.8. Research Methodology

As shown on figure 1-1 the research methodology starts with literature review. The justification of the research and conceptual frame work were derived from literature findings. As disaster management is a new concept to Sri Lanka much information had to be retrieved from literature, to describe up expected situation. Expected situation in the field and the conceptual frame work were used to conduct field work data collection. Field work findings were analysed and interpretations were used for recommendations. Literature findings also provided some recommendations.

1.9. Thesis Structure

Chapter 1: This chapter introduces a general background of the research, problem statement, motivation, research objectives, research questions and research methodology of the research.

Chapter 2: This Chapter focuses on literature review on the role of geo-information in disaster management and explores adoption of geo-information and technology in organizational contexts and summarises organizational factors that can be affected actual usage of geo-information and technology.

Chapter 3: This chapter describes the data collection approach, selection of organizations, data collection, data sources and difficulties faced during the field work.

Chapter 4: This chapter covers the field work responses and observations. Each section more focuses to the usage of geo-information and the factors. In addition to that field work covers SLUMDMP information through interviews.

Chapter 5: This chapter discuss the interpretations for field work findings with related to literature.
Chapter 6: This chapter provides conclusions of the research and recommendations. The recommendations are two categories called recommendations for future studies and the usage of geo-information and technology.
2. Literature Review

2.1. Introduction
This chapter addresses research question 3,4,5 and 6. The aims of literature reviewing are to define basic terms which are used in the thesis, to identify how other scientists and professionals are describing experience of geo-information and technologies in disaster management and know what practice is severally regarded as beneficial or counter productive to use geo-information and technology.

2.2. Definitions
This section describes basic terms which are used in this thesis.

2.2.1. Disaster Management
“The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards” (van Westen, 2007).

2.2.2. Geo-information and Technology
Geo-information in this thesis is defined as digital or paper format description of geographic location, characteristics and information (Iglesias, 2005) related to real world features which facilitate decision making regarding disaster management. As a tool or system which facilitates decision making, the high techniques computers, GPS, GIS software and web base data base systems are considered under technology.

2.2.3. Definition of GIS
GIS is valuable tool for the input, storage, integration, analysis and cartographic visualisation of geo-information. GIS facilitate attribute data to be linked with spatially geo-referenced data (Montoya, 1999).

2.2.4. Sub National Level Organizations
The “sub national level” is consisted of local authorities under provincial councils, organizations under District Secretariat, Line Departments such as Urban Development Authority, district level Non Government Organization (NGOs) and CBO (Community Base Organizations) in this thesis (See fig.3.1). In some pages sub national level organizations are denoted by “district level organizations”.

2.2.5. Definition of Usage
The word “usage” has defined by the meanings such as practicing, applying, or handling. The usage of geo-information and technology is measured by the variables of aspect of application, output of use, product of consume, name of users, level of the organization which uses geo-information.
2.2.6. Potential Usage

The “potential usage” in this thesis is defined in terms of the technology and geo-information. The GIS software, spatial enable data base systems, GPS and palm top computers are considered under technology. The topographic maps, hazard maps, hazard zoning maps, flood model, satellite images, local rain fall data, local flood levels, spatial data bases, community level maps, and aerial photographs are considered under geo-information. The potential usage can be defined as which geo-information or technology that can be used in which aspect of disaster management. The chapter 2.5 will provide more overview of geo-information and technology which applies in disaster management aspects.

2.3. Conceptual Frame Work of Research

![Figure 2-1: Conceptual frame work of Research](image)

The actual usage of geo-information and technology can be observed in the field. The potential usage of geo-information and technology has been supported by literature. According to the conceptual frame work as depicted in fig 2-1 the gap between the as it is situation and the to-be situation can be bridged by the number of factors. Factor can be defined as an aspect or feature and when it operates in the environment, it influences the actual usage of geo-information. The influence may be negative or positive. The positive impact of the factors brings the actual usage towards the potential usage. The factors can be identified in the literature and practical world. The chapter 2.6 describes the factors and their impact on geo-information usage according to literature.
2.4. Key Elements of Disaster Management

<table>
<thead>
<tr>
<th>PRE-DISASTER PHASES</th>
<th>POST-DISASTER PHASES</th>
</tr>
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<tbody>
<tr>
<td>Risk Identification</td>
<td>Mitigation</td>
</tr>
<tr>
<td>Hazard Assessment</td>
<td>Physical &amp; structural mitigation work</td>
</tr>
<tr>
<td>Vulnerability Assessment</td>
<td>Land use planning and building codes</td>
</tr>
<tr>
<td>Risk Assessment</td>
<td>Economic incentives</td>
</tr>
<tr>
<td>GIS mapping and scenario building</td>
<td>Education, training and awareness</td>
</tr>
</tbody>
</table>

Figure 2-2: Key Elements of Disaster Risk Management
(Slide from Geo-information for Disaster Risk Management, Sources: World Bank, DMF & USAID) (van Westen, 2007)

Only the flood and landslide disasters are considered because Ratnapura is highly affected by them. The risk identification, mitigation, preparedness and emergency response are considered as aspects of disaster management in this thesis. From Fig 2.2, the following components of each aspect of disaster management have also been considered.

- **Risk identification** - Risk assessment, GIS mapping and scenario building
- **Mitigation** - Land use planning and building codes, education awareness and training
- **Preparedness** - Monitoring and forecasting
- **Emergency Response** - Rescue, clean up, and damage assessment

2.5. Role of Geo-information and Technology in Disaster Management

**Definition:** The role of the geo-information and technology can be introduced as a systems or tools which support decision making process in disaster management (Abdulharis et al., 2005). As a system or tool, geo-information and technology has numerous applications in disaster management. According to the literature findings, some of the geo-information and technology that can be used in
disaster management are described below. These are called potential usage of geo-information and technology in disaster management.

**Geographic Information System (GIS)**
Abdulhari et al. (2005) has written that GIS as system to support decision makers in the aspects of risk identification, mitigation, preparedness and recovery in disaster management. As a tool GIS has proven crucial for displaying, retrieving, analysing of spatial data in disaster management (Abdulhari et al., 2005). It facilitates managing large data sets, developing in models, building risk assessment, land use management, forecasting casualties, and generating risk maps (Iglesias, 2005; Montoya and Masser, 2003). GIS facilitate to find shortest distance to travel and reach locations in emergency operations (Korte, 1992). According to UNISDR in 2004 GIS systems are increasingly being utilized for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures. According to the scientist, GIS can be used in risk identifications, mitigations, preparedness and emergency responses in which all aspects of disaster management.

**Data base systems**
1. A data base system can be defined as methodology and tool which support for maintaining data systematically (UNDP, 2006). “Risk managers require access to information allowing them to apply, manage and understand disaster scenarios. Thus GIS databases initially developed for administrative tasks, are now being incorporated to meet the needs of natural hazard risk management” (Poona et al., 2006).
3. In Latin America, “DesInventar” system developed to build disaster data base for capture, analysis, and graphic representation of geo-referenced information on disaster occurrence (DMC, 2007). The UNDP in 2006 has written that the spatial data base “DesInventar” can be used as a tool in damage assessment in post disaster events, support in mitigation and preparedness plans and provide historical data for risk and vulnerability assessment (UNDP, 2006).
4. Sri Lanka Disaster Resources Network (SLDRN) is a web base data base of resources for responding to disasters when they occur (DMC, 2007).
5. The spatial enable data bases provide most disaster occurs every year, most of disaster prone areas affected due to disaster, intensity of disaster in affected areas can be provided by data bases. These can be more useful in decision making in all aspects of disaster management activities (Mohanty, 2006).

**GPS**
GPS can compute its position, velocity and exact time. In normal circumstances (hike, drive, walk) this technique can be used with topographic map to find the location. But in emergency situation this technology is very useful even without a map. GPS prevents people walking around in circles. “Due to high positional accuracy and ability to log “real time” Global Positioning System (GPS) has great potential in disaster Management. GPS can be used for ground observations of building characteristics, casualties leading to loss estimation. Further GPS can be used in conjunction of digital video (DV)” (Montoya, 2002).
Palmtop Computers
The use of palm top or hand held computers is rapidly increasing in the developed world. The flexibility to handle out side of the office, offering wireless communication, ability to making maps are some of the advantages of palm top computers. Montoya has written “With the introduction of palm top computer system it is possible to capture, manipulate, analysis, and visualize data in the field. This is flexible and speed in particularly relevant during disaster response phase” (Montoya, 2002).

Topographic Maps
The topographic maps are tool to view the arrangement on the earth surface on paper or computer screen. Topographic maps are one of most widely used map (USGS, 2003). Hazard base maps are done based on Topographic maps (base contour map). Topographic maps consist of datasets such as geodetic points, roads, buildings, and height points that are required for mapping other hazard data layers (DMC, 2007). Topographic maps used for micro scale demonstrations in disaster management (Stancalie and Craciunescu, 2005) whereas satellite images play an important part visualizing macro scale processes.

Hazard base Maps
“Hazard base maps consist of emergency data layers that are required for disaster response such as hospitals, fire stations, police stations, utility networks, disaster area, permit control, and burning areas” (Mansourian A. et al., 2004). Hazard base maps also consist of data sets such as geodetic points, roads, buildings, and height points as in topographic maps.

Hazard Zoning Maps
1. Hazard maps can be used for assessing the influence of flood (Hien et al., 2005).
2. Risk mapping and flood plain zoning provides the most advanced warning and will increase the preparedness to people living in the vulnerable areas (Frantzova et al., 2005).
3. Zoning mapping can be used in risk reduction activities, preparedness planning, vulnerability and risk assessment, training courses and preparing land use zoning planning (DMC, 2007).

Flood model
1. “Modelling, simulations support for planning coordination for decision support.” (Kohler, 2005).
2. Flood models are used to predict to risk, calculate risk and the potentially quantum of damages (Abdulharis et al., 2005).
3. Flood model are used to develop useful and realistic scenarios to be used in trainings (Abdulharis et al., 2005).
4. Flood model can be used to see a situation before and after an emergency and to set priorities for the rebuilding (Abdulharis et al., 2005).

Satellite images
1. “satellite images play an important part visualizing macro scale processes and changes of the landscape” (Kohler, 2005).
2. With framework of flood surveying satellite images can provide up to date geographical information. Before flooding, satellite images can be used to identify land cover and during
flooding it provides inundation areas, map extent. After flooding satellite images provides effect of flood, flood deposit and debris etc (Stan calie and Craciunescu, 2005).

3. Satellite images allow to map vulnerabilities of terrain properties such as water, forest, geology, vegetation etc (Stoimenov et al., 2005).

4. With the launching of IKONOS 1 in 1997, satellite images are used in disaster management due to high resolution. But cost is very high and can not be achieved most of developing countries (Montoya, 2002).

5. Satellite based real time systems support to performance of response and relief aspects in disaster management (Abdulharis et al., 2005; Montoya, 1999).

6. National and international meteorology service make use of satellite images for meteorology forecast for rainfall (Plate and Insisiengmay, 2002).

7. The availability of satellite images allows rapid damage assessments to be carried out to coordinate the disaster response. This allows the emergency response of supplies and personnel to be sent to the needed areas and a better management of disaster response (Peiris N and Free, 2005).

8. Satellite images and photographs provide multi-temporal imagery which can be used in hazard analysis (van Westen, 2007).

**Rain fall and Flood level records**
Local rain fall or flood level records can be used risk assessment, early warning activities (DMC, 2007). The rain fall runoff model can be developed to predict the peak discharge using rain fall and rain gage data. These models can be used for flood warning issuing (Kafle et al., 2007).

**Community Level Maps**
Community level maps can be used as a tool for extracting indigenous knowledge of environmental problems and hazards. Local knowledge can be used to cross check the technological results through community level mapping (McCall, 2007). Further it shows evacuation routs, safe areas for evacuation and temporary shelters (DMC, 2007). There are less applications of participatory mapping to hazard identification, vulnerability assessment and risk mapping (McCall, 2007).

**Aerial Photographs**
1. Flood stage damage mapped with the aerial photographs and integrated with GIS will be very helpful to create map product for damage assessment and planning flood control measures (Frantzova et al., 2005).
2. Aerial photographs allow to map vulnerabilities of terrain properties such as water, forest, geology, vegetation etc (Stoimenov et al., 2005).

2.6. **Factors Influencing Usage of Geo-information and Technology in Disaster Management**
The Geo-information needed for disaster management depends upon the characteristics of disaster have to deal with, geographical, social, economic, institutional, legal and technical environment (Dieh and van der Heide, 2005). The most relevant factors which influence usage of geo-information in disaster management can be introduced as critical factors. Those are external or internal to institutions. Identifying critical factors also depend on the geo information requirements and
institutional environments vary from country to country. Some problems similar to lack of technical environment; funding mechanism regularly face in less developed countries may not the problems which are faced by developed countries. So defining critical factors become crucial and should reveal through proper research. According to the literature review the following discussion is to build a foundation to identify factors.

According to Frantzova (2005) “Risk management process depend on availability of technology, availability of financial resources, perception of society, as well as huge quantitative and qualitative data that are not absolute and are changing in the time”.

Reducing national hazard is definitely one of the major obligations for both national and local government in every country. Kaji (1991) says “the biggest resources for mitigation damage are the residents in damaged area and the people’s involvement in disaster area cannot be underestimated. Government can acquire local people and their indigenous knowledge organization developed strategies for implementation of geo-information in managing disaster events. This becomes possible through complementary participation of people and organization of state, NGO, scientific and technological institute, the financial sector of others. The use of available local resources is often maximized mitigation programme. For utilization of geo-information through local level the public perception of disaster mitigation is an important factor”.

Maskrey (1991) mentioned several reasons to failure of disaster mitigation projects:
   1. In Latin America although disaster mitigation programme managed by government and NGO for limited time period, they cannot addressed for vulnerability. They conducted mitigation programme based on their specialized technology and professional skills without public involvement. Their general models failed due to inapplicable to local specific situations.
   2. Some countries mitigation has been motivated by only political and economic self interest.
   3. Due to wrong mitigation planning vulnerability of majority of region in Latin America has broaden and grows up. This is questioning the methodology for mitigation planning and corrects to be take new approach.
   4. Most of failures were due to lack of scientific and technological knowledge.

Success and failure of GIS implementation depend on organizational and technical factors (Yaakup et al., 1997). Sahay and Walsham (1996) mentioned that implementation GIS technology in general is problematic and in developing countries additional issues to be addressed.

From the finding of British case studies on “Impact of GIS on British local government” exemplify prime reason for introduction GIS appeared as social and political rather than technical in nature. The majority of GIS technology implementation depends upon the head of the department. Factors such as the institutional frame work and availability of spatial data may influence the speed of GIS diffusion but the more vital factor is how these issues are translated and understood within the organization (Campbell and Masser, 1995).

Implementation of GIS does not come without problems and it must be analyzed carefully in several points of view (Montoya, 1999). According to Montoya before applying GIS following factors should be considered.

   The financial investments are necessary in terms of hard ware and soft ware.

   1. The financial and temporal investment also needs to staff training.
   2. The acceptance of GIS as a tool to take decisions by decision makers.
   3. The existence of appropriate model to apply GIS.
Note: Some factors are derived by reviewing literature in GIS implementation, adoption, and utilization within organizations. Those factors are not related to specific application area and considered as influencing factors of usage in the context of disaster management.

Table 2-1 has been prepared to present the explanations about the factor by scientists and professionals. The factors were categorized in seven major categories called organizational, data, man power, technology, political, financial and sustenance approach.

Table 2-1: Factors in literature review and explanations

<table>
<thead>
<tr>
<th>Factors</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational</td>
<td></td>
</tr>
</tbody>
</table>
| Organizational routine (related official procedure to use GIS) | 1. The local authority needs routine for embedding its GIS knowledge and experience ready to be pulled out and used in response to situations. GIS routine formation is a good focusing point since it involves creation of agreement about what disaster management task has to done, what is legal basis for the task, how to do it, how geo-information will be use this planning and decision making (Iglesias, 2005).

2. “The problems of low use of geo information for local disaster risk management refers to how organization structures its related disaster risk management activities to process geo-information”(Iglesias, 2005). “organizational structure comprises the formal arrangement of the organization, such as mission statements and organizational charts” (Sieber, 2000).

| Employee acceptance | “Employee acceptance of the technology has been correlated to successful usage conversely, employee resistance has suspended the most technically advanced system (Sieber, 2000).

2. “It should be noted that people often have reason to fear change, because authority/status, control over work, career opportunities, and job satisfaction can be diminished. These dynamics may or may not improve with the addition of GIS responsibilities” (Sieber, 2000). |
<p>| Data availability at a required scale | 1. Geo-information in the Indonesian offices were outdated, no system to keep back up,    |</p>
<table>
<thead>
<tr>
<th>Factors</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>multidiplinary environment</td>
<td>on data storing and managing and scales of satellite images are too small for certain details are identified as major problems in usage of geo-information by the Tsunami experience of Indonesia government (Abdulharis et al., 2005).</td>
</tr>
</tbody>
</table>
| Availability of digital data sets | 1. “Digital data sets are value of resources in GIS adoption” (Iglesias, 2005).  
2. “Availability of data is inhibiting factor in the case of GIS implementation in developing countries” (Sahay and Walsham, 1996)  
3. “No digital data sets is a critical factor in geo-information strengthen in local authorities” (Sherstha, 2007) |
| Availability of update data     | 1. “Risk management process depends huge quantitative and qualitative data that are not absolute and are changing in the time” (Frantzova et al., 2005).  
2. “Out dated nature of data is inhibiting factor to GIS implementation” (Sahay and Walsham, 1996) |
| Information are in standard format (Data compatibility) | 1. “Potential users need information to be in appropriate format, available at the right format, in the right time and right place, most importantly to support their case” (Campbell and Masser, 1995).  
2. No standardised format of data that are not supported by standard software is a problem of GIS in developing countries (Sahay and Walsham, 1996). |
| Data arrangement                | 1. “lack of data and information, existing data is disorganized, no digital datasets are critical factors in geo-information strengthen in local authorities” (Sherstha, 2007). |
| Reluctance to share data        | 1. “Reluctance to share data is weakness to apply GIS in local government in developing country” (de Man and van den Toorn, 2002). |

<table>
<thead>
<tr>
<th>Factors</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Man power</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Decision taker’s knowledge about technology | 1. “Decision making is often confronted to a central official who, despite having inadequate knowledge about the technology, is responsible for taking critical decisions related to implementation.” (Sahay and Walsham, 1996)  
2. “The majority of GIS technology implementation depends upon the head of the department” (Campbell and Masser, 1995). |
| Trained staff         | 1. “Town Lalithpur in Nepal see value of trained personnel in GIS adoption” (Iglesias, 2005)  
2. “Acute shortage of manpower who are capable of understanding and using GIS and general lack of awareness about GIS specially among planners is inhibiting factor” (Sahay and Walsham, 1996).  
3. “lack of adequately trained staff is critical factors in geo-information strengthen in local authorities” (Sherstha, 2007) |
| Technology            |                                                                                                                                               |
| Availability of Equipments, Hardware, Software | 1. “Availability of hard ware and software is a strength of organization to implement GIS” (de Man and van den Toorn, 2002).  
2. “Risk management process depends on availability of technology” (Frantzova et al., 2005).  
3. “lack of equipment are critical factor in geo-information strengthen in local authorities” (Sherstha, 2007) |
| Political             |                                                                                                                                               |
| Political influence   | 1. In some countries mitigation is depend on political and economic interest (Maskrey, 1991).  
2. From the finding of British case studies on “Impact of GIS on British local government” exemplify prime reason for introduction GIS appeared as social and political rather than technical in nature (Campbell and Masser, 1995).  
3. Mayor would like to uses GIS application for political lobbying to gain co-operation from communities and other local authorities (Iglesias, 2005). |
<table>
<thead>
<tr>
<th>Factors</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Financial Resources to acquire and maintain GI and technology | 1. Limited financial resources impede investment in technological and human resources (de Man and van den Toorn, 2002).  
2. “Funding constraints for acquiring and maintaining in GIS is inhibiting factor” (Sahay and Walsham, 1996). |
| Funding on Training and Research Programmes | 1. “Financial factors provide constraints acquiring and maintenance of training and research programmes. Funding for a GIS project often comes as a part of an aid package that dries up long before the project completed. The long time involved in implementing GIS also makes it difficult to provide sustained funding” (Sahay and Walsham, 1996). |
| Sustenance Approach                         |                                                                                                                                                                                                            |
| Indigenous Knowledge through Public Participation. | 1. Government can acquire local people and their indigenous knowledge organization developed strategies for implementation of geo-information in managing disaster events (Kaji, 1991). |
| Perception of Society                       | 1. “For utilization of geo-information through local level the public perception of disaster mitigation is an important factor”(Kaji, 1991).                                                                 |
| Existence of growing demand                 | 1. “Growing demand for useful information from heterogeneous group of users is an opportunity to apply effectively GIS in local government” (de Man and van den Toorn, 2002). |

Note: The literature review is included prior to the field work and after the filed work. Table 2-1 was prepared prior to field work. On further studying some other literature was also reviewed.

Yaakup (1997) has written “the important issue in the implementation of GIS and Decision Support System at local authority level is the overall information management which takes account of data availability, computing capabilities and management requirements. There will be mismatches of data availability and information needs as well as between data collection and data processing. Without well developed information management strategies it is likely that major problems will be arised GIS utilization. Speed and data storage capacity of computer systems are going on increasing with the
cost of computer still dropping. Development of computer technologies has indeed benefited developing countries”.

Chanza (2003) has written that one need to consider technical GIS staff, urban planners and all groups in training programmes. For retaining the training staff, Chanza (2003) propose incentive schemes.

Montoya (1999) says “the perception of hazards in developing countries tends to be more dependent upon religious views and therefore, natural hazards are seen as “Act of God” that cannot and should not be prevented and only their consequences dealt with.

Poona et al. (2006) has written “There are substantial problems with availability of, and accessibility to reliable, up-to-date, and accurate data. The need for reliable, up-to-date, and accurate data is significant if one is to successfully react to and manage a disaster situation.

Divitura (2005) say that the unawareness of producers and lack of knowledge to refer maps affects usage. Similarly Jayawardane (2007) mentioned that some effort taken by government disappeared due to lack of awareness of the availability of geo-information products among users.

2.7. Sri Lanka Urban Multi Hazard Disaster Management Project (SLUMDMP)

The Sri Lanka Urban Multi-hazard Disaster Mitigation Project (SLUMDMP) was established in October 1997 and ended 2000. SLUMDMP was implemented by the Asian Disaster Preparedness Centre (ADPC) and was managed by three local partnership organizations which are National Building Research Organization (NBRO), Centre for Housing Planning and Building (CHPB), Urban Development Authority (UDA) and with the assistance from ADPC.

Mapping tasks are engaged by SLUMDMP partnership agencies as follows.

**NBRO:** Preparation of landscape hazard zoning maps  
Preparation of integrated landslide hazard zoning maps

**UDA:** Maps of existing wards, population density and present land use.  
Flood hazard zoning maps  
Maps of road net work, accidents, social services, telephone net work, water supply net work and location of gem mines  
Proposed zoning plan for Ratnapura

Apart from UDA and NBRO, CHPB hold the project management and training responsibilities in SLUMDMP. Map work book for Ratnapura area was compiled by all partnership agencies in the project. SLUMDMP was considered as one of successful initiatives by the Sri Lankan government for disaster mitigation (Jayawardane, 2007). The project demonstrates a methodology for identifying hazards and for selecting appropriate strategies to avoid or reduce hazard related losses. SLUMDMP assists municipal officials to develop improved tools and skills in development planning and risk management. Demonstration activity elements include hazard and vulnerability mapping, risk analysis, strategic planning, policy and procedural changes, training and professional development, and networking. Preparing maps for hazard areas and building guide lines were accomplished in the project period (ADPC, 2000).
Strengths of SLUMDMP

- High level co-operation from Mayor and officials in Ratnapura Municipal,
- NBRO has experience in the landslides of hazard mapping by a prior Landslide and Hazard Mapping Project (1990-1995). Availability of hardware, trained staff in digitizing, and GIS software by prior project were a great advantages to finish landside hazard mappings (ADPC, 2000).

Obstacles of SLUMDMP

- Providing town sheets for Ratnapura Municipality were delayed by data producing agencies,
- Lack of base maps in the required scales,
- Non availability of 1:10,000 maps,
- No accurate records, related to landslides and flood,
- “History of unrealized project proposals for Ratnapura flood mitigation resulted in low credibility of new proposals with the community” (ADPC, 2000).

2.8. Summary

This chapter described the basic definitions in the thesis, conceptual framework of research, and the key elements of the disaster management. The numbers of geo-information and technology which can be considered as potential usage were reviewed in literature. The factors in literature review were categorized and tabulated. According to that those categories are organizational, data, manpower, technology, political, financial and sustenance approaches. The more information about strength and weaknesses of SLUMDMP were also described in literature.
3. Field Work

3.1. Introduction

This chapter addresses the research questions 1, 2 and 3. Field data collection covers the as it is situation in the fig.2-1. Section 3.2 describes the data collection approach and how the organizations were selected. Sub chapter 3.3 further provides the data collection method and data sources. The difficulties faced in the field work period and the way these were resolved are explained in section 3.4.

3.2. Data Collection Approach

The aim of the data collection was to find data and evidence related to a number of questions:

- How far organizations in Ratnapura used geo-information and technology in disaster management.
- How geo-information and technology is used in Sri Lanka Urban Multi Hazard Disaster Management Project (SLUMDMP) in municipality level.
- Which factors can influence usage of geo information and technology regarding Disaster Management (DM) in Ratnapura was among objectives of the research. Field work was conducted from 17 September to 17 October 2007.

The field work data collection was started in the Ratnapura Municipal Council Office. On the first day discussion it was explained that after the establishment of the District Disaster Management Coordinating Unit (DDMCU) the Municipal Council also had become a member of the District Disaster Management Committee (DDMC). The District Secretary (DS) is the chairman of the DDMC and the Mayor in the Municipal Council coordinates with the DS. Some officers in the municipality suggested that, in order to get a good insight in actual disaster management practice in Ratnapura it would be better to visit the DDMCU, also because the municipality was said to have no responsibility in Disaster Management. Furthermore, the municipality seemed to have few users of geo-information and related technology for DM. Upon this suggestion, it was decided to visit the DDMCU in Ratnapura. This DDMCU is officially under the authority of the Disaster Management Centre in Colombo (DMC). The DDMCU is attached to the DS for coordinating and implementing district and village level DM activities. DMC is the National level organization which implements plans through DDMCU.

During the DDMCU visit it was indicated that more than 30 organizations were coordinating activities with them, and thus potentially relevant for the scope of this research (appendix III.1). It was however considered impossible to visit each of these in the limited time period available. With this time constrains in the context of thesis it was decided to limit the investigation to organizations which were actively or passively using geo-information technology for disaster management activities. According to information from DDMCU this included the Land Use Physical Planning Office in Ratnapura, the Irrigation Department, the Urban Development Authority as well as the Municipal Council. These were all visited in the first week. An important observation from their responses was that none of these organizations assumed direct responsibility with regards to DM. Yet, all visited
organizations indicated to contribute to DM in various aspects. The fuzzy environment with regards to disaster management in Ratnapura made it necessary to get a richer picture. Therefore, I visited the DMC in Colombo during the second week of field work period. A power point presentation document given by the Director of the Technology and Mitigation Unit helped to build up clearer picture of coordinating mechanism from national level to sub national level. This picture was further on used as a basis for the selection of organizations to visit (fig. 3-1).

Given this complex organizational environment, the approach of unstructured interviews was used during field work, following Kumar (2005). The advantages of collecting data by interviews as a method to use when the situation is complex, is that one can collect in depth information. This overall context provides a clearer understanding of the real environment of the 17 organizations that were visited. Still it must be acknowledged that most of the organizations have no specific mandate for disaster management although they conduct activities related to disaster management.

3.2.1. Selection of Organizations
The diagram in Fig. 3-1 explains the selected organizations in Ratnapura. This included 6 National level organizations and 11 sub National level (District level) organizations. The details of the respondents are as described in the Table 3-1 hereunder:

![Coordination Mechanism for Disaster Risk Management](image)

**Figure 3-1: Coordination Mechanism for Disaster Risk Management**
Source: Power point presentation by U.M.L.Chadradasa, Director, Technology and Mitigation Unit, DMC, 2007
Table 3-1: Organizations and Respondents

<table>
<thead>
<tr>
<th>Level of Organization</th>
<th>Organization</th>
<th>Interviewed People</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Level</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
|                       | 1. Disaster Management Centre (DMC), Colombo | 1. Director technology and Mitigation  
2. Assistant Director Information and Technology  
3. Consultant UNDP |
|                       | 2. Irrigation Department, Colombo | 1. Director, Hydrology  
2. Deputy Director, GIS Unit |
|                       | 3. Urban Development Authority (UDA), Colombo | 1. Deputy Director, GIS Unit |
|                       | 4. National Building and Research Organization (NBRO), Colombo | 1. Head of the Landslide Studies and Services Division (LSSD) |
|                       | 5. Geology Survey and Mines Bureau (GSMB), Colombo | 1. Geologist |
|                       | 6. Meteorological Department, Colombo | 1. Deputy Director |
|                       |              |                   |
| Sub National Level Organizations | Local government Level |                   |
|                       | 1. Municipal Council Office (MC), Ratnapura | 1. Engineer  
2. Draftsman  
3. Public Health Nursing Sister  
4. Mayor |
|                       | 2. District Disaster Management Coordinating Unit (DDMCU), Ratnapura | 1. District Coordinating Officer  
2. Disaster Risk Management Officers |
|                       | 3. Grama Niladhari Office (GN Office), Muwagama | 1.“Grama Niladhari” Officer |
|                       |              |                   |
|                       | District Secretariat Level |                   |
|                       | 1. District Secretariat Office Ratnapura | 1. Additional District Secretariat, Ratnapura |
|                       | 2. District Disaster Management Coordinating Unit (DDMCU), Ratnapura | 1. District Coordinating Officer  
2. Disaster Risk Management Officers |
|                       | 3. Grama Niladhari Office (GN Office), Muwagama | 1.“Grama Niladhari” Officer |
### Data Collection

As mentioned above, given the complex organizational environment during the fieldwork the method of open interviews was adopted to collect responses and views on this environment (Kumar, 2005). The observations and secondary data, such as reports, acts, and presentations were also collected from the organizations visited in addition to the interview. The first interviews at the above-selected organizations focused on the responsibility they hold or perceived to hold regarding DM. If there was a direct or indirect responsibility perceived, it was a starting point to explore how far geo-information technology would apply within their functions. If organizations used geo-information technology, open interviews were further conducted to find the type of use, purposes of use, capacities and barriers for less usage and how far they want to use in which applications. This approach further revealed the organizations’ capabilities to handle information, their strengths and what they need to improve usage. The appendix III.2 provides an overview of which data were collected and how these were collected.

The factors which were found in literature had to be prioritized to find more critical factors. Then a workshop was organized for rating factors. It was a time saving and structured method to find...
critical factors than open interviews. The respondents were given factors by questionnaire. During this workshop, participants were asked to rate each factor according to their (perceived) importance. 17 officers having a background in disaster management and geo-information usage were invited for this factor rating exercise (Details are provided in appendix III.3).

3.4. Difficulties in the Field Work

3.4.1. Workshop

Although 17 officers from different organizations were invited for workshop, most of invitees could not come on the day which was scheduled, as the District Secretariat had also called for another meeting at that time. After this district secretariat meeting, only 9 people could gather and complete the rating of critical factors. The DDMCU helped by giving their conference room. The workshop was organized only for technical people in Ratnapura. The Colombo officers could not be invited given to the long distance from Colombo to Ratnapura. Organizing a separate workshop in Colombo also was appeared to be impossible due to tight schedules of officers. Therefore, the questionnaires used for the workshop were brought to the other 6 officers who were absent during the workshop and to other uninvited Colombo officers. Finally, the questionnaires (Appendix III.4) were answered by 15 people from 9 organizations.

3.4.2. Interviews

Even though interviews were scheduled with prior appointments, some officers were absent on the scheduled date. Interviews had to reschedule due to that reason. Since officers were over occupied on their duty interviews were delayed two or three hours. With their tight schedules some officers restricted the time interviewed. Those were again interviewed over the phone. Interrupting interviews by telephone calls and clients caused problems for continuations.

Interviews were conducted in English and in the local Language. Most of the time the local language made interviews more sense. Even though some officers were willing to discuss, time was a barrier. I was interviewing them after office hours too. Some respondents did not agree if interviews were recorded.

3.5. Summary

To explore the wider organizational environment of disaster management a number of different types of organizations were visited. This generated a complex method of data collection, where by I was pointed to new other organizations during each visit to organizations. This also implied that for the validation process I had come back to the same organizations which were already visited. Although frequently interviews were interrupted for many reasons, on the whole there was considerable willingness to respond and the discussions were satisfactory.
4. Field Work Findings

4.1. Introduction
This chapter provides the findings of the field work to addressing research questions 1, 2 and 3. The Chapters 4.2 and 4.3 present the fieldwork findings more relevant to the conceptual frame work of the study. The appendix IV.1 provides more details of the current and future functions of the organizations in disaster management. The more overview of filed work findings in each visited organizations are presented in the appendix IV.2. The appendix IV.2 summarizes the interviews which were conducted during the filed work. The responses for the questionnaire by 15 respondents in the workshop are summarized in appendix IV.3.

4.2. Usage
From the field work in Ratnapura, the geo-information and technology utilization was observed as shown in table 4.1. The organizations engage in disaster management in a multi disciplinary environment. Their contribution varies in different disaster management aspects. The table 4.1 provides an overview of geo-information and technology used by each organization. Under each aspect of disaster management, the components of disaster management have also been mentioned.

The current functions in the appendix IV.1 were used to prepare table 4-1. The functions of development controlling in hazard areas (by UDA and Municipal Council), controlling illicit gem mining (by GJA), zoning mapping (by NBRO), controlling harmful mining and rock blasting (by GSMB) are assumed as land use planning relevant to disaster management.

The functions of flood mapping and model formulating are taken in to account under GIS mapping and scenario building in risk identification aspect.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Purpose of use</th>
<th>Geo-information products and technology currently use</th>
</tr>
</thead>
</table>
| 1. Irrigation Department, Colombo | Risk Identification GIS mapping | Technology:  
- Arcview software  
- Hand held GPS, Scanners, Digitizers-02  
- Internet facilities (use only for emails)  
- Fax and photo copy machines  
| Preparedness Monitoring and forecasting | Geo-information:  
- 1:50,000 topographic maps in digital and paper format from Survey Department |
<table>
<thead>
<tr>
<th>Organization</th>
<th>Purpose of use</th>
<th>Geo-information products and technology currently use</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. DMC, Colombo</td>
<td>Risk Identification</td>
<td><strong>Technology</strong></td>
</tr>
<tr>
<td></td>
<td>Risk assessment, GIS mapping and scenario building</td>
<td>• ArcIMS server, GIS workstation server</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Licensed Software ArcGIS 9.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Plotters, Computers, Scanners, Digitizers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Internet facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• “DesInventar” data base</td>
</tr>
<tr>
<td></td>
<td>Mitigation Awareness</td>
<td><strong>Geo-information</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1:50,000 digital topographic map for whole country given the Survey Department on free of charge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1:10,000 digital topographic maps for some part of country</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1:50,000 and 1:10,000 topographic maps in paper format.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Aerial photographs for demonstration purposes</td>
</tr>
<tr>
<td></td>
<td>Emergency Response</td>
<td>• Rain fall data from the Meteorological Department</td>
</tr>
<tr>
<td></td>
<td>Damage assessment</td>
<td>• Flood levels from Irrigation Department</td>
</tr>
<tr>
<td>3. Irrigation Department, Colombo</td>
<td>Risk Identification</td>
<td><strong>Technology</strong></td>
</tr>
<tr>
<td></td>
<td>GIS mapping</td>
<td>• Arcview software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hand held GPS, Scanners, Digitizers-02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Internet facilities (use only for emails)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fax and photo copy machines</td>
</tr>
<tr>
<td></td>
<td>Preparedness</td>
<td><strong>Geo-information</strong></td>
</tr>
<tr>
<td></td>
<td>Monitoring and forecasting</td>
<td>• 1:50,000 topographic maps in digital and paper format from the Survey Department</td>
</tr>
<tr>
<td>4. Urban Development Authority, Colombo</td>
<td>Mitigation Land use planning</td>
<td><strong>Technology</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Arcinfo, ArcGIS, ERMapper, ERDAS, Arcview, ENVI software available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• more than 10 computers are work stationed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Printers, Plotters, Scanner, Computers 26 (Including 4 Laptop)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Internet facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Geo-information</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flood zoning maps from the Irrigation Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Land slide zoning maps from the NBRO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1:10,000 digital maps for some part of country from the Survey Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1:50,000 topographic maps in digital format</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1:50,000 and 1:10,000 topographic maps in paper format</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Satellite images (IKONOS and LIDAR images)</td>
</tr>
<tr>
<td>Organization</td>
<td>Purpose of use</td>
<td>Geo-information products and technology currently use</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>--------------------------------------------------</td>
</tr>
</tbody>
</table>
| 5. National Building and Research Organization (NBRO), Colombo | Risk Identification | **Technology**  
ILWIS, ArcGIS, ArcInfor software  
Computers, Scanners, Digitizers, Plotters, GPS  
Internet Facilities (use only for emails)  
**Geo-information**  
1:50,000 topographic maps in paper format  
1:50,000 digital topographic maps  
1:10,000 digital topographic maps but not for whole Ratnapura area  
Rain fall data from the Meteorological Department  
Flood heights from the Irrigation Department |
|  | Risk assessment Mitigation |  |
|  | Land use Planning, Awareness Preparedness | Monitoring and forecasting |
|  | Emergency Response | Damage assessment |
| 6. Geology Survey and Mines Bureau, Colombo | Emergency Response | **Technology**  
Arcview, ILWIS software,  
Computers, Scanners, GPS  
Internet facilities (use only for emails)  
**Geo-information**  
1:50,000 digital topographic maps  
1:50,000 and 1:10,000 topographic maps in paper format |
|  | Damage assessment |  |
| 7. Mete. Department, Colombo | Preparedness | **Geo-information**  
Satellite images |
| 8. Municipal Council Office, Ratnapura | Mitigation | **Technology**  
AutoCAD for building and planning activities  
Computers  
Photocopy machine (not working)  
**Geo-information**  
1:5000 contour maps prepared by the UDA to use in development plan control  
1:5000 town sheets from the Survey Department  
Self prepared sketches of the area for awareness programmes |
<p>|  | Land use Planning, Awareness |  |
|  | Emergency Response | Rescue and cleanup |
| 9. District Secretariat Office, Ratnapura | “We don’t use any kind of geo-information products in decision making in DM” |  |</p>
<table>
<thead>
<tr>
<th>Organization</th>
<th>Purpose of use</th>
<th>Geo-information products and technology currently use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>10. District Disaster Management Coordinating Unit (DDMCU), Ratnapura</strong></td>
<td><strong>Mitigation</strong>&lt;br&gt;Awareness&lt;br&gt;<strong>Emergency Response</strong>&lt;br&gt;Response</td>
<td><strong>Technology</strong>&lt;br&gt;• Two desktop computers and three laptops are available&lt;br&gt;• Internet facilities (use only for email facilities)&lt;br&gt;• Fax and photocopy machines&lt;br&gt;• ArcView, ArcInfo&lt;br&gt;<strong>Geo-Information</strong>&lt;br&gt;• 1:10,000 topographic maps in paper format&lt;br&gt;• 1:50,000 topographic maps in paper and digital format&lt;br&gt;• Multi hazard map (self prepared) for awareness programmes&lt;br&gt;• Rain fall data and river level data from the Meteorological Department and the Irrigation Department in heavy rain conditions</td>
</tr>
<tr>
<td><strong>11. Grama Niladhari Office, Muwagama</strong></td>
<td><strong>Preparedness</strong>&lt;br&gt;Monitoring and forecasting&lt;br&gt;<strong>Emergency Response</strong>&lt;br&gt;Response</td>
<td>• Self prepared sketch to area identification</td>
</tr>
<tr>
<td><strong>12. Land Use Policy Planning Office (LUPPO), Ratnapura</strong></td>
<td><strong>Risk Identification</strong>&lt;br&gt;Risk Assessment&lt;br&gt;<strong>Mitigation</strong>&lt;br&gt;Land use Planning Awareness</td>
<td><strong>Technology</strong>&lt;br&gt;• ArcView3.5 and ArcInfor software&lt;br&gt;• Computers, Digitizer, fax machine&lt;br&gt;• Landslide investigating data base&lt;br&gt;<strong>Geo-Information</strong>&lt;br&gt;• Land slide zoning maps prepared by NBRO are used in risk identification&lt;br&gt;• Self prepared Landslide density map in Grama Niladharvi divisions to get rough idea about risk areas. These are used in awareness programme.&lt;br&gt;• 1:50,000 topographic maps in digital and paper format from the Survey Department</td>
</tr>
<tr>
<td>Organization</td>
<td>Purpose of use</td>
<td>Geo-information products and technology currently use</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>------------------</td>
<td>------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>13. Urban Development Authority, Ratnapura</td>
<td>Mitigation</td>
<td><strong>Technology</strong></td>
</tr>
<tr>
<td></td>
<td>Land use Planning</td>
<td>• Arcview, Autocad Software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Computers, Scanners, Photocopy machine, Fax machine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Internet facilities (only use for emails)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Geo-Information</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flood hazard maps from the Irrigation Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Land slide maps are from NBRO</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1:50,000 topographic maps in digital and paper format from the Survey Department</td>
</tr>
<tr>
<td>14. Geology and Survey Mines Bureau, Ratnapura</td>
<td>Mitigation</td>
<td>“We do not use any kind of geo-information products. 1:50,000 topographic map is used very rarely for location identification”</td>
</tr>
<tr>
<td></td>
<td>Land use Planning</td>
<td></td>
</tr>
<tr>
<td>15. Gem and Jewellery, Authority in Ratnapura</td>
<td>Mitigation</td>
<td>“We do not use any kind of map for gem mining license issuing. Divisional secretary has given village name list in which license are not to be issued”</td>
</tr>
<tr>
<td></td>
<td>Land use Planning</td>
<td></td>
</tr>
<tr>
<td>16. District Irrigation Office, Ratnapura</td>
<td>Preparedness</td>
<td><strong>Technology</strong></td>
</tr>
<tr>
<td></td>
<td>Monitoring and forecasting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Arcview software</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Internet facilities (use only for email)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fax machine, Computers, Photocopy machine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Internet facilities(use only for Emails)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Geo-Information</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 1:50,000 topographic maps in paper and digital format from the Survey Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Rain fall data from the Meteorological Department</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Flood heights</td>
</tr>
<tr>
<td>17. Sri Lanka Police Department, Ratnapura</td>
<td>Mitigation</td>
<td>“We do not use any kind of geo-information product on disaster management activities”</td>
</tr>
<tr>
<td></td>
<td>Awareness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emergency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Response</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rescue and cleanup</td>
<td></td>
</tr>
</tbody>
</table>
The tables 4-2 to table 4-5 are used to present filed work findings. The purpose of theses tables is to show the gap between actual usage and potential usage. These tables are prepared by following methodology.

1. According to the literature review and based on some assumptions (appendix IV.7), a table (appendix IV.8) has been prepared to show the potential usage of geo-information and technology in disaster management.

2. Based on the fig. 2-1 risk identification, mitigation, preparedness and emergency responses are looked as disaster aspects to prepare individual tables (tables 4.2-4.5).

3. The organizations engage on disaster management in different aspects. Each aspect has different components (Chapter 2.4). According to that, their geo-information usages are different. If an organization did not specially mention that they do not use any kind of geo-information product on particular disaster management aspect (eg. Red Cross and Police Department mentioned they do not use any kind of geo-information on emergency responses) is has been assumed that products which has been mentioned in the table 4-1 are used on the all responsible aspects in disaster management.

4. Although some organizations for an example UDA in Ratnapura, Irrigation Office in Ratnapuara and Municipal council have recorded past flood events, those records are not concerned as systematic data bases (4.0 in appendix IV.2).

5. Four tables were prepared for all aspect of disaster management. The potential usage of geo-information and technology that could be used in each aspect in all tables has been considered from appendix IV.8.

6. Although some organizations did not use any kind of geo-information products, those were included in the tables because these organizations contribute to disaster management aspects in Ratnapura. But district secretariat office was not included in any table. As the administrative body of the district, district secretary only authorizes certain tasks which are taken by other agencies. The UDA in Colombo has also not been considered in the tables because of the UDA in Ratnapura stands for development planning in Ratnapura.

7. The following legend is used for indicate the type of geo-information and technology usage for each aspects.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Purpose of use</th>
<th>Geo-information products and technology currently use</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. Red Cross Society, Ratnapura</td>
<td><strong>Risk Identification</strong>&lt;br&gt;Participatory mapping&lt;br&gt;<strong>Emergency Response</strong>&lt;br&gt;Rescue and cleanup</td>
<td><strong>Technology</strong>&lt;br&gt;• Internet facilities (use only for email)&lt;br&gt;• Computers&lt;br&gt;<strong>Geo-Information</strong>&lt;br&gt;• 1:50,000 topographic map in paper format&lt;br&gt;• “Sabaragamuwa” Province map&lt;br&gt;• Rough sketch prepared by Grama Niladhari</td>
</tr>
</tbody>
</table>
8. The term “Can be used” implies that the geo-information products are supported by literature or assumptions as a suitable geo-information product or technology to use. (see appendix IV.8)

9. According to the assumptions, some products are considered as no “need to use”

4.2.1. Risk Identification Aspect

The table 4-2 has been prepared to present actual and potential usage of geo-information in risk identification aspect.

4.2.1.1. Comments Related to Table 4-2

- The five organizations engage in risk identification as follows.
  - NBRO, LUPPO - Risk assessment
  - DMC - Risk assessment and preparing hazard base map
  - Irri. Dep. Colombo - Preparing flood models and maps
  - Red Cross - Participatory mapping
- The systematic data bases are used by the LUPPO and DMC.
- It can be seen that none of the organization which involves in risk identification, use satellite images, aerial photographs, palm top computers, hazard base map, community level maps, web base data bases, flood model and maps in risk identification aspect.
- The Red Cross uses self prepared sketches for GN division.
- Hazard zoning maps are used only by NBRO and LUPPO in risk assessment.
- From the whole table, it is noticed that considerable number of geo-information products and technology that can be used according to potential usage, are not used by the organizations for risk identification aspect.

4.2.2. Mitigation Aspect

The table 4-3 has been prepared to presents actual and potential usage of geo-information in risk mitigation aspect.

4.2.2.1. Comments Related to Table 4-3

- The nine organizations engage in disaster mitigation aspect as follows.
  - DMC, DDMCU, SLP - Awareness.
  - UDA, GSMB, GJA - Land use planning.
  - MC, NBRO, LUPPO - Awareness and land use planning.
- From nine organizations which contribute in mitigation aspects the Gem and Jewellery Authority (GJA) and the Police Department do not use any kind of geo-information product. The GSMB make use of topographic sheets very rarely for location identification (2.13 in appendix IV.2).
- From the organizations which deal with awareness and training none of organization use flood model or community level maps on their programmes. Although developing realistic scenario is very useful in awareness programmes (Abdulharis et al., 2005) still flood maps or models are not used in the field.
- The topographic map has higher probability to employ in mitigation aspects while other geo-information products have very low usage according to the table.
- From the table 4-3, it can be observed that considerable amount of cells represent that “Can be used and is not used in the field”. It presents the geo-information products and technologies have few applications in mitigation aspect.
- The MC, DDMCU and LUPPO use self prepared sketches.

**Table 4-2: Geo-information and technology usage in Risk Identification**

<table>
<thead>
<tr>
<th>Potential usage Risk Identification</th>
<th>Type of geo-information and technology</th>
<th>Actual usage is in the filed</th>
<th>National</th>
<th>Sub National</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GIS Software</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Technology</td>
<td>Web base data bases</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GPS</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Palm top computer system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Topographic maps</td>
<td>U</td>
<td>U</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Hazard base maps</td>
<td>U</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hazard zoning maps</td>
<td>P</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flood models and maps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Satellite images</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Local rain fall</td>
<td>U</td>
<td>U</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Local Flood levels</td>
<td>U</td>
<td>U</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Systematic data bases</td>
<td>P</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Community level maps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aerial photographs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reference:**
- P- Geo-information is produced and use
- Y- Technology is used
- U- Geo-information is taken from other source and use
- P1-Rough sketches for GN division
- U1-1:50000 Topographic map and province map

<table>
<thead>
<tr>
<th>“Can be used” and is used in the field</th>
<th>“Can be used” but is not used in the field</th>
<th>Not mentioned in literature yet and is used</th>
<th>“No need” to use and is not used</th>
</tr>
</thead>
</table>
Table 4-3: Geo-information and technology usage in Mitigation

<table>
<thead>
<tr>
<th>Type of geo-information and technology</th>
<th>National Level</th>
<th>Sub National</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIS Software</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Web base data bases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topographic maps</td>
<td>U</td>
<td>U1</td>
</tr>
<tr>
<td>Hazard base maps</td>
<td>U</td>
<td>U</td>
</tr>
<tr>
<td>Hazard zoning maps</td>
<td>P</td>
<td>U</td>
</tr>
<tr>
<td>Flood models and maps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satellite images</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local rain fall data</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Flood level data</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Systematic data bases</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>Community level maps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerial photographs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>P3</td>
</tr>
</tbody>
</table>

“Can be used” and is used in the field
“Can be used” but is not used in the field
Not mentioned in literature yet and is used
“No need” to use and is not used

Reference:
P: Geo-information is produced and use
P2: District multi hazard map
P3: Self prepared sketches of the area
P1: Land slide hazard density map
U: Geo-information is taken from other source and use
Y: Technology is used
U1: 1:5000 contour maps
4.2.3. **Preparedness Aspect**

The table 4-4 has been prepared to present actual and potential usage of preparedness aspect.

4.2.3.1. **Comments Related to Table 4-4**

- Five organizations engage in preparedness aspect. Only the component of monitoring and forecasting has been concerned in preparedness aspect.
- None of the organization use systematic data bases, community level maps, flood model, hazard base maps and web base data base system in monitoring and forecasting.
- The landslide areas are monitored by GN office. GN office keeps the self prepared sketches for identifying landslide area in the filed.
- Even excluding the cells “no need to use and not used”, it can be seen that green cells which indicate “can be used and is used in the field” are very few. This represents very less applications of technology and geo-information involved in disaster preparedness aspect.

4.2.4. **Emergency Response aspect**

The table 4-5 has been prepared to present actual and potential usage of emergency response aspect.

4.2.4.1. **Comments Related to Table 4-5**

- The 8 organizations engage in emergency rescue operation as follows.
  DMC, NBRO, GSMB - Damage assessment.
  MC, DDMCU, GN Office, SLP, Red Cross - Rescue and clean up activities.
- The district level organizations which engage in response activities seemed to have less users of geo-information products or technology in rescue operations. Although the number of geo-information products could be used according to the potential usage, the actual geo-information and technology in emergency response is very less.
- Only DMC use systematic data base for damage assessment.
- DDMCU and GN office use self prepared sketches for identifying risk areas.
- From the whole table it can be identify the geo-information and technology usage is very low.
Table 4-4: Geo-information and technology usage in Preparedness

<table>
<thead>
<tr>
<th>Type of geo-information and technology</th>
<th>Actual usage in the Field</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>National Level</td>
</tr>
<tr>
<td>GIS software</td>
<td>Y</td>
</tr>
<tr>
<td>Web base data bases</td>
<td></td>
</tr>
<tr>
<td>Topographic maps</td>
<td>U</td>
</tr>
<tr>
<td>Hazard base maps</td>
<td></td>
</tr>
<tr>
<td>Hazard zoning maps</td>
<td></td>
</tr>
<tr>
<td>Flood model and maps</td>
<td></td>
</tr>
<tr>
<td>Satellite images</td>
<td></td>
</tr>
<tr>
<td>Local rain fall data</td>
<td>U</td>
</tr>
<tr>
<td>Local Flood levels</td>
<td></td>
</tr>
<tr>
<td>Community level maps</td>
<td></td>
</tr>
<tr>
<td>Systematic data bases</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

Reference:
P: Geo-information is produced and use
Y: Technology is used
U: Geo-information is taken from other source and use
PI: Self prepared sketches

- “Can be used” and is used in the field
- “Can be used” but is not used in the field
- Not mentioned in literature yet and is used
- “No need” to use and is not used
Table 4-5: Geo-information and technology usage in Emergency Response

<table>
<thead>
<tr>
<th>Potential Usage</th>
<th>Emergency Response</th>
<th>Actual usage in the field</th>
<th>National level</th>
<th>Sub national</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of geo-information and technology</td>
<td>DMC</td>
<td>NBRO</td>
<td>GSMB</td>
<td>MC</td>
</tr>
<tr>
<td>GIS Software</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Web base data bases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palm top computer system</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Topographic maps</td>
<td>U</td>
<td>U</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazard base maps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazard zoning maps</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood model or maps</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satellite images</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Local rain fall data</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Local flood levels</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td></td>
</tr>
<tr>
<td>Systematic data bases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community level maps</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Aerial Photographs</td>
<td></td>
<td></td>
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<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1: District multi hazard map</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P2: Self prepared sketches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U- Geo-information is got from other source and use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y- Technology is used</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P- Geo-information is produced and use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reference:
P1: District multi hazard map
P2: Self prepared sketches
U- Geo-information is got from other source and use
Y- Technology is used
P- Geo-information is produced and use
4.2.4.2. Comments Related to all Tables 4-2 to 4-5

The information about users, producers, organizations which engage in each aspect of disaster management, potential usage and the actual usage have been provided by tables 4.2 to 4.5. In these tables, a considerable amount of cells are appearing as the geo-information products and technology that “can be used but is not used” in the field. The actual usage is represented by “can be used and is used in the field” and “not mentioned in the literature yet and is used” cells which represent green and pink colours respectively. When comparing the yellow cells with green and pink cells, the yellow appears more. Although a range of geo-information and technology is available in literature to use, only limited applications are being used in Ratnapura. This shows the gap in between actual and potential usage.

4.3. Critical Factors in Geo-information and Technology usage

Different factors influence the geo-information usage. If a factor can more influence the usage in a significant way, it is identified as “critical “factor. The level of influence is measured through the responses. If the majority of respondents perceive a factor as significantly important, it is identified as a critical factor relevant to geo-information and technology usage. It may give positive or negative influence.

4.4. Factors

The factors relevant to geo-information usage have found in two approaches, i.e. through interviews and through a work shop.

4.4.1. Factors Relevant to Interviews

The factors which were found through interview statements can also be presented in a table. The summary of factors and the responses in the interviews are given in the table 4-6. The findings have been categorized into major factor categories.

Table 4-6: Factors and responses relevant to filed work

<table>
<thead>
<tr>
<th>Factors</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organizational</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Organizational routine</strong> (Related official procedure to use GIS)</td>
<td>1. “One officer is fully occupied for GIS mapping work, another one assigned for Landslide risk assessment field inspection” (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. There is an official procedure to use GIS (2.3 in appendix IV.2).</td>
</tr>
<tr>
<td><strong>Employee acceptance</strong></td>
<td>1. Technically qualified staff can easily grasp knowledge (2.7, 2.15 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. “Even though trained people are willing to teach some officers, they are not encouraged enough to learn software” (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>3. The technology acceptance is at satisfactory level (2.9 in appendix IV.2).</td>
</tr>
<tr>
<td>Factors</td>
<td>Responses</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Knowledge sharing</strong></td>
<td>1. “We share our knowledge, If I know something I will not hesitate to teach another one” (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. “Officers who gain knowledge teach others also” (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>3. “As everybody try to keep specialty, knowledge sharing is not totally satisfactory among staff” (2.15 in appendix IV.2).</td>
</tr>
<tr>
<td><strong>Cooperation among branches</strong></td>
<td>1. Two branches, working together is an advantage to accomplish the task (2.2 in appendix IV.2).</td>
</tr>
<tr>
<td><strong>Data</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Data availability at a required scale</strong></td>
<td>1. Scale of contour maps which is used for development control is not enough (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. At least 1:2000 scale maps are required for accurate map preparing (2.3 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>3. NBRO is in need of large scale digital base maps for preparing spot wise identifying zoning maps (2.4 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>4. 1:10,000 digital maps are not available for whole country (2.5, 2.1 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>5. “Available data scales are not enough. At least 1:10,000 data are needed” (2.11, 2.1 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>6. Unavailability of data at required scale is a problem in hazard maps and modelling (2.15 in appendix IV.2).</td>
</tr>
<tr>
<td><strong>Availability of digital data sets</strong></td>
<td>1. “There are no digital data to get at required time” (2.12 in appendix IV.2).</td>
</tr>
<tr>
<td><strong>Availability of update data</strong></td>
<td>1. “Contour maps were prepared in year 1996 and now topography has changed” (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. “On average data is update” (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>3. “Non availability of update base contour map for required scale is a serious issue” (2.1 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>4. Land use is not updated in 1:50,000 scale maps. Vulnerability is changed with the changing land use (2.4 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>5. Unavailability of update data is a problem in hazard maps and modelling (2.15 in appendix IV.2).</td>
</tr>
<tr>
<td><strong>Information are in standard format (Data compatibility)</strong></td>
<td>1. “Some time we experienced data incompatibility. Eg: extent is not matched with the Census Department” (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. “We face with data compatibility problems” (2.1 in appendix IV.2).</td>
</tr>
<tr>
<td>Factors</td>
<td>Responses</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Data arrangement (Data bases)</td>
<td>1. “There is no way to get information at one place” (2.17, 2.12 in appendix IV.2).</td>
</tr>
<tr>
<td>Reluctance to share data</td>
<td>1. Unwillingness to share data among organizations is a problem in hazard maps and model producing (2.15 in appendix IV.2).</td>
</tr>
<tr>
<td>Data Restrictions</td>
<td>1. Data restrictions from producers have become a barrier (2.1 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. Restriction to show contours on hazard maps is a disadvantage for visualizing hazard areas (2.3 in appendix IV.2).</td>
</tr>
<tr>
<td>Data Accuracy (Correctness)</td>
<td>1. 1:50,000 sheets accuracy is not satisfactory level (2.1 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. “Some layers are overlapped in 1:50,000 sheets” (2.5 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>3. Data accuracy is a problem (2.12 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>4. The inaccurate data is a problem in hazard maps and modelling. “One time we found that very old tank is not in 1:50,000 sheets” (2.15 in appendix IV.2).</td>
</tr>
<tr>
<td>User Friendly Data</td>
<td>1. “Contour maps are very difficult to read” (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. Land slide zoning maps prepared by NBRO are difficult to read. Information is not enough to identify areas (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>3. “Section wise data gained from Survey Department take much time to merge” (2.1 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>4. Lowest administrative levels (GN level) are not shown in maps (2.3 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>5. “Colour contrast of 1:50,000 maps are not good. It’s difficult to read” (2.5 in appendix IV.2).</td>
</tr>
<tr>
<td>Data Cost</td>
<td>1. Data expensiveness has become a barrier (2.1, 2.3, and 2.9 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. “Price is not a problem because only limited people use products” (2.5 in appendix IV.2).</td>
</tr>
<tr>
<td>Data Completeness</td>
<td>1. “Contour map for the central area of municipal limit was missing” (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td>Man power</td>
<td></td>
</tr>
<tr>
<td>Trained staff</td>
<td>1. “Only one officer out of 4 technical officers in work branch knows to work in GIS” (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. “Staff has to be trained” (2.2, 2.11, 2.12, 2.17 in appendix IV.2).</td>
</tr>
<tr>
<td>Factors</td>
<td>Responses</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>3. “We have trained staff in GIS. But trained staff leaves the organization looking for higher wages, we need GIS experts” (2.3 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>4. “Resources such as staff, knowledge, financial, are adequate to follow current functions” (2.6 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>5. “Technical staff should be trained new technology” (2.15 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>6. “We have only one IT specialist in GIS branch. We are in need of GIS trained staff as still they are not recruited” (2.1 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>7. Some officers are knowledgeable in GIS. But respondent mentioned staffs are needed to be trained (2.9 in appendix IV.2).</td>
</tr>
<tr>
<td>Size of the technical staff</td>
<td>1. “Number of staff is not enough in work branch. All are more occupied in work” (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. “We have only five GIS trained officers, Number of staff is not adequate” (2.2 in appendix IV.2)</td>
</tr>
<tr>
<td></td>
<td>3. “Number of staff is not sufficient for current functions” (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>4. “We have only one IT specialist in GIS branch” (2.1 in appendix IV.2).</td>
</tr>
<tr>
<td>Support from higher authorities on technology</td>
<td>1. “No body was sent for Year 2004 technical training by higher authorities” (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>2. A respondent indicated that director technology is GIS well known officer and gives maximum support to develop hazard base maps (2.1 in appendix IV.2).</td>
</tr>
<tr>
<td>Decision taker’s (in central offices) knowledge about technology</td>
<td>1. A respondent indicated that the decision makers at central offices are from good technical back ground (2.15 in appendix IV.2).</td>
</tr>
<tr>
<td>Technology</td>
<td>1. Only the AutoCAD software is used in the work branch. There are no scanners, not enough computers (2.7 in appendix IV.2).</td>
</tr>
<tr>
<td>Availability of Equipments, Hardware, Software</td>
<td>2. Although computers are available hand held GPS was a requirement (2.1, 2.9 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>3. The software Arcinfo and Arcview was available. ArcGIS, fascination with new technology and internet facilities were requirements (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td></td>
<td>4. The UDA is in need of multi media set, more computers, laptops and GPS (2.12 in appendix IV.2).</td>
</tr>
</tbody>
</table>
5. GIS software, more computers, scanners and digitizing tables are mentioned as requirements. “available technologies are not inadequate to prepare flood model” (2.15 in appendix IV.2)

6. The Police Department is in need of compass (2.16 in appendix IV.2).

7. Plotters and ArcGIS software are requirements (2.2 in appendix IV.2).

8. Although hardware software and technology were available new computers, Printers, Photocopy Machines, Handheld GPS were also mentioned as requirements (2.3 in appendix IV.2).

9. Current technology is at satisfactory level (2.6, 2.5 in appendix IV.2).

### Political influences

1. “Considering hazard in development control has become useless. We have to give electricity and water permission for illegal constructions due to political interference” (2.7 in appendix IV.2).

2. “With the government change newly appointed ministers promote new concepts and LUPPO also prepare their programmes parallel to them. With proposed programme such as “Gamaneguma” they tend to expedite land use zoning mapping” (2.11 in appendix IV.2).

### Financial Resources to acquire and maintain GI and technology

1. “There is only 100 rupees in the Disaster Management vote” (2.7 in appendix IV.2).

2. “We need more funds on vehicle repairing, and acquire new technology” (2.11 in appendix IV.2).

3. “Fund allocations for equipments are not enough” (2.2, 2.5, 2.12 in appendix IV.2).

4. Financial Constraints had become barrier to buy equipment when necessary (2.3 in appendix IV.2).

5. Financial resources are adequate to follow current functions (2.6 in appendix IV.2).

6. “Due to financial problems flood model is delayed” (2.15 in appendix IV.2).

### Funding by foreign agencies

1. “Flood mapping project is funded by UNDP. It is difficult to conduct flood mapping only by the department funds” (2.2 in appendix IV.2).

2. UNDP Financially support on training (2.1, 2.9 in appendix IV.2).
### Factors

<table>
<thead>
<tr>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. The future programmes will be funded by foreign projects (2.6 in appendix IV.2).</td>
</tr>
<tr>
<td>4. Resources are available because of IFRC project (2.17 in appendix IV.2).</td>
</tr>
<tr>
<td>5. Funds will be received for future programmes (2.6 in appendix IV.2).</td>
</tr>
</tbody>
</table>

### Sustenance Approaches

#### Indigenous Knowledge through Public Participation.

<table>
<thead>
<tr>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “When LUPPO gives recommendations to change land use, gets indigenous knowledge from communities to propose suitable crops. Some time people living in the particular area provide better information and proposals through their experiences.” (2.11 in appendix IV.2).</td>
</tr>
<tr>
<td>2. Community level mapping is done through public participation (2.17 in appendix IV.2).</td>
</tr>
</tbody>
</table>

#### Perception of Society

<table>
<thead>
<tr>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Although municipality does not approve building plans in hazard areas, people build illegally (2.7 in appendix IV.2)</td>
</tr>
</tbody>
</table>

#### Existence of growing demand

<table>
<thead>
<tr>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “Government offices take land use maps only for displaying purposes, Maps are very rarely used by people. Even government officers have no map culture. They may not know our productions” (2.11 in appendix IV.2).</td>
</tr>
</tbody>
</table>

#### Other Resources

<table>
<thead>
<tr>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. “DMC is still established in a rent out building. For establishing good GIS unit, office space is not enough.” (2.1 in appendix IV.2).</td>
</tr>
</tbody>
</table>

**Note:**
- The responses from UDA in Colombo were not taken in to account for preparing the table because the UDA in Colombo has no direct responsibility of disaster management activities in Ratnapura.
- The respondents have given their opinions in their own words. I have interpreted their own statements to factors and factor categories. When comparing with factors in literature, there were some differences in the field. Some new factors could be identified in interviews.
- A number of organizations emphasised that they are provided foreign funds. Therefore, a new factor called “funding by foreign agencies” has been created. According to the field work findings, only two organizations mentioned that they are financially supported for training programmes by UNDP (2.1 and 2.9 in appendix IV.2). Those agencies are also included in funding by foreign agencies.
• The responses such as “There is no way to get information at one place” are perceived as data bases requirements.
• Finally, 27 factors classified in to 8 factor categories, could be identified during the interviews (appendix IV.5).

New Factors Mentioned by Organizations
• “Co-operation among branches to accomplish the task” under organizational factor category.
• “Data accuracy”, “data expensiveness”, “data restriction”, “data completeness”, and “user friendly data” under the data category.
• “Size of the technical staff” under man power factor category.
• “Funds by foreign agencies” under financial category.
• “Office space” as other resources.
• “Knowledge sharing among the staff” under organizational factors.

4.4.1.1. Summary of Factors in Interviews
The factors which were mentioned by organizations (table 4-6) were arranged in a table (appendix IV.5). According to the frequency of mentioned by the organizations, the factors have been ranked within their categories.

Findings on ranking under each category (appendix IV.5):

Organizational
• The employee acceptance of technology has been more valued under organizational major factor category.

Factors relevant to Data
• Data in appropriate scale has been highly valued.
• Data accuracy (correctness) and user friendly data has been considered as second priority in data category.

Manpower
• Trained staff in manpower seemed to be more important in manpower category.
• Size of the technical staff identified as a new factor.

Financial Factors
• Financial resources in acquiring GIT have been more valued within financial category.
• Funding resources from foreign agencies have become influencing factor.

Sustenance Approaches
• Acquiring indigenous knowledge through public participation under sustenance approaches has been mentioned by two organizations.

Technology
• Availability of software and hard ware seemed to be most important.

Political Factors
• Political influences are very rarely mentioned.
4.4.1.2. Critical factors relevant to interviews

The factors were ranked without considering their categories (appendix IV.6) and the eleven prioritized factors are given in table 4-7. When the factors were ranked without considering categories, the frequencies varied from 11 to 1 (appendix IV.6). Prioritized factors varied between 11 and 4.

Table 4-7: The critical factors in the interviews

<table>
<thead>
<tr>
<th>Factor</th>
<th>No of organization mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of software, hard ware and equipments</td>
<td>11</td>
</tr>
<tr>
<td>Trained Staff</td>
<td>10</td>
</tr>
<tr>
<td>Data in appropriate scales</td>
<td>8</td>
</tr>
<tr>
<td>Financial resources on acquiring GIT</td>
<td>8</td>
</tr>
<tr>
<td>Data Accuracy</td>
<td>5</td>
</tr>
<tr>
<td>User friendly data</td>
<td>5</td>
</tr>
<tr>
<td>Funding resources from foreign agencies</td>
<td>5</td>
</tr>
<tr>
<td>Employee acceptance of geo-information technology</td>
<td>4</td>
</tr>
<tr>
<td>Data cost</td>
<td>4</td>
</tr>
<tr>
<td>Availability of update data</td>
<td>4</td>
</tr>
<tr>
<td>Size of the technical staff</td>
<td>4</td>
</tr>
</tbody>
</table>

4.4.2. Factors Relevant to Workshop

The findings over seven factor categories have been presented in the appendix IV.3. The factors are rated giving marks as follows.

Strongly agree-1   Agree-2   Neutral-3   Disagree-4   Strongly Disagree -5

All of the factors except the political influence have got average marks below 2.5 (appendix IV.4). Since average marks vary between 1.27 and 2.47, it indicates that the 16 factors used in the workshop have been accepted as important by the participants. Getting average marks 3.33 by political influences, also more close to neutral. But it is not disagree. Then it can be seen that all factors except political influences had been considered as more affected factors (according to workshop results). The factor prioritization within each of the factor categories has been described as follows (see appendix IV.3).

Finding on ranking (see appendix IV.3):

Technology

- The availability of soft ware, hard ware and equipments has become more important in technology.
Organizational Factors

• According to average marks gained by each factor, existing official procedure to use GIS has been highly valued.
• Employee acceptance of geo-information has been selected as second importance.

Factors relevant to Data

• Availability of digital data has been identified more important.
• Availability of update data has become second important factor relevant to data.
• Data compatibility has been identified as less importance compared with other factors.

Manpower

• Timely and sufficiently trained staff has been identified more important.
• Decision maker’s knowledge about technology can be identified as second importance.

Financial Factors

• Funding resources to acquire geo information and technology has been identified as more important.

Sustenance Approaches

• The perception of society about hazard has been identified more important.
• Existing of demand for useful information has been identified as second important.

Political Factors

• Political influences seemed to be least important with compared to all other factors.

4.4.2.1. Critical factors relevant to workshop

According to work shop results, the factors (without considering the factor categories) have been ranked (see appendix IV.4). The eleven prioritized factors are in table 4-8.

Table 4-8: Work shop Results Relevant to Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Ave. Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timely and sufficiently trained Staff</td>
<td>1.27</td>
</tr>
<tr>
<td>Availability of digital data</td>
<td>1.27</td>
</tr>
<tr>
<td>Availability of software hardware and equipments</td>
<td>1.33</td>
</tr>
<tr>
<td>Availability of update data</td>
<td>1.33</td>
</tr>
<tr>
<td>Data arrangement and maintain system like data bases</td>
<td>1.40</td>
</tr>
<tr>
<td>Decision makers knowledge about technology</td>
<td>1.47</td>
</tr>
<tr>
<td>Availability of data in appropriate scales</td>
<td>1.53</td>
</tr>
<tr>
<td>Willingness to share data</td>
<td>1.60</td>
</tr>
<tr>
<td>Funding resources to acquire Geo-information, GIS, Geo-</td>
<td>1.60</td>
</tr>
<tr>
<td>information technology</td>
<td></td>
</tr>
<tr>
<td>Funding on training and research programmes</td>
<td>1.73</td>
</tr>
<tr>
<td>Perception of society about hazard</td>
<td>2.00</td>
</tr>
</tbody>
</table>
4.4.3. Comparison of Workshop Results and Interview Results

The first eleven factors from the workshop results, and the interview results, have been arranged to show the similarities and difference in both approaches. The results of table 4-7 and table 4-8 were used to prepare table 4-9.

Table 4-9: The similarities and differences in workshop and interview results

<table>
<thead>
<tr>
<th>Work Shop Results</th>
<th>Interview Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trained Staff</td>
<td>Trained Staff</td>
</tr>
<tr>
<td>Availability of software hardware and equipments</td>
<td>Availability of software hardware and equipments</td>
</tr>
<tr>
<td>Availability of update data</td>
<td>Availability of update data</td>
</tr>
<tr>
<td>Availability of data in appropriate scales</td>
<td>Data in appropriate scales</td>
</tr>
<tr>
<td>Funding resources to acquire GIT</td>
<td>Financial resources on acquiring GIT</td>
</tr>
<tr>
<td>Decision makers knowledge about technology</td>
<td>User friendly data</td>
</tr>
<tr>
<td>Availability of digital data</td>
<td>Funding resources from foreign agencies</td>
</tr>
<tr>
<td>Data arrangement and maintain system like database</td>
<td>Data Cost</td>
</tr>
<tr>
<td>Funding on training and research programmes</td>
<td>Data Accuracy (Data correctness)</td>
</tr>
<tr>
<td>Perception of society about hazard</td>
<td>Size of the technical staff</td>
</tr>
<tr>
<td>Willingness to share data</td>
<td>Employee acceptance of geo-information technology</td>
</tr>
</tbody>
</table>

Findings:
Similar factors such as availability of data in appropriate scales, trained staff, funding resources to acquire GIT, availability of update data, availability of software, hard ware and equipments were prioritized by respondents in workshop and interviews.

Note:
In addition to the comparison of critical factors, two remarkable findings could be identified through the workshop results and the interview results (appendix IV.4 and appendix IV.6).

When the factors are ranked, without considering their categories availability of digital data and perception of society about the hazard have been mentioned as critical factors by workshop participants. Those two factors have come to first 11 factors in the workshop.

But according to the interview results those two factors are not considered as much influencing factors.

From the both approaches (workshop and interviews), the identified critical factors are tabulated in table 4-10. Those factors were selected from the prioritized factors in interview results and the work
shop results (table 4-9). According to that 17 critical factors have been categorised in to six categories in the table 4-10.

Table 4-10: Critical factors from work shop and interviews

<table>
<thead>
<tr>
<th>Factor Category</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Availability of software hardware and equipments</td>
</tr>
<tr>
<td>Organizational</td>
<td>Employee’s acceptance of geo-information technology</td>
</tr>
<tr>
<td>Manpower</td>
<td>Trained Staff</td>
</tr>
<tr>
<td></td>
<td>Size of the technical staff</td>
</tr>
<tr>
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<td>Decision makers knowledge about technology</td>
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<td>Sustenance Approach</td>
<td>Perception of society about hazard</td>
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4.5. Summary

The following can be observed from the tables 4-2 to 4-5.

- It has been identified that there is a gap (Chapter 4.2.4.2.) between the potential and actual usage of the geo-information and technology. Considering all the tables (4-2 to 4-5) it can be concluded that the geo-information and technology has very limited applications in disaster management.
- When compared to other aspects, the emergency response makes the least use of geo-information and technology (table 4-5 in Chapter 4.2).
- Topographic Maps are applied more than other geo-information products in disaster management (tables 4-2 to 4-5 in Chapter 4.2).
- Some organizations employ self prepared sketches in disaster management activities (tables 4-2 to 4-5).
- National level organizations use more GIS than sub national level organizations (Chapter 4.2 tables 4-2 to 4-5).

Based on interviews and the workshop, identified critical factors are shown in table 4.10. In addition to that, similarities and differences in factors in both approaches were also observed. Some new
factors which are not mentioned in the literature were found in the field (Chapter 4.4.1). Trained staff and availability of hardware and software have been highly valued in both approaches. Some factors which were highly valued in workshop have not been valued in interviews. The local knowledge is highly valued higher than the technology (2.8, 2.17, and 2.16 in appendixes IV.2) in disaster management.

Although workshop participants and individual interviews indicated that political influences are less important in technology adoption, the SLUMDMP respondents mentioned the political influences (3.2 in appendix IV.2). The SLUMDMP efforts seemed to be difficult to assess during the field work (3 in appendix IV.2).
5. Interpretation

5.1. Introduction

This chapter addresses the issues (inconsistencies and highlighted finding) which arose in chapter 4. Those issues are more discussed in light of previous findings, experiences and the theoretical foundations which were given in chapter 2. The sequence of discussion as follows: First the gap is addressed and then the degree of sustainability of project results.

5.2. The gap in the potential and actual usage

The Chapter 4.2.4.2 represented that geo-information and technology has very limited applications in disaster management.

The question is how this can be explained. A number of factors are further discussed:

1) The preference of using local knowledge and experience over technological usage
2) Bureaucratic inertia

1) Local knowledge: Examples in 2.8, 2.17 in appendix IV.2 indicated that people prefer to use indigenous knowledge when dealing with floods, also because as stated 3.1 in appendix IV.2 many products of the technology are too complicated to read or understand, or as stated 3.2 in appendix IV.2, simply not useful. In general, there is a tendency among “ordinary citizens” to feel very negative about the usefulness of the technology for their own environment. This raises a dilemma for the designers of the GI systems, namely how to design in such a way that the products appeal to local citizens, and that they can immediately see the benefits in their own environment.

2) Bureaucratic inertia: The section 2.7 in appendix IV.2 in indicates the unwillingness of higher authorities in municipal council to sustainable engage in new technologies. 3.3 in appendix IV.2 indicated that projects depend on political attitudes. Even though, as stated in table 2.1 (Chapter 2.6) – embedding in organizational structures may provide more drive towards fully exploiting the technology, political will and political lobbying seems to have a strong effect here. On the other hand, this seems to conflict with what was found during the workshop. Individual workshop members indicated that political reasons may not account for willingness to adapt or not. Perhaps it is not the elected politicians, but the higher/senior officials within the government organizations. They also have an intra-organizational political interest. Lebel (2005) refers to this as “the politics-of-scale”, meaning that people within the government engage more in discussions over who has authority over what area, than who has authority (and responsibility) over what event. This leads to bureaucratic inertia. The bureaucratic inertia may place a gap in actual and potential usage. If politicians were invited to the workshop the results may be different.

5.2.1. The local knowledge is highly valuable

As stated above, most of visited organizations highly believe that local level experiences are enough to manage disaster events. As was stated 2.17 in appendix IV.2, such an attitude is fostered by
international NGO’s, such as the Red Cross. According to the respondent at District Secretariat office the local knowledge of the people is enough to manage flood situation. If the respondent uses maps in daily life he had never used maps or any kind of geo-information product in a decision making in disaster situation (2.8 in appendix IV.2.).

This attitude may have several (historical) reasons:

1) It may be due to lack of awareness of geo-information products which can be used in disaster management. 2.9 in Appendix IV.2 indicate that much of the technology is foreign and thus not developed in-house. Such a practice reduces the ownership and responsibility that individuals have, and as a result that a whole organization may have. The study of (Jarvenpann and Staplesa, 2001) shows how this principle works. It can be concluded that less awareness of products leads to low usage.

2) It may be due to cultural beliefs: The underlying reasons for resistance are partly explained by Montoya in 1999, “the perception of hazards in developing countries tends to be more dependent upon religious views and therefore, natural hazards are seen as “Act of God” that cannot and should not be prevented and only their consequences dealt with (Montoya, 1999). This statement may be same for Ratnapura. “People live in Ratnapura believe that God belong to area, protects them in disaster situations” (SLRCS, 2007).

As a person who live and born in Ratnapura, even higher officers in government service (2.8 in appendix IV.2.) may have the same perceptions about the hazards. It may cause not attempt to use any kind of technology to reduce the effect of flood. But further study is needed to come to conclusion.

5.2.2. The national level organizations use more GIS than the sub national level organizations

All tables (tables 4.2-4.5) provide evidence that national level organizations seem to use more GIS software than sub national level organizations in the current functions. This provides the argument why sub national level organizations apply less, and how most of national level organizations such as the DMC, NBRO, and Irrigation Department use GIS software. GIS licensed software is used only by LUPPO, UDA Ratnapura, and the Irrigation Department at sub national level (DDMCU use software borrowing from colleagues).

This may be due to lack of resources such as:

1) Trained staff: Although the lack of trained staff has been mentioned by sub national level organizations (2.7, 2.11, 2.15, 2.17 in appendix IV.2) the findings are not adequate to conclude. The national level organizations also have mentioned about lack of trained staff (2.1, 2.4, 2.3 in appendix IV.2).

2) Equipment and technology: The table 4.1 in Chapter 4.2 show that equipment such as printers, computers, scanners, internet facilities, plotters, digitizers are available at national level organizations more than sub national level organizations (National level and sub national level
organizations are clearly mentioned in Table 3.1). And also some organizations in sub national level depend upon the equipments in their national level organizations (2.15, 2.12 in appendix IV.2). According to Frantzova et al. (2005) availability of technology and financial resources are important in risk management. Because some of organizations contribute risk management by preparing maps, land use management and data collection for flood model, the lack of technology and financial resources are affected to GIT in disaster management. In my personnel experience, national level offices have more resources than sub national level. Since my field work findings are not included number of trained staff, financial capacities and number of equipments such as computers, printers in each organization, I am inclined to think that geo-information and technology usage is influenced by availability of resources. But further study should be done to validate results.

3) Technology has not been institutionalized: The section 2.7 in appendix IV.2 indicates that still the municipal council has not been exposed to technology. Although AutoCAD software is used in work branch, GIS is not applied. Their computer capacities and speeds are also low (3.1 in appendix IV.2 “useless to spend money on repairing computer, because speed is slow”). Yaakup et al. (1997) has written that information management systems are an important issue in GIS implementations at local level authorities. No proper information management system within the organization may be affected to embedding GIS into organization. It may be due to inadequate hardware in the municipality.

5.2.3. Political power influence geo-information usage

The Chapter 2.6 and section 2.11 in appendix IV.2 show that the changing political power encourages implementation of projects related to disaster management. But sections 3.2 and 2.7 of appendix IV.2 indicate that geo-information usage has been badly affected by political power changes. This provides an argument political reasons affect to success and failure of the projects. There may be some reasons behind that.

1) Individual Characteristics: The politicians may deal with technical matters on their individual characteristics. According to the statement of highest authority in the Municipal Council “I try to fulfil the requirements in technical department with available resources” (2.7 in appendix IV.2) can be interpret as not a strong statement as “I will try to find resources to fulfil the requirements”. The higher authorities seemed to be more concerned about the work and not the resources. If the resources are available he may supply. Observations showed the higher authority in the Municipal Council seemed not much aware about technology.

Maskrey (1991) has mentioned that mitigation depends on political interest. Most probably, interest comes from the individual characteristics. On my own experience I have seen that when the politicians come from professional back ground such as engineers, doctors they like to promote their own filed. It may be due to the knowledge in the own field.

As described before, politicians may also believe the local knowledge more than technology. Since the local level politicians are inhabitants of the area, they can have similar cultural beliefs. According to that, they may not be very supportive to mitigation activities based on technology. But further study should be done to examine the effect of professional background.
2) Policy Shift: The findings provide that with the political power change, the functions started by previous politicians are neglected by newly appointed politicians (sections 2.7, 3.3 in appendix IV.2). Newly appointed politicians may have a culture of innovation. If the previous politicians are opposition to their thoughts, new people may be reluctant to start from the stopped point of previous politicians.

Politicians have vital role in resources allocations, Act establishment, policy formulations and institutions establishing. The all of activities are affected to technology improvement in an organization. On personnel experience, I can further add at the initial stage politicians back up development programmes. But they loose the interest before the end of the task. It may be due to exhausting allocated resources such as funds on the particular tasks. It may be due to characteristics of policies. Since my field work findings are not enough to come to conclusions it should be verify by further research.

5.2.4. When compared to other aspects the emergency response makes the least use of geo-information and technology.

The Sri Lanka Police, Red Cross and the Municipal Council Office do not use any kind of geo-information technology in emergency operations.

There may be some reasons for not using any kind of geo-information product.

1) Unawareness of potential: The responses of Police Department indicate that they are in need of compasses and maps for quick responses (2.16 in appendix IV.2.). It can be interpreted that the Police Department is in need of direction or location identification in disaster management. But it has not been mentioned that they use computers, GPS or GIS overlaying techniques. Apparently the Police Department has not been exposed to this technology. The statement of “government department does not acquire technology rapidly” (2.15 in appendix IV.2) and “Even government officers have no map culture” (2.11 in appendix IV.2) indicates that government offices are not exposed to the technology and geo-information. It can be attributed to unavailability of maps, hard ware and software to use. Similarly, Frantzova et al. (2005) have written “risk management process depend upon the availability of technology”. Unawareness of the technology depends upon the unavailability of technology. Then the unavailability of technology creates the gap between actual and potential usage.

2) Reluctance to change attitudes: At the same time, the Police Department believe the local knowledge about the flood is also more useful (2.16 in appendix IV.2). The Red Cross also suppose that local knowledge in citizen is enough to manage disaster (2.17 in appendix IV.2). These issues may come with the cultural beliefs (already discussed in Chapter 5.2.1).

3) Unawareness of producers: Although the Health Department in Municipal Council engages in emergency response activities, responses indicate that the Municipal Council also does not use much GI in their work (2.7 in appendix IV.2). This may be due to unavailability of geo-information or unawareness of potential usage. According to the responses in section 2.7 of appendix IV.2, it can be seen that not only lack of knowledge to refer maps but also unknowing the place to get map. Similarly
Divitura (2005) says that the unawareness of producers and lack of knowledge to refer maps affects usage. It may be due to lack of training about the products.

The above discussion shows that the reasons for no usage of any kind of geo-information products in emergency responses may be due to unavailability of products to use, lack of training to use and cultural beliefs. It influences the actual usage in negative way.

5.2.5. Topographic maps use more than other geo-information products

According to the field work findings (see tables 5.1-5.4), topographic map has been used more than any other geo-information products. This practice may have several reasons.

1) Availability of maps: Most organizations have topographic maps (table 4.1). The field work findings show that no organization uses hazard base map, flood model, or community level maps in disaster management aspects (tables 4-2 to 4-5 in Chapter 4.2). The flood models (by Irrigation Department), hazard base map (by DMC), and community level maps (by Red Cross) are still in the process of preparing (appendix IV.1 current functions of organizations). This may be the reason to use only the topographic map for disaster management activities. Sahay and Walsham (1996) has mentioned that data availability has an influence on usage. High usage of topographic maps may be due to the unavailability of other products.

2) Low price: Kohler (2005) says that “Topographic maps are used for micro scale demonstrations where as satellite images play an important part visualizing macro scale processes and changes of the landscape”. This statement indicates that the satellite images can be successfully applied than topographic maps. But the satellite images are used by Meteorological Department and UDA in Colombo (2.3, 2.6 in appendix IV.2). Montoya in 2005 has written “Satellite images are used in disaster management due to high resolution. But cost is very high and can not be achieved most of developing countries”. If the satellite images can be used in rapid damage assessment (Poona et al., 2006) high cost may be the reason for no usage. As stated by scientists low price of topographic maps may increase usage.

Although Meteorological Department uses satellite images for weather forecasting, the UDA uses for development planning activities. Field work findings prove that those organizations are funded by foreign agencies. This proves that financial matters such as high cost of product and availability of financial resources to acquire GI affects usage.

3) Ability to use more purposes: Topographic maps consist of datasets such as geodetic points, roads, buildings, and height points (DMC, 2007). According to the field work findings most of organizations partly contribute to disaster management activities. Their main responsibilities are different. Then those organizations have trend to use topographic maps on their main responsibilities too. This can be conclude that high usability enhance the usage.

The above discussion prove that availability of maps, low price and usability for more purposes increase the usage.
5.2.6. Some organizations employ self prepared sketches in disaster management activities in tables 4.2 - 4.5.

According to field work findings GN Office and Red Cross had prepared sketches for marking hazard areas within GN boundaries. It may be due to unavailability of maps to use. But Red Cross has 1:50,000 topographic maps in their offices. Then there may be another reasons to prepare own sketches. It may be due to no knowledge to refer maps, maps are not clear, or necessary information are not mentioned in the maps. On my observations Red Cross officer were able to read maps.

The field work findings (2.7, 2.4, and 2.5 in appendix IV.2) provide some examples of maps are not readable, not user friendly and non availability of necessary data (GN level-lowest administrative boundaries). De Man in 2002 says that “Lack of readily available data is a weakness”.

Although 1:5000 contour maps are used by the Municipal Council for development control plan approvals, self prepared maps are used for awareness programmes (2.7 in appendix IV.2). Contour maps are not suitable for location identification. The Municipal Council may prepare sketches because there is no other information to use. According to Shrestha (2007), lack of data is critical to geo-information usage in local authorities.

On the above discussion illustrates that unavailability of necessary information as well as available products are not user friendly influence the usage of GI products.

5.2.7. The trained staff is highly valued in field work findings

Giving the preference to trained staff by the majority of organizations during the interviews and work shop results indicate the trained staff as an important factor in geo-information utilization. The statements of “we are in need of trained staff” (2.1 in appendix IV.2), “staffs is in need of training” (2.2 in appendix IV.2) and “trained staff leaves the organization looking for higher wages” (2.4 under appendix IV.2) provide the evidence of most of organizations mentioned about the trained staff is important under man power.

There may be different perspectives.

1) It may be due to lack of GIS operators: According to the respondent, GIS operators have not been recruited to the DMC yet (2.1 in appendix IV.2). Sahay and Walsham (1996) refer “the shortage of manpower is inhibiting factor related to GIS” and Iglesias (2005) mentioned “Town Lalithpur in Nepal see value of trained personnel in GIS adoption”. When the GIS operators are not available to use GIS, it causes the gap between the actual usage and potential usage. It can be concluded that lack of trained staff is critical factor in geo-information usage.

2) Employee acceptance of technology: The statement of “Even though trained people willing to teach some officers they are not encouraged enough to learn software” (2.11 in appendix IV.2) proves that employee acceptance is not satisfactory in some organizations. It may be due to fear of change, computer related anxiety, higher authority control over work. Sieber in 2000 (Chapter 2.6) has explained that similar reasons effects in GIS implementations. It may cause the gap in technology usage.

It can be concluded that trained staff and the employee acceptance are critical factors in geo-information usage.
5.2.8. **New factors found during the filed work**

As described in chapter 4.4.1, new factors could be identified during the interviews, in addition to the factors mentioned in the workshop.

According to Dieh and van der Heide (2005) geo-information needed depends upon the characteristics of disaster, geographical, social, economic, institutional, legal and technical environment. Although Dieh and van der Heide (2005) have not mentioned about the factors which influence the usage, it was taken in to account that the factors which influence the usage also depend upon geographical, social, economic, institutional, legal and technical environment.

Similar to the above explanation, the identified new factors are very relevant to Ratnapura, and those may be different from factors which were found in literature.

The government of Sri Lanka has restricted to issue sensitive data to government agencies due to defence reasons (2.4 in appendix IV.2). As a country in war, such types of restrictions are very relevant to Sri Lanka and it affects usage.

Complaints about data expensiveness (2.4, 2.1, and 2.9 in appendix IV.2), lack of office space (2.1 in appendix IV.2) and depending on foreign funds to acquire technology (2.2, 2.6, and 2.17 in appendix IV.2) are the example of economic reasons which restrict usage.

Although the “size of the staff” has not been reviewed in literature as an influencing factor, it greatly affects to functions of the organizations in my professional experience. This can prove by the examples of “If I know this document is valuable I have no time to read it” (3.1 in appendix IV.2) and “Number of staff is not sufficient for current functions” (2.11 in appendix IV.2). Most of the time people are over occupied on duties due to lack of staff. This caused problems during the filed work also (Chap. 3.4.2.). These issues may be due to institutional or economical reasons.

Knowledge sharing among staff and cooperation among branches to accomplish the task were identified as new factors during the interviews. Jarvenpam and Staplesa (2001) partly explain the acts like helping, sharing, and volunteering are not directly rewarded. But this contributes the organizational performance. This theory was found after the filed work and can be added to literature as influencing factor although it has not directly mentioned about geo-information usage.

According to the above discussion it can be concluded that geo-information need as well as factors which influence the usage of geo-information depends upon economic, institutional, social, legal and technical environment.

5.2.9. **Similarities and Differences in Workshop and Interview Results**

The chapter 4.4.3 provides some similarities of work shop results and interview results. Five similar factors can be found from first 11 critical factors in interview results and work shop results. This may be due to the most of respondents in the interviews also participated to factor rating exercise.

The factors which were derived through literature review are not specific application area and those are general in GIS implementation, adoption and diffusion within an organization. This study shows that some those factors are applicable in geo-information usage in disaster management context.

Some factors which were highly valued in workshop have not been valued in the interviews (Chapter 4.4.3). During the work shop, factors were given to people in a structured way. But in open
interviews, factors were recognized from the discussions with the respondents. Factors which were revealed through the interviews show the insight of the people. But most of the time interviews were disturbed by telephone calls and clients. Some interviews were conducted within very limited time and officers restricted time due to they are over occupied on their own duty. This may results to get low frequencies over some factors. If I had more time to interview them, different results could be obtained. Limitation of interviewed time and interruptions may be caused to obtain different results.

5.3. The Degree of Sustainability of Project Results Achievements

Jayawardhane (2007) says the SLUMDMP is the most successful disaster mitigation project in Sri Lanka. Preparing multi hazards maps, training and awareness programmes conducting for professionals (Engineers, planners, scientist, local politicians) and building guide lines are mentioned as project achievements (Jayawardane, 2007).

On field work observations, (3.1 in appendix IV.2) the officers had forgotten even the project name within 7 years. The work book, building guide line books were in the cupboards without using. SLUMDMP output were seemed to be useless. This provides arguments how it was successful projects. Although (Jayawardane, 2007) has not mentioned how he defined the successfulness, there may be different perspectives for no usage of SLUMDMP out puts.

1) Ineffective training programmes: It may be caused to forget the project name within 7 years. The statements of “No one knows to use this documents, this is complicated document” (3.2 in appendix IV.2) indicate their trainings were not successful. It indicates that knowledge has not been institutionalized. (Hung et al, 2004) cited by Cheng (2006) proposed that inadequate end user training effects to failure of Enterprise Resource Planning Projects. Similarly SLUMDMP output also may be affected by inadequate trainings. It leads to no usage.

2) No monitoring system: Chapter 3.1 in appendix 4.2 indicated that there were no training after 2000 April. It can be interpreted that there was no monitoring system after project completing. Shrestha in 2007 says in most of the developing countries, GIS is introduced by projects and is rarely used after the projects completed. As the GIS projects in most developing countries, SLUMDMP output maps may also be faced the same situation. It may be due to lack of monitoring system. And also Cheng (2006) has written lack of enough analysis of flow of technology as a risky factor for in successful projects. It can be concluded that no monitoring system after project completing badly affected to project output usage.

3) No funding mechanisms: If the project allocated Rs.200, 000.00 to disaster management annual budget it may have stopped now. The financial inability of municipality indicates by only the Rs.100.00 exists in disaster management budget (2.7 in appendix IV.2). This may be the reason to that the computer is still being kept without upgrading (3.1 in appendix IV.2). Sahay and Walsham (1996) say lack of financial resources to acquire and maintain GI and technology as a inhibiting factor. It affects usage.

4) Project output may not user friendly: The evidences of “useless to spend money on repairing computer because speed is slow”, “It’s very complicated document”(3.1 in appendix IV.2) and
“Maps are not scale enough” (3.2 in appendix IV.2) provides some evidence of project has not provided equipments and documents which can be easily handled. It may be the reason to no usage.

According to all facts it can be concluded that ineffective training and awareness programmes, no monitoring system, no funding mechanism after project completing and project output are not user friendly may cause to less usage.

5.4. Summary

This chapter mainly focused to discuss the filed work findings relevant to the literature. When considering whole discussion following conclusions can be made relevant to critical factors. The awareness of geo-information products (Chapter 5.2.1), trained staff (Chapter 5.2.4, 5.2.7), usability of information (Chapter 5.2.5), cost of products (Chapter 5.2.5), availability of technology (Chapter 5.2.5, Chapter 5.2.2), employee acceptance (Chapter 5.2.7) and availability of necessary information (Chapter 5.2.6, Chapter 5.2.4) have become critical factors which influence the gap between actual and potential usage.

The ineffective awareness programmes, no method to institutionalize the knowledge, no monitoring system, no funding mechanism after project completing and project outputs are not user friendly have been identified as critical factors to sustainability of the project.

The similarities and differences in literature factors and filed work factors prove that all factors are not constant. Factors depend on the local situation. Similarities prove that the factors relevant to GIS adoption, implementation, and utilization are also affects geo-information usage.

Some inclusive discussions such as effect of policy shift, local believes, professional background of politicians, availability of resources at national level and sub national level in this study are recommended for further research.
6. Conclusions and Recommendations

6.1. Introduction

This chapter describes the findings and answers the research questions. Additionally, it gives the recommendations to strengthen the usage, and provides recommendations for further research.

6.2. Conclusions

Although the geo-information and technology can play vital role in decision making for disaster management, this study shows that limited applications in Ratnapura. Still disaster management follows local knowledge than embedding the technology to organizations for decision making.

The purpose of this research was to strengthen the usage of geo-information and technology within the organizations for disaster management. According to that main objective of the research was to identify critical factors in geo-information and technology usage. The identified factors in the table (4-10) may be given positive or negative impact to actual usage.

In general, the factors operate giving negative impact. That causes to create a gap between actual and potential usage.

6.2.1. Answers to research questions

Research Question No.1: How is current usage of geo-information and technology in Disaster Management in Ratnapura?

The current usage of geo-information and technology in disaster management is very limited in applications. People manage disaster based on local knowledge. This creates a gap between actual and potential usage of geo-information and technology (Chapter 4.2.4.2).

Research Question No.2: What factors affect to usage of GI and technology in disaster management in Ratnapura?

According to the interview results, 27 factors could be identified in Ratnapura (appendix IV.6). Not all factors give the same impact. 17 factors were included in work shop. According to participants, all 17 factors are not same important (appendix IV.4).

Then, 11 prioritized factors from interview results and 11 prioritized factors from workshop results were combined to find more influential factors. Those factors are called critical factors. Critical factors are shown in table 4-10.

Research Question No.3: What can we learn from SLUMDMP?

As a learning exercise the weaknesses and strengths of the SLUMDMP can be considered in future projects. At the implementation stage, high level cooperation from political body and prior experiences of involved agencies had been encouraged the project (Chapter 2.7). As revealed in the field work (3.2 in appendix IV.2), the SLUMDMP out put were limited in applications due to complexity in documents and not much advanced computers. The degree of sustainability of the
project may be affected by ineffective awareness programmes, no monitoring system, none existence of funding mechanism after project completing and usability of project outputs. Although SLUMDMP is not a sustainable project itself, the strength and weaknesses around it will be useful.

**Research Question No.4:** What is the potential usage of geo-information and technology in disaster management?

The potential usage of geo-information and technology is already discussed as applications of geo-information and technology in each disaster management aspect (Chapter 2.5 and appendix IV.8). Accordingly 8 types of geo-information products such as topographic maps, hazard maps, hazard zoning maps, flood model and maps, satellite images, local rainfall data, local flood levels, systematic data bases, community level maps and aerial photographs have been identified through literature and assumptions. GIS software, web base data bases, global positioning systems and palm top computers are considered as technology. Appendix IV.8 provides more overview of those products and technology. And also in which aspects of those products and technology can be used.

**Research Question No.5:** What recommendations can be made to strengthen usage of GI and technology?

The main objective was to identify critical factors which influence usage in positive and negative way. Then the recommendations are created to diminish negative influences and to enhance the positives as well. This research question will be answered in chapter 6.3.1.

### 6.3. Recommendations

The recommendations can be divided into two categories.

- **Recommendations for strengthen the usage of geo-information in disaster management.**
- **Recommendations for further research.** Reference

#### 6.3.1. Recommendations for strengthen geo-information and technology usage

The recommendations mainly address the critical factors in table 4-10. Based on literature, field work findings and own experiences, the following recommendations are generated to strengthen the usage.

- **Reference to table 4-10:** The availability of hardware and software has been a critical factor. Government can make more proposals to implement upcoming projects (Chapter 1.2) via foreign funding agencies. Because the agencies which are invested by foreign agencies are satisfied with equipments (examples: 2.2, 2.1, 2.6 and 2.17 in appendix IV.2). The available hardware and software can be upgraded through funding assistance (3.1 in appendix IV.4.2).
- **Reference to table 4.10:** The employee’s acceptance of geo-information and technology has become crucial. If people do not accept the technology, the government can give the ownership of future projects to employees. It will increase the awareness and acceptance of the technology.
- **Reference to table 4.10:** The sufficiently trained staff under manpower has become critical. The government can take necessary action to recruit new GIS trained people to organizations. GIS staff has not yet been recruited to the DMC (2.1 in appendix IV.2). The qualified students in Post Graduate Institute of Sri Lanka (PGIS) in Peradeniya University can be appointed.
• The resistance to change, computer related anxiety, reluctance to exposure on technology can be solved through better trainings.

• Reference to table 4.10: The problems under manpower can be diminished through training more staff in an effective way. Most of the time, there is little attention to technology from the head of department due to less awareness of the technology. Chanza (2003) explains appropriate training need to be given the all groups. Therefore it is recommended to train managerial level in GIT as well as operational level. Arranging workshops, outdoor training awareness campaigns will provide the opportunity to share knowledge among the people.

• Financial problems to conduct training programmes can be overcome through training people by trained staff. The filed work findings prove that people in some organizations are willing to train others and share the knowledge (2.7, 2.15 in appendix IV.2).

• Leaving the trained staff looking for higher wages has become a problem (2.4 in appendix IV.2). Introducing long term incentives for skilled trained staff is helpful to motivate and retain them within the organization (Chanza, 2003).

• Reference to table 4.10: The barriers from individual characteristics of cultural belief and reluctance for the changes can also be reduced by awareness programme.

• Reference to table 4.10: The problems related to data were highlighted in field work findings. The data producing agencies can take necessary steps to produce user friendly, correct and up to date data for the users. The staff training can be conducted in effective manner to avoid data accuracy (correctness) problems. Non availability of digital data in required scales can be solved by expediting data digitizing. Recruiting new staff and proposing incentive schemes are recommended to accelerate the current functions in data producing agencies. Introducing standards for software and data codes will enhance the data sharing among organizations. The establishment of National Spatial Data Clearing house can be an option to give access to disaster relevant data from a single place (eg. web site).

• Hazard maps producing agencies should take necessary steps to publish their product among users. As Jayawardane (2007) mentioned that awareness of the availability of geo-information products among users can influence the usage.

• Reference to table 4.10: The perception of the society about the hazard has become a critical factor. The organizations can be discouraged to implement decisions through the technology, when the public do not consider their decisions. Then the public perception about the technology and hazard should be improved through the awareness programmes. People can be learnt the value of decision making through technology. It can be assisted to avoid illegal constructions in vulnerable areas. It motivates decision makers to use the geo-information and technology in the context of disaster management.

• Chapter 5.2 raises a dilemma to design of GI systems, which will appeal to citizen and immediate benefits to them. If the GIT hardly was introduced to organizations, local knowledge might be diminished. On the other hand, depending only on the local knowledge is also not a good solution. Local knowledge can be failed in unexpected situation (2.8 in appendix IV.2). If a newly appointed officer is not well aware about the area, the technology is more helpful in decision making. As Maskrey explained in 1991, only the technology and professional skills can not address the vulnerability. Local knowledge integrate thorough public participation is an important factor in disaster management. The technological results can be cross checked with the local knowledge (McCall, 2007). Therefore participatory
method is suggested to keep the better balance between local knowledge and the technology. It facilitates to integrate GIT and local knowledge to address disasters.

- The coordination among organizations has to be improved for enabling better utilization of geo-information. As a well equipped organization, UDA in Colombo (2.3 in appendix IV.2) can be collaborated to prepare flood maps with the Irrigation Department.

- Reference to Chapter 5.10: The lessons and experiences from past projects can be taken for strengthening the geo-information usage in proper way. The evaluation of success or continuation of projects can be proposed as a solution to popular project efforts. The documents relevant to geo-information usage can be prepared in broader aspect which will not be changed by the policy changes.

- The newly appointed politician can be provided previous project documents. Those will be very sound documents to continue previous functions.

- It is recommend to build up proper coordination among the politicians and the government officers. The feeling of self importance of government officers can be diminished through awareness activities. Government officers can be knowledgeable the role of politician’s in policy making, resource allocating and Act establishing. That will helpful to enhance technology in organizational activities.

6.3.2. Recommendations for Further Research

The following researches are recommended for the future.

- Reference to Chapter 5.2: To examine in more details what local knowledge could be used in system design. It is better to carry out an action research which facilitates to improve the way of addressing the issues and solve the problems. It improves the strategies, practices and knowledge of the environment of practicing.

- Reference to Chapter 5.2.1: More research about the local beliefs can be conducted to verify if local beliefs effect up take of technology.

- Reference to Chapter 5.2.2: To verify the resources available in national level and sub national level affect the usage.

- Reference to Chapter 5.2.3: To verify if professional back ground of politicians has an influence on the uptake of technology.

- Reference to Chapter 5.2.3: To verify the effect of policy shift to continue technology.

- Disaster Management is a broad subject which has several aspects. Therefore, it is recommended selecting one area such as mitigation if the time is limited to collect data. It provides to get clear picture about the geo-information usage since it reduces the number of organizations to be visited. My research provides a road map to select organization to visit in each disaster management aspect (See tables 4-2 to 4-5).

- Although the interview method supported to obtain depth information, structured questionnaire can be used to reduce the time consuming.
6.4. Research Limitations

Several limitations were encountered in the study period, which are as follows.

- The existing literature about the geo-information and technology in disaster management relevant to developing countries is still limited. Most of the literature is based on sophisticated technology and seemed to be not applicable to use in developing countries.

- As disaster management process involves many organizations, lot of organization had to be visited during field work. This resulted in superficial insights of the organizations. Therefore more information would be needed to bring better conclusions.

- Because the disaster management is totally new concept to Sri Lanka most of organizations contribute in various functions without a proper mandate. So unknowing their contribution and responsibilities relevant to disaster management, raised difficulties when interviews were conducted. I had to recognize that they have a contribution to disaster management.

- As interviews were conducted with very limited number of people within the organizations. Therefore the responses are subjective. Most of respondents were managerial level and I could not verify by asking more people.

- According to the complex environment I could not identify one aspect of disaster management. Within the limited field work period I could not deeply study the organizational functions in each aspect.
References

Kafle, T.P. et al., 2007. BASIN SCALE RAINFALL - RUNOFF MODELING FOR FLOOD FORECASTS.
Korte, B.G., 1992. The GIS Book. On Word Press,1580 Center Drive, Santa Fe NM 87505, USA.
Kumar, R., 2005. Research Methodology. SAGE Publications Ltd, 1 Oliver’s Yard, 55 City Road, London EC1 Y SP.


McCall, M.K., 2007. Participatory Mapping and Participatory GIS (PGIS) for DRR, Community Risk and Hazard Assessment

MDMHR, 2006. Towards a Safer Sri Lanka: Road Map for Disaster Risk Management


Appendix III.1

Organizations coordinate with DDMCU, Ratnapura

1. District Secretariat Office
2. Irrigation Engineer Office, Ratnapura
3. Meteorological Department
4. Road Development Authority
5. Sri Lanka Navy
6. Sri Lanka Army
7. National Water Supply and Drainage Board
8. Ceylon Electricity Board
9. Urban Development Authority
10. Provincial Education Office
11. National Housing Development Authority
12. Agrarian Services Department
13. Samurdhi Authority
14. Land Use Physical Planning Department
15. Survey Department
16. Range Forest Office
17. Central Environmental Authority
18. Red Cross Society
19. LEADS organization(NGO)
20. St. John’s Brigade
21. Lions Club
22. Police Department
23. Provincial Health Department
24. Central Transport Board, Ratnapura
25. Geological Survey and Mines Bureau
26. Disaster Relief Services Department
27. Pradeshiya Saba Ratnapura
28. Provincial Council in Ratnapura
29. Gemidiwila Organization
30. Base Hospital, Ratnapura
31. Sri Lanka Telecom
32. Municipal Council in Ratnapura
### Appendix III.2

**Data Collection Description**

<table>
<thead>
<tr>
<th>Organization</th>
<th>Method of data Collection</th>
<th>Collected Documents</th>
</tr>
</thead>
</table>
| 1. Disaster Management Centre, Colombo    | Interviews, Documents      | 1. Disaster Preparedness and Response Plan on Provincial Council level, District level, Divisional level and Grama Niladhari Level  
2. Organizational Structure of Disaster Management Centre  
3. Brochures  
5. Road map for Disaster Risk Management: Volume 2, Project Proposal |
| 2. Irrigation Department, Colombo         | Interviews                 |                                                                                     |
| 4. National Building and Research Organization (NBRO) | Interview         |                                                                                     |
| 5. Geology Survey and Mines Bureau, Colombo | Interview, Document      | 1. Book on seminar on Current Geo hazard and remedial measures                         |
| 6. Meteorological Department              | Interview                  |                                                                                     |
2. SLUMP work book  
3. Photograph of organization  
4. Flood photos in year 2003 huge flood |
<p>| 8. District Secretariat Office            | Interview                  |                                                                                     |
| 9. District Disaster Management Coordinating Unit | Interview, Workshop      | 1. Road map of Disaster Management in Sri Lanka, Volume 1 and Volume 2 in digital format |</p>
<table>
<thead>
<tr>
<th>Organization</th>
<th>Method of data Collection</th>
<th>Collected Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3. Video clip on Disaster Management in Ratnapura</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Photograph of organization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. National Disaster Management Plan (Preliminary Draft)</td>
</tr>
<tr>
<td>11. District Land Use Policy Planning Division (LUPPD)</td>
<td>Interview, Documents</td>
<td>1. Hazard zoning maps and land use maps in digital format</td>
</tr>
<tr>
<td></td>
<td>Workshop</td>
<td></td>
</tr>
<tr>
<td>12. Urban Development Authority, Ratnapura</td>
<td>Interview, Workshop</td>
<td>1. Organizational chart</td>
</tr>
<tr>
<td>13. Geology and Survey Mines Bureau, Ratnapura</td>
<td>Interview, Workshop</td>
<td></td>
</tr>
<tr>
<td>14. Gem and Jewellery, Authority in Ratnapura</td>
<td>Interview</td>
<td></td>
</tr>
<tr>
<td>15. District Irrigation Department, Ratnapura</td>
<td>Interview</td>
<td>1. Photographs of organization</td>
</tr>
<tr>
<td>16. Sri Lanka Police Department, Ratnapura</td>
<td>Interview</td>
<td>1. Photographs of organization</td>
</tr>
<tr>
<td>17. Red Cross organization, Ratnapura</td>
<td>Interview, Documents</td>
<td>1. Introduction of Community participatory maps</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. The Vulnerability and Coping Ability of People Assessment Report</td>
</tr>
</tbody>
</table>
Appendix III.3

Invited Officers for Factor Rating Exercise
1. District Land use Planning Officer, Ratnapura
2. Engineer, Municipal Council, Ratnapura
3. District Superintendent of Surveys, Ratnapura
4. Engineer, Irrigation Department, Ratnapura
5. Urban Planning Officer, Urban Development Authority, Ratnapura
6. Meteorological Officer, Meteorological Department, Ratnapura
7. Disaster Risk Management Officer, DDMCU, Ratnapura
8. Disaster Relief Services Officer, Social Services Department
9. Director, District Planning Unit, Ratnapura
10. Engineer, District Secretariat Office, Ratnapura
11. Executive Officer, Red Cross, Ratnapura
12. Chief inspector, Police Station, Ratnapura
13. Senior Environmental Officer, Central Environmental Authority, Ratnapura
14. Engineer, Road Development Authority, Ratnapura
15. Director, Gem and mining Authority, Ratnapura
16. Planning Officer, Provincial Council, Ratnapura
17. Mining Engineer, Geological Survey and Mines Bureau, Ratnapura
18. MSc Student, Post Graduate Institute of Surveying, University of Peradeniya in Sri Lanka

Officers support to filled the questionnaire for factor Ranking

Participated to work shop:

1. Two (2) Disaster Risk Management Officers District Disaster Management Coordinating Unit
2. Director, District Land Use Policy Planning Office (LUPPO)
3. Asst. Director, District Land Use Policy Planning Office, Ratnapura
4. Urban Planning Officer, Urban Development Authority (UDA), Ratnapura
5. Draftsman, Urban Development Authority (UDA), Ratnapura
6. Engineer, Municipal Council, Ratnapura
7. MSc Student, Post Graduate Institute of Surveying, University of Peradeniya in Sri Lanka
8. Superintendent of Surveys, Survey Department, Ratnapura

Questionnaire brought to them:
1. Director Technology and Mitigation, Disaster Management Centre, Colombo
2. Assistant Director Information and Technology, Disaster Management Centre, Colombo
3. Director, Hydrology, Irrigation Department, Colombo
4. Deputy Director, GIS unit, Irrigation Department, Colombo
5. Head of the Land Slide Studies and Services Division (LSSD), National Building and Research Organization (NBRO), Colombo
6. Senior Superintendent of Surveys, GIS Branch, Survey General Office, Colombo
Appendix III.4

Organization:........................................................................................................
Name of Contact Person:......................................................................................
Designation:...........................................................................................................
Tel.:.......................................................................................................................
Email:....................................................................................................................
Address:...............................................................................................................  

Following factors found from literature review and those can influence geo-information and technology usage within an organization. Please give your preference according to their value in disaster management context.

Organizational Factors

1. Existing official procedure (GIS routinizing) to use GIS is an important factor.

2. Geo-information and technology usage depend upon employee acceptance of geo-information technology.

Data

3. Availability of data in an appropriate scales influence geo-information and technology usage.

4. Availability of digital data affects geo-information and technology usage.

5. Availability of update data is important in geo-information and technology usage

6. Data compatibility is important in geo-information utilization.

7. Data arrangement and maintain system like data bases is important.

8. Willingness to share data affects to geo-information usage in disaster management.
Manpower

9. The technical knowledge of decision makers at the implementation stage of geo-information affects to usage.

10. Timely and sufficiently trained Staff is an influencing factor.

Technology

11. Availability of software hardware and equipments influence geo-information and technology usage

Political

12. Implementation of Geo-information and technology is depend upon political interest

Financial

13. Funding resources provide constrains to acquire Geo-information, GIS, Geo-information technology.

14. Training and research programme are affected by financial matters.

Sustenance approaches

15. Acquiring indigenous knowledge through Public Participation is very important in applying GI in disaster management.

16. Existence of growing demand for useful information from heterogeneous group of users is an opportunity to apply GI effectively.

17. Perception of society about hazard influence geo-information and technology usage
### Appendix IV.1

Organizational Future and Current Functions

<table>
<thead>
<tr>
<th>Organizations Visited</th>
<th>Organization’s Current Functions</th>
<th>Future Functions</th>
</tr>
</thead>
</table>
| 1. DMC, Colombo       | 1. DMC is at the initial stage in preparing hazard base map which can be used in every aspects of disaster management. Administrative boundaries are going to be considered until GN level in hazard maps. It had been already started to develop basic layers like road net work, hazardous points, schools, hospitals, fuel storage and flood prone areas in GIS environment for Colombo district.  
2. Disaster inventory system (DesInventar) has been created recently. Hazard, vulnerability, risk assessments, and damage assessment are done based on “DesInventer” data base  
3. Developing web base Sri Lanka Disaster Resources Net work (SLDRN)  
4. It has been created Intranet to coordinate 9 organizations (Involved organizations: Meteorological Department, NBRO, Irrigation, SLBC, TV, Police Department, DMC Colombo, DDMCU Gampaha  
5. Conducting education and awareness programme to general public as well as government officials.  
6. Early warning issuing in disaster situation. | 1. To prepare hazard base map for whole country at least most vulnerable districts.  
2. To issue web base multi hazard base map and data bases in district administration, local administration, community base organization, NGO etc. Make hazard map on free access at least among government organizations  
3. To keep the DesInventar data base update through DDMCUs.  
4. To expand intranet facilities among mostly involving organizations with other DDMCUs in the whole country.  
5. The Road map for next 10 years consists of 119 projects. DMC is going to be implemented these projects via DDMCUs. |
| 2. Irrigation Department, Colombo | 1. Preparing flood maps by a project which came through DMC under UNDP  
2. Preparing a flood model is almost at | 1. To complete flood mapping before March 2008 |
<table>
<thead>
<tr>
<th>Organizations Visited</th>
<th>Organization’s Current Functions</th>
<th>Future Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>the initial stage 3. Monitoring and forecasting through flood warning issuing</td>
<td></td>
</tr>
<tr>
<td>3. Urban Development Authority, Colombo</td>
<td>1. Development planning considering vulnerability in declared areas (land use planning) 2. Land and use controlling by regulations. In municipal level, development control is done by delegating power to local authorities. 3. Two years French project has been started to prepare 1:10,000 land use base maps in selected 6 districts in coastal areas. It is going to develop GIS applications for every kind of hazards in the areas selected.</td>
<td>1. Preparing 1:5000 land use maps for selected town areas in coastal areas 2. To create web portal GIS base land use map for customers</td>
</tr>
<tr>
<td>5. Geology Survey</td>
<td>1. Tsunami warning issuing</td>
<td>1. Further develop Tsunami</td>
</tr>
<tr>
<td>Organizations Visited</td>
<td>Organization’s Current Functions</td>
<td>Future Functions</td>
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</tbody>
</table>
| and Mines Bureau, Colombo | 2. If the number of land slides high act as supportive body to NBRO in land slide investigations and damage assessment.  
3. Land use planning by controlling harmful mineral and sand mining activities through examining hazard in field visits | warning issuing |
| 6. Meteorological Department, Colombo | 1. Issuing weather forecasting to general public and responsible agencies (NBRO, DMC, and Irrigation) in disaster situation. Meteorological Department issue hourly basis rainfall data on DDMCU’s request. | 1. Automated river gages, rain fall in near future |
| 7. Municipal Council Office, Ratnapura | 1. Land use planning through development plans controlling in Municipal area  
2. Awareness, relief, response activities carryout with DDMCU  
3. Inform disaster situations to public.  
4. Rescue, clean up, temporary operations in disaster events | 1. Conduct disaster management programmes with DDMCU |
| 8. District Secretariat Office, Ratnapura | 1. Gives the maximum support to DDMCU as administrative body in the district. | 1. Conduct District disaster management activities with DDMCU |
| 9. District Disaster Management Coordinating Unit, Ratnapura | 1. When disaster occurs responsible agencies are coordinated by the DDMCU and provides 24 hours alert service.  
2. On the absent of disaster events, DDMCU works on monthly plan relevant to ten years road map. According to that DDMCU conduct awareness programmes, promote GN level committee establishment in villages, strengthen community participation concept, establishing evacuation routes, cross ways, retaining walls and coordinating | 1. “Act as a supporting and coordinating body to DMC for implementing the projects in Road map. According to the road map coming 5 years has planned for mitigation activities” (DMC, 2007) |
<table>
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<tr>
<th>Organizations Visited</th>
<th>Organization’s Current Functions</th>
<th>Future Functions</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>activities in each phase.</td>
<td></td>
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<tr>
<td></td>
<td>3. Contributes damage assessment and risk identifications through updating “Desinventar” data base from the information which is given by GN divisions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. After receiving flood warning from the Irrigation Department, early warnings are issued to line agencies and public.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Rescue, clean up, temporary operations in disaster events.</td>
<td></td>
</tr>
<tr>
<td>10. Grama Niladhari Office Muwagama</td>
<td>1. Engage in relief activities with the coordination of Divisional Secretariat and DDMCU</td>
<td>1. Proceed the current activities</td>
</tr>
<tr>
<td></td>
<td>2. Inspect and inform divisional secretary or local authorities if there is any possibility to land slide happens (monitoring and forecasting)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Supply more accurate and reliable information to DDMCU in a disaster event to update “Desinventar” data base.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Active participation on any disaster management activities by DDMCU</td>
<td></td>
</tr>
<tr>
<td>11. District Land Use Policy Planning (LUPPO), Office Ratnapura</td>
<td>1. Identify resettlement sites</td>
<td>1. Out of 17 divisional secretariat areas still Ratnapura divisional secretariat area has not finished produce land use maps. It is hoped to finish as soon as possible</td>
</tr>
<tr>
<td></td>
<td>2. Investigate Land slides and risk assessment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Conduct Awareness programmes with DDMCU</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. The LUPPO keeps vacant land data base and land slide investigation request database. D.S Division, GN division, Location, Risk High, moderate, low access route to location and coordinates of location, number of families to be evacuated are the attributes of the data base. This data</td>
<td></td>
</tr>
<tr>
<td>Organizations Visited</td>
<td>Organization’s Current Functions</td>
<td>Future Functions</td>
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<tr>
<td>base is given to DDMCU as hardcopy.</td>
<td>5. Regarding land use planning, gives some recommendations to change land use according to intensity of hazard. 6. Preparing Land use Atlas 7. Preparing proposals to change land use to District Secretary considering hazards 8. Site visit for risk assessment of land slide hazards</td>
<td></td>
</tr>
<tr>
<td>12. Urban Development Authority, Ratnapura</td>
<td>1. Development planning considering vulnerability of the UDA declared areas, land use control by regulations, hazard consider in urban planning (land use planning) 2. Political power of Municipal council changes in every four years period. UDA take places awareness programme for newly appointed staff in municipal council on development control in municipal declared areas.</td>
<td>1. Proceed the work as already doing</td>
</tr>
<tr>
<td>13. Geology and Survey Mines Bureau, Ratnapura</td>
<td>1. Land use planning by controlling harmful mineral and sand mining through examining hazard by field visit.</td>
<td>1. Not specified</td>
</tr>
<tr>
<td>14. Gem and Jewellery Authority in Ratnapura</td>
<td>1. Land use planning by controlling illegal gem mining by field visit</td>
<td>1. Not specified</td>
</tr>
<tr>
<td>15. District Irrigation Department, Ratnapura</td>
<td>1. Flood warning issuing (Monitoring and forecasting) 2. Contribute risk identification by data collection for flood model and maps. That information sends to head office in Colombo</td>
<td>1. Complete data collection for the task of flood mapping and model creating 2. Rain gages are going to be automated in near future</td>
</tr>
<tr>
<td>16. Sri Lanka Police Department, Ratnapura</td>
<td>1. Response and relief operations when disaster occurs 2. Awareness programme to school children</td>
<td>1. Proceed Current activities coordinating with DDMCU</td>
</tr>
<tr>
<td>Organizations Visited</td>
<td>Organization’s Current Functions</td>
<td>Future Functions</td>
</tr>
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</tr>
<tr>
<td></td>
<td>3. Inform general public in disaster events.</td>
<td></td>
</tr>
</tbody>
</table>
| 17. Red Cross Society, Ratnapura | 1. Conduct Community Base Risk Management Projects with DDMCU to prepare Community Base Hazard Maps  
2. Engage in emergency response operation in any disaster event | 1. Red cross has started 3 years project and one year has been passed. In next two years hope to complete project successfully. |
Appendix IV.2

Summary of Interviews

1.0 Introduction

The open interviews were conducted to data collections. It was basically focused on the tasks which were being done relevant to disaster management, and how far geo-information products and technology were used by the visited organizations. Keeping data bases or recording systems were also concerned during the field work. This appendix provides the highlighted findings in each visited organization during filed work. The descriptive interviews have been summarized for each organization.

2.0 Organizations

2.1 Disaster Management Centre (DMC), Colombo

The Disaster Management Act No. 13 of 2005 established the DMC in Colombo under the National Council for Disaster Management. The DMC has many plans to implement in the future with the coordination of respective government organizations, divisional secretaries related government and non government and community base organizations.

1. According to respondent, Director Technology was a GIS well known officer. One respondent indicated that Director Technology gives maximum support to develop hazard base map.

2. UNDP financially supports on training, and acquire equipments.

3. According to respondent Hardware and soft ware were at a satisfactory level

4. “We have only one IT specialist in GIS branch and we are in need of GIS trained staff as still they are not recruited”

5. “1:10,000 scale digital data are not available in DMC. Even 1:10,000 scale is not enough for town areas. Large scale data is required”

6. “Maps are not free. Digital data usage has been restricted due to high cost. The prices are not affordable for small projects and other organizations to handle day to day business. Except highly financial projects, others cannot bear the prices. Then they handle with what they have. High cost of digital data can be introduced as a major problem to use.”

7. “DMC is still established in a rent out building. For establishing good GIS unit, office space is not enough.”

8. “We face with data compatibility problems. Survey Department codes and Census Department codes are not same. Different organizations use different software. Data gained are not compatible among organizations”

9. “Section wise data gained from Survey Department take much time to merge”

10. Hand held GPS was one requirement.

11. Data restrictions from producers had become a barrier.

12. “Non availability of base contour map for required scale is a serious issue. Topography has changed so much with disaster occurrence and development activities” (DMC, 2007)

13. “1:50,000 sheets accuracy is not satisfactory level”
2.2 Irrigation Department, Colombo

The Irrigation Department has the technology and hold the responsibilities for flood mapping from 1996. The flood mapping project had come to the Irrigation Department through DMC under UNDP funds. Almost 90% of flood mapping in “Kaluganga” river area in Ratnapura had been completed by the project. There is a separate GIS branch to accomplish flood model with the coordination of Hydrology branch. Respondent indicated that two branches working together is an advantage to accomplish the task.

1. “Flood mapping project is funded by UNDP. It is difficult to conduct flood mapping by only with the Department’s funds”
2. Plotters and ArcGIS software were requirements.
3. “Flood mapping is based on 1:50,000 scale maps prepared by the Survey Department. But scale is not satisfied. At least 1:2000 scale maps are required for accurate map preparing”
4. “Staff has to be trained”
5. “We have only five GIS trained officers, Number of staff is not adequate”
6. “Fund allocations for equipments are not enough”
7. Internet was used only for Email checking. Monthly email facilities are limited to only 30 hours.
8. “Fund restrictions can be effects to quality of products.”

2.3 Urban Development Authority (UDA), Colombo

The Urban development authority contributes to disaster management by development planning in hazard prone areas. According to the respondent the hazard prone areas are left for recreational or water activities in land use planning. The UDA uses landslide prone hazard maps prepared by NBRO and flood zoning maps from the Irrigation Department.

Asked about the capacities of the organization the GIS unit replied “The best GIS centre in Sri Lanka is in UDA. Therefore a number of financed projects come to UDA. Nowadays we are involved in a French project by which land use base maps are being prepared in six tsunami affected districts. We have more than 60 officers in GIS unit. Our main requirement is to create a web portal containing GIS base land use map for customers. We are rich of equipment such as computers, plotters, scanners and high technique printers”.

Although researcher visited UDA for getting more information about SLUMDMP project, no information could be obtained.

1. UDA has been given a soft loan to carry out French project
2. Respondent indicated more internet facilities was a requirement
3. “1:10,000 digital sheets are not available for whole country”

2.4 National Building and Research Organization (NBRO)

The NBRO is the sole agency preparing land slide zoning maps in Sri Lanka. They generate land slide zoning maps at 1:50,000 scale and 1:10,000 scale in several districts including Ratnapura. One objective of zoning maps producing is development planning process in organizations such as Land Use Physical Planning Unit (LUPPU), National Physical Planning Department (NPPD) and Urban Development Authority (UDA).
NBRO is involved in matters regarding land slides via local authorities and district secretariat offices. After DMC was established, NBRO became more involved in disaster management through DMC.

1. A respondent indicated that staff needs GIS training.
2. New computers, Printers, Photocopy Machines, Handheld GPS were requirements in terms of technology
3. Trained staff leaving the organization looking for higher wages was a problem.
4. Maps does not showing until lowest administrative level, was indicated as problem.
5. “For security reasons there is an agreement not to appear contours on hazard maps. So we don’t show contours on hazard maps and it is a disadvantage for visualizing hazard areas.”
6. Respondent indicated that land use in 1:50,000 scale maps prepared by Survey Department are not updated. Vulnerability is changed with the changing land use.
7. “Financial Constraints have become barrier to buy equipments when necessary”.
8. “Data expensive has become a barrier”
9. A respondent said that NBRO is in need of large scale digital base maps for preparing spot wise identifying zoning maps. But large scale maps such as in 1:10,000 are not available when they required them.
10. “We need GIS experts”

2.5 Geological Survey and Mines Bureau, Colombo
According to the responses, the main responsibility of GSMB is relevant to earthquake disaster management activities. Tsunami warning is issued by the GSMB in the earthquake situations.

1. “Available software and hardware are enough for current functions”
2. Respondent indicated that 1:10,000 digital data were required
3. According to the respondent, 1:50,000 digital topographic sheets was not accurate enough
4. “Colour contrast of 1:50,000 maps are not good. It’s difficult to read”
5. “Map cost is not a problem because only limited people use products”
6. “Some layers are overlapped in 1:50,000 taken from the Survey Department”
7. A respondent indicated that funding resources are not enough to buy equipments

2.6 Meteorological Department, Colombo
The responsibility of weather forecasting to public and responsible agencies in a disaster situation belongs to the Meteorological Department. The Meteorological Department issues rain fall data to NBRO, DMC and the Irrigation Department. According to the intensity of the rainfall, the Meteorological Department issue rainfall data in hourly, 3 hourly, 6 hourly bases. On weather forecasting, satellite images can be considered as one component of spatial data among other data such as global meteorological data and upper air data.
Respondent indicated that resources such as staff, knowledge, technology, financial, are adequate to follow current functions. The future programmes will be funded by foreign projects.

2.7 Municipal Council, Ratnapura
The Municipal Council engages in mitigation, response, relief and preparedness aspects of disaster management. The Mayor coordinates with DDMCU response and temporary relief services in disaster
management activities. This is done through the health section in the Municipal Council. The responsibility of mitigation activities belongs to the work branch of the municipality.

The Health section indicated that they didn’t use any kind of map or computer technology in disaster management activities. The public information about the hazard areas and self prepared sketches in the area are used in their project proposals and awareness programmes. Although one time NBRO officers had informed that hazard zoning maps could be used for awareness programmes, a respondent mentioned not knowing from where to get maps and how to refer those.

By the Urban Development Authority (UDA Act, 1987) Act in 1987, the development control power has been delegated to the Municipal Councils. The Plan committee gathers to approve building and land sub-division plans once a week. No digital maps are used for disaster management works and no back ground equipments such as scanners, digitizer, software, GIS users are available at the municipality. 1:5000 contour map and town sheet maps are used only for building plan approval. When the site is too steep, clients are referred to NBRO to present a hazard report of the site.

According to respondent the Information technology was very low in the Municipal Council Office. Even after having computer basic training, clerical staff still keeps records in written files. Sometime, they spend a much time to find files. There was no computer based system to record information regarding flood occurrences. Damages in major flood events have been written in files and there was no continuation of records. If they collect information relevant to major flood events some records couldn’t be found.

According to observations, the Municipal Council engineer and accountant were working on a temporary basis. The photocopy machine was not working and internet facilities were used only for mailing.

A respondent said that financial capacity was very low and only 100.00 rupees allocated for disaster management.

When I asked about support by the higher authority for technological improvement in the organization one respondent answered “During the previous political authority, cabling had been done to supply network connection to computers. But after the political power changed, the whole process was stopped halfway. No improvement has taken place since new political power. The higher authority wants to address the problems of victims by giving lunch packets. They don’t have idea about long term mitigation. It’s difficult to convey technical matters to higher authority as they are only a political body”

During the discussion with the higher authority, the particular respondent indicated that he was not much aware about the technology. Respondent said that “I try to fulfil the requirements of technical department with available resources”.

1. When I asked about the employee acceptance of technology, a respondent said “Staff in work branch is technically qualified. We can easily grasp knowledge. If we are given training, we are willing to accept GIS applications too”
2. Internet facilities, scanners and plotters were mentioned as requirements.
3. A respondent mentioned that 1:5000 contour map scale was not large enough, difficult to read and not available for all wards. Other problem was contour maps had been prepared in 1996 and now topography has changed
4. According to respondent there was only four technical officers in the work branch and one officer knows to operate GIS software.
5. “Only one officer out of 4 technical officers in work branch knows to work in GIS”
6. When I asked about the support from higher authorities about the technical matters one respondent said “Higher authorities do not support to any technological improvement in the organization, no body was sent for Year 2004 technical training by higher authorities”

7. “Number of staff is not enough in work branch. All are more occupied on work”

8. “Considering hazard in development plans approving has become useless. People build illegally in hazard areas. We have to give electricity and water permission for illegal constructions due to political interference”

2.8 District Secretariat Office, Ratnapura

The District Secretariat office acts as a supportive and administrative body for all activities in the District level disaster management activities. Before DDMCU was established, disaster related activities were done through Social Service Department under the District Secretary. But it was just a fact finding body for giving assistance to empower people and to provide temporary relief.

According to a respondent, District Secretariat Office gives maximum support to DDMCU for their activities. DDMCU is housed in the same office building of the District Secretariat. Responses indicated that the District Secretariat Office does not use geo-information products for any disaster management activities.

On further discussion respondent revealed, “As a person born and living in Ratnapura I know flood. I have never used any kind of map in disaster events. But in my day today business I use maps. People living in Ratnapura use their indigenous knowledge to cope with floods. With the pattern of the river flow, people knows flood come coming. Their indigenous knowledge is more helpful to runaway. They know where to go and know higher areas to evacuate. There is no need to use maps. But flood can come in an unexpected way as in 2003.”

2.9 District Disaster Management Coordinating Unit, Ratnapura

With the consequence of the disaster management Act District Disaster Management Coordinating Unit (DDMCU) is established under DMC. DDMCU is attached to the District Secretary office to function district disaster coordinating activities.

The DDMCU uses topographic sheets in scales 1:10,000, 1:50,000 and district multi hazard map for identifying disaster prone areas for flood, land slides, high wind and drought. Though district multi hazard map is not an accurate document it gives a rough idea about the risk in each GN divisions. But still GIS based hazard maps or flood models are not used by DDMCU. One officer explained value of having map or model as “Maps play very important role in risk assessment and vulnerability assessment.

The new disaster inventory data base system of “DesInventar” is updated monthly by sending CD to DMC because it is still not linked. District secretary send disaster event’s reports, which are collected from each Grama Nialadhari divisions to DDMCU. DRM officers have trained other staff to update “DesInventar” data base to update weekly. Ratnapura district has finished information collection for Sri Lanka Disaster Resources Network (SLDRN) which is given location wise web page where resources are available in disaster event.

When the respondent was asked the purpose of collecting the rain fall and flood levels the comment was “If the rain fall increase up to 200 mm and continue, over 24 hours, we know the areas which can be inundated by our experience, although Irrigation department has authority to issue flood warning we also identify flood occurrences and get prepared”
1. A respondent mentioned “If funds are provided for training by UNDP, it is not adequate”
2. Some of the staff knew how to check emails and work in a computer environment. According to the respondent, their technology acceptance was at satisfactory level.
3. Handheld GPS was mentioned as a requirement.
4. “Staff needs GIS training”
5. Respondent mentioned that “Data Expensiveness is a problem for us”
6. 1:10,000 scale digital data were not available.
7. “We experienced that some maps are not accurate with ground”
8. “If we have Disaster Risk Management Officer in IT, it would be good idea”

Own Observations:

1. Although DDMCU was not supplied GIS software officially, some officers work on digital data in GIS environment. They have got digital maps and GIS software from colleagues. Those maps were used for area identification.
2. One DRM officer was following a MSc in GIS and RS. Three DRM officers and coordinator are in good academic background. They all were graduates.
3. DDMCU officers responded that they were in need of more resources such as human resources, knowledge, and technology for better service.
4. Office looked more crowded.
5. Most of the officers who were from military service and have backgrounds in mapping.
6. DDMCU has maintained two record books for local flood level and rainfall in heavy rain situations. If the intensity of rain was high hourly and half hourly records had been maintained.

2.10 Grama Niladhari Office, Muwagama

GN had prepared own sketches of his division to identify the flood prone areas, donate aids and compensate in disaster event. GN officers didn’t use computers for their official work. Detailed information in written format for each major disaster event had been maintained by Grama Niladhari. Some records were not in good state and could be damaged easily. Those data bases include number of damaged houses, property, lives, etc. In a disaster event, records are sent to the Social Service officer in divisional secretariat office. Social Service officer in divisional secretariat office forwards the information to DDMCU. The respondent indicated that he does not have a broad idea about handling maps and working with computers.

2.11 Land Use Physical Planning Office (LUPPO), Ratnapura

Although disaster management is not the main responsibility of LUPPO, as a coordinating organization, the LUPPO provides useful information to the DDMCU. The LUPPO in Ratnapura examines the suitability of resettlement sites and identifies high risk areas in natural disasters for land slides. LUPPO in Ratnapura had prepared a Land slide density map in Grama Niladhari divisions to get a rough idea about risk areas. They had provided these maps to the DDMCU. LUPPO officers participate as resource persons in awareness programmes conducted by the DDMCU. School children and teachers are educated how to mitigate disasters by controlling land misuse. 1:50,000 scale topographic map and land slide density map were used in awareness programme.
As a supportive organization to DDMCU they provide information to DDMCU such as the number of points examine in a month for land slides and number of people live in risk areas etc. The LUPPO use the land use planning hand book which provides guide lines for resettlement site selections and how to change agriculture in such areas. By next year, LUPPO will be equipped with printers, digitizing table and computers.

Most of the divisional secretariats ask for recommendations in land slide risks for some lands before distributing people. But LUPPO officers give recommendations on their experiences. Even though are not educated in that field as NBRO officers, respondent mentioned that most of time their predictions were correct.

A respondent mentioned “We generate data by our selves and sometimes we experience data inconsistency with other organizations. Eg: extent is not matching with census department. Code mismatching is one problem to share data among organizations”

When the respondent was asked about the political influence in their duty relevant to disaster management, the reply was “With the government change newly appointed ministers promote new concepts and LUPPO also prepare their programmes parallel to them. With proposed programme like “Gamaneguma” they tend to expedite land use zoning mapping.”

1. A respondent mentioned that from four Asst. land use planning officers only one officer was very familiar in GIS. He had been fully assigned on GIS mapping and data base creating.

2. When the researcher asked about public perception a respondent mentioned “public information provide valuable information in land slide area investigations, When LUPPO gives recommendations to change land use, gets indigenous knowledge from communities to propose suitable crops. Some time people live in the area provide more information and proposals through their experiences than officers”

3. ArcGIS software, fascination with new technology, training on new technology, internet facilities and 1:10,000 digital sheets were mentioned as requirements.

4. “Even though trained people willing to teach some officers they are not encouraged enough to learn software. Untrained staff wishes to get training from the head office. Due to long distance and accommodation problems it’s impossible”

5. “Staff has to be well trained”

6. According to respondent there was no legal power to give recommendations for land use change according to risk.

7. When the researcher asked about the financial capacities response was “We need more funds on vehicle repairing, and acquire new technology and if we have more funding resources our performance will be better than now”

8. “We have only 1:50,000 scale digital data for whole district, But 1:10,000 is our requirement”

9. Number of staff is not sufficient for current functions

10. “Unwillingness to share data affects to our functions”

11. “Government offices take land use maps to display purposes, Maps are very rarely used by people. Even government officers have no map culture. They may not know our productions. It may be our fault because we don’t give enough publicity about our products”

12. 1:50,000 scale Land slide zoning maps are used for land use map making. Those maps are prepared by NBRO in SLUMDMP project. LUPPO indicated that they were not satisfied with the scale and details shown on land slide zoning maps prepared by NBRO. According to respondent those zoning maps were not user friendly and do not show even Grama Niladhari
GN) Division names and village names. Those are difficult to read. Information appears are not enough to identify areas.

2.12 Urban Development Authority (UDA), Sabaragamuwa Provincial Office, Ratnapura

Although disaster management is not a direct responsibility, UDA contributes to disaster management through development planning activities. UDA follows land slide hazard maps prepared by NBRO, flood prone maps by Irrigation Department and Geological maps by GSMB on the development planning of Ratnapura town. In addition to that extra regulations were included in most vulnerable areas.

A respondent commented that there is no organization to get information from one place about hazards. Lots of organizations have some records about last flood events such as number of deaths, number of families’ inundation, damaged and partly damage. At least there is no system to mark flood level. When the researcher asked about the geo-information in disaster management respondent more talk about development planning activities.

1. Responder said that UDA has qualified technical staff and 3 officers can handle GIS
2. Respondent mentioned that, more computers, laptop, multimedia set and GPS were requirements.
3. Unavailability of 1:10,000 scale maps and data accuracy was mentioned as problems.
4. UDA responder indicated that data accuracy was a problem
5. UDA commented that there were no digital data to get at required time.
6. “We need more training”
7. “We need money to buy computers”
8. “When we need multi media set, it has to be received thorough head office in Colombo”

2.13 Geological Survey and Mines Bureau (GSMB), Regional Office, Ratnapura

Rock blasting, Sand and mineral mining cause geological disasters in Ratnapura. Mining licenses are issued to control harmful mining and rock blasting. GSMB issues licences based on field observations. 1:50,000 sheets are used very rarely for field work observation to identify areas. No other geo-information products are used for any activity in the GSMB, Ratnapura.

The respondent appeared low knowledge in disaster management. I was pointed out to visit GSMB in Colombo to observe better practice.

2.14 Gem and Jewellers Authority, Ratnapura

The responsibility of the organization related to natural hazard is to control illicit gem mining which can lead to slope instability and environment degradation. With the coordination of the Gem and Jewellers Research Training Institute, gem miners are educated through workshop and seminars in order to prevent illicit gem mining. They have authority to issue gem mining license. In this case, the Divisional Secretariat had informed land slide prone areas by village names. They do not use any kind of maps on their functionalities.

2.15 District Irrigation Office, Ratnapura

Although the Irrigation department is not directly involved in the disaster management, they have technical background and responsibility for issuing flood warnings. Flood situations are predicted by rain fall data and the water speed in river. The irrigation department take rain gages from state owners
because rain gages which are supplied by meteorological department are not enough to flood forecasting in “Kaluganga” river. Flood models or maps have been a main requirement for a long time to issue flood warning. Flood hazard operation manual which provides guide line for techniques to be used in flood warning is under the preparing stage.

A respondent said “more accurate data on slope, level, cross sections and topography of inundation areas are required for creating flood model. Prepared model should be reliable to use at least 5-6 years. Still Irrigation department is in the half way of flood modelling and now flood model is being developed in head office. We involve in data collection part in flood mapping and modelling.”

The Irrigation department informs the responsible officers when flood events are identified. Even in midnight, the Irrigation Department had informed flood occurrence to District secretary several months ago. Researcher observed that some officers work after office hours to accomplish their tasks.

1. When the respondent was asked about the technical back ground about the decision makers the response was “The responsible officers who take decisions are knowledgeable enough in technology”
2. “District Irrigation office is consisted with two computers and 11 technical staff including engineer. Staff is to be trained in GIS and they have capability to abstract knowledge as they are in technical back ground”
3. Respondent mentioned GIS software, more computers, scanners, and digitizing tables as requirements
4. A respondent said “Due to financial problems, inadequate technology and lack of human resources cause to delay flood model creating. Technical staff has to engage on other duties in office”
5. On the technical capacity response was “MIC11 software dongle key which is used for data feeding is very expensive and only three dongle keys available in the whole Irrigation Department. Data has to send to Colombo for feeding”
6. When I asked about trained staff respondent commented as “Staff is trained by GIS department in Colombo and Irrigation Training Institute. But training is not sufficient. Technical staff should be trained new technology. Only irrigation engineer knows to operate Arcview”
7. A respondent commented about the problems related to data as “Data are not available to required scales, not accurate, not update and unwilling to share among organizations are the problems in hazard maps and modelling producing”
8. The response on the knowledge sharing among the staff was “As everybody try to keep specialty, knowledge sharing is not totally satisfactory among staff”
9. The respondent commented that “government departments don’t acquire technology rapidly”

2.16 Sri Lanka Police Department, Ratnapura
The Police Department contributes disaster management in response, temporary relief, mitigation and preparedness phase. With the coordination of DDMCU Police Department involves in activities such as building temporary huts, announcing flood, evacuate people by motor boats and training people. But the Police Department does not use any kind of geo-information product on their disaster management activities. A respondent mentioned “We used our own experience to find evacuation
roads to and people in Ratnapura know to cope with flood better than government officers. But if there is any map it would be easier on our work”

Respondent mentioned “We are given good support from public in rescue and relief activities, But for quick response activities we need more resources like boats, compasses

2.17 Sri Lanka Red Cross Society, Ratnapura

Although the Sri Lanka Red Cross Society is not an organization only for disaster management, it contributes to Disaster Management by doing community base risk management projects and emergency operations. The Red Cross Society coordinates with DDMCU in disaster management activities. Five villages have been selected in Ratnapura area according to past hazard records to avoid duplication in disaster management activities by different organization. Village Disaster Management Committees (VDMC) are formed through villagers as their main target is to do community base disaster management. International Federation of Red Cross (IFRC) funds for that project. Red Cross Society makes people to draw risk maps according to their indigenous knowledge. These maps include inundation areas, flood height, water flowing speed, duration of water remains. Community base maps provide very useful information for identification of vulnerable areas, risk assessment purposes, aid distribution for victims in village level, and future disaster management activities.

According to respondent “As three years project is funded by IFRC, communication facilities, computers, fax machines are at a satisfactory level in District Red Cross Office Ratnapura. Community Base Organizations (CBO) implements disaster management activities with the help of community base hazard maps. CBO office is established in each village and if it can be provided internet computer facilities it would be very useful.”

According to the respondent the Red Cross does not use any kind of geo-information products in emergency response activities. And further described “We don’t want to use any kind of map because of people live in Ratnapuapu know their area well”.

Responses Relevant to Factors and Usage

1. IFRC provides funds
2. Multi hazard map, more information as secondary data and national level data base were pointed out as their requirements.
3. Staff should be trained to use multi hazard map and data bases
4. “There is no way to get information at one place”
5. “Staff should be trained more”

3. Sri Lanka Multi Hazard Disaster Management Project

3.1 Responses from Municipal Council Office, Ratnapura

The SLUMDMP had been introduced to Ratnapura municipal council in 1997 (SLUMDMP Report 2000) and at the first interviews respondents seemed to be forgotten even the project name. Most of officers who engage in disaster management activities are newly appointed after finishing the pilot project in year 2000. SLUMDMP work book and building Guide Lines Book could be found in a cupboard. A respondent commented “I was given the SLUMDP work book and The Building Guide Lines Book by a previous officer on his retirement. But no one knows how to use these documents. I came here on April 2000 and as I know even at that time SLUMDMP work book or any guide line
THE USAGE OF GEO-INFORMATION AND TECHNOLOGY IN DISASTER MANAGEMENT BY SUB NATIONAL LEVEL ORGANIZATIONS
CASE STUDY – RATNAPURA IN SRI LANKA

book were not referred when land subdivision or construction plan approved. Even if I know this document is valuable I have no time to read it. It’s a complicated document. Some maps are not clear and it’s difficult to use for area identification. So we have never used this. Even we were not given a training to use this map book. We have one computer given by SLUMDMP and now it’s not working. It’s useless to spend money on repairing that computer. It’s speed is very slow”

3.2 Responses from Previous Project Leaders
Two SLUMDMP project leaders were interviewed in DMC, Colombo. One officer was a former director in CHPB and now she works in DMC. So it was not necessary to visit CHPB. One officer commented “SLUMDMP implemented properly from 1997 to 2000 in Ratnapura municipal area. But after finishing the project period there is no continuation in municipalities, But still SLUMDMP outputs are very useful as guide lines in preparing future plans in DMC. There were some weak points of SLUMDMP. Hazard maps prepared in the SLUMDMP period are not detailed and scales are not enough to get a decision. If the public can understand their vulnerability by a map it would be very useful. Then people themselves can take a decision on not to invest in risk areas. So that information should be provided to the people in future. Then the financial institutions such as banks also can ask people to bring a certificate from responsible agency about the vulnerability of land. This process can automatically contribute hazard control. Municipal councils are totally political bodies and with the changing of the power, commitment on some task also changing. Continuation on some projects depend on political attitudes and perception on technology”

3.3 Responses from NBRO
The NBRO officers’ response about the SLUMDMP project was “Ratnapura Municipal Council was provided more detailed hazard maps and planning guide lines for their development projects. During project period, Municipal Councils were instructed to follow guide lines, to consider disasters, and to follow zoning maps. Ratnapura municipal council office was provided computer too. Municipal Councils allocated Rs.200,000 in their annual budget for disaster Management activities. Also municipal council office was provided data base to keep hazard records. Everything stopped just after the finishing the project and political changes. Not only Ratnapura but also other pilot project area called Nawalapitiya Municipal Council followed SLUMDMP out puts well. With the political change municipal councils stopped instructions followed by SLUMDMP. Although SLUMDMP activities are not properly implemented in Municipal authorities sometimes they refer cases to bring a report from NBRO about the hazardous of land slides.”

4. Further Observations
According to the findings in the filed work, only the “Desinventar” data base which records large scale and small scale damages can be introduced as systematic data base keeping. Other organizations for instance the Municipal council, UDA in Ratnapura, Irrigation Office in Ratnapura were appeared keeping disaster event records just for their own information. That information appeared not using for decision making in disaster aspects. Some officers couldn’t find files where they had written past events. For each major event they had maintained separate files. Only the LUPPO sends their records to DDMCU as hard copy. I observed that most of the organizations visited had not a clear idea about in which aspects and how they contributed to disaster management.
# Workshop Results

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**Note:** According to the responses to questions, marks are given as below.
- Strongly agree - 1
- Agree - 2
- Neutral - 3
- Disagree - 4
- Strongly Disagree - 5

The marks gained by 15 responses are averaged for each research question (average marks column).

According to the averaged marks gained by each factor, the factors were ranked inside their major categories.
## Appendix IV.4

**Factors Ranking Without Considering Categories (Workshop Results)**

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Appendix IV.5

Summary of Factors in Interviews

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DMC | DMC, Colombo
Ignite 1 | Ignite Dep, Colombo
SB | NBRO, Colombo
GSMB | GSMB, Colombo
Meteorological | Meteorological Dep, Colombo
Municipal 1 | Municipal Council, Ratnapura
GN Office | Grama Niladhari office, Ratnapura
DDMCU | DDMCU, Ratnapura
LUPPO | LUPPO, Ratnapura
UDA | UDA, Ratnapura
GSMB | GSMB, Ratnapura
Gam | Gam and Jewellery Authority, Ratnapura
Ignite 2 | District Ignite Department, Ratnapura
Police | Sri Lanka Police Department, Ratnapura
Red Cross | Red Cross Society, Ratnapura
### Factors Ranking Without Considering Categories (Interview Results)

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<td>Size of the technical staff</td>
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<td>Support of the Higher Officers</td>
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<td>Political influences</td>
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<td>Acquiring indigenous Knowledge</td>
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<td>Cooperation among branches</td>
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Appendix IV.7

The Assumption for Potential usage

The appendix IV.7 has been prepared based on literature review in chapter 2.5. According to the reasonable assumptions some geo-information products and technology have been considered as suitable to use when the literature does not directly support. Finally the appendix IV.8 has been prepared by summarizing chapter 2.5 and appendix IV.7.

From Fig 2.2, the components of each aspects of disaster management were considered as follows

**Risk identification**
- Risk assessment, GIS mapping and scenario building (The term risk assessment was used instead of three terms called vulnerability assessment, risk assessment, hazard assessment)

**Mitigation**
- Land use planning, education awareness and training

**Preparedness**
- Monitoring and forecasting

**Emergency Response**
- Humanitarian assistance/rescue & clean up and damage assessment

**GIS**
GIS can be used in all components of each aspect of disaster management (see chapter 2.5).

**Data base systems:**
- According to the description in Chapter 2.5, that data base systems can be useful in all components such as risk assessments, GIS mapping, land use planning, awareness, monitoring and forecasting, rescue and clean up activities in disaster management.

**GPS**
- GPS can be used for data collecting in post disaster events (damage assessment in emergency response) (See chapter 2.5)
- It can be assumed that GPS can be used in data collection for risk assessment purposes and GIS mapping in risk identifications.
- GPS can be use in rescue and clean up operation in emergency operations (See Chapter 2.5).

**Palm top computers**
- Palm top computers also can be used in risk assessment, GIS mapping, damage assessment, rescue and clean up activities as well as GPS. Further it facilitates manipulate, analysis, and visualize in the field (See Chapter 2.5).

**Topographic Maps**
- The topographic maps are used to prepare GIS based hazard maps. This help to risk assessment in risk identification.
Based on topographic maps, hazard zoning maps which can be used to mitigation and preparedness aspects are generated. Therefore topographic maps are also considered as suitable to use in mitigation and preparedness aspects.

Topographic maps are used to prepare hazard base maps. Since hazard base maps are used for response aspect topographic maps also can be used.

### Hazard Base Maps
- Hazard maps can be used in emergency responses (see chapter 2.5)
- Hazard base map includes fundamental layers and emergency layers. It is assumed it can be useful in all components such as risk assessment, GIS mapping, land use planning, awareness, early warning, damage assessments, rescue and clean up activities.

### Hazard Zoning Maps
- Hazard zoning maps can be used for risk assessment in risk identification, land use planning and training courses in mitigation and improve preparedness (see chapter 2.5).
- It is assumed that hazard zoning maps can be used in damage assessment, clean up in a disaster situation.

### Flood models and flood maps
- Flood model can be used calculating and predicting risk and realistic scenario building (chapter 2.5).
- It can be used in training and land use planning in mitigation aspects.
- As hazard zoning maps, flood model and maps also can be assumed that give first warning in preparedness phase to people.(chapter 2.5)
- Existing flood models can be used in preparing new flood models.
- Flood models can be used to see the before and after situation in emergency response (Abdulharis et al., 2005) that facilitates to damage assessment and clean up activities(chapter 2.5).

### Satellite Images (see chapter 2.5)
- Ability to see effect of damage before and after leads to damage assessment in response phase.
- Satellite images generate rain fall data which will be used to issue early warning in preparedness aspect.
- According to van western in 2007 satellite images can be used in risk identification.
- Satellite images can be used in awareness programmes in mitigation aspects.
- It can be assumed that satellite images can be used GIS mapping in risk identification and land use planning in mitigation aspect also.
- Satellite images provide land cover during flooding, inundation areas, and map extent. This information also can be used in rescue and clean up operations.
- According to the above facts satellite images can be used in risk assessments, GIS mapping, land use planning, early warning, and rescue and clean up activities and damage assessments.

### Rain fall and flood level records
- Rain fall can be used in risk assessment and GIS mapping and scenario building in risk identification (see chapter 2.5).
• Rain fall use for early warning in preparedness aspect (see chapter 2.5).
• Awareness programmes in mitigation aspect can be facilitated by local rain fall and flood records.
• Flood level and rain fall data can be assumed to be useful information in rescue, clean up and damage assessment activities also.

Community Level Maps
• Community maps provide useful information in risk assessments in risk identification (See chapter 2.5)
• Community level maps show useful information such as evacuation routes; safe areas and temporary shelters which can be used in facilitate emergency response. (See chapter 2.5)
• It is assumed that community level maps provide useful information for damage assessments, awareness programmes and land use planning activities.
• Community level mapping are assumed to be useful in GIS mapping and scenario building and monitoring and forecasting in preparedness aspect.

Aerial Photographs
• Aerial photographs can be used in integrating GIS, for damage assessments in emergency response aspects (see chapter 2.5).
• Aerial photographs can be used for mapping vulnerabilities of terrain properties in risk identifications (see chapter 2.5). Therefore it is assumed aerial photographs can be used for risk assessment also.
• Aerial photographs are assumed to be useful in land use planning activities and awareness programme in mitigation aspects.
• Aerial photographs are assumed to be used for response and relief aspect as well as satellite images. The effect of flood, flood deposit and debris can be interpreted by aerial photographs.
• It can be assumed that aerial photos can be used GIS mapping in risk identification and land use planning in mitigation aspect also.
## Potential Usage of Geo-information and Technology

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