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Proposal of Web-GIS based Disaster Information Sharing System and its possible utilization in Lalitpur Metropolitan City

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Abstract
Information sharing is more crucial during a disaster. For local governments, it's necessary to act on disasters quickly. In this paper, a disaster information sharing system (DISS) has been projected by considering administrative authorities of local bodies towards disaster mitigation. DISS enables the visual organization and presentation of disaster information, including to neighboring communities as geospatial information. In addition, as a characteristic of the system interface, two-layered tabs and menu buttons enable the organization of disaster corresponding operations and guide the flow of procedures. National Research Institute for Earth Science and Disaster Prevention (NIED), Japan has developed a Web-GIS based disaster response platform which enable creation of GIS data and quick sharing among the users. We undertook a project to replicate a similar Web-GIS based platform by using the same open source disaster information sharing system (DISS) in the context of Nepal. Study tries is to demonstrate a straightforward, effective and economical Web-GIS based Disaster Information Sharing System and its attainable utilization on the Lalitpur metropolitan city that simplifies information flow throughout the disaster period which might be useful for emergency response aftermath of a disaster. In this system the disaster and response information are properly classified and organized based on "Essential Element of Information (EEI)".

Keywords
Disasters, Web-GIS, Disaster Information, Emergency Response, NIED, Lalitpur Metropolitan

1. Introduction

During an emergency, quick and effective dissemination of relevant information is vital for the effective response to the disaster. Timely and accurate information sharing of the disaster location, information about type and extent of damage helps in rapid, co-ordinated and adequate response for the affected groups of people for saving their lives as well as property. Information sharing via a web-based platform is more effective and efficient which makes sense in a real emergency situation. With the proper interpretation of this information, an appropriate and precise response action plan can be prepared by the mobilization of limited resources and taskforce.

At the local government level where the damage situation is ascertained and reported to a superior institute, and where disaster countermeasures suitable for the damage situation are taken, NIED has long studied and developed a disaster information sharing system (public-private risk-control cloud system) for use as a system to support the smooth utilization of disaster information [1, 2]. The disaster information sharing system is a mechanism based on Web-GIS for sharing geospatial as well as tabular information indicating disaster situations and corresponding statuses via the Internet. This disaster information sharing system enables the visual organization and presentation of disaster information to the stakeholders including the neighboring communities. In addition, as a characteristic of the system interface, two-layered tabs and menu buttons enable the organization of disaster corresponding operations and guide the flow of procedures. Accordingly, the disaster information sharing system has an aspect of a disaster corresponding system that supports the elimination of manuals on disaster correspondence.

Our study was in collaboration with NIED which has already configured the system for use in Lalitpur metropolitan city and provided their server for the purpose of this study. NIED has been doing research and development of a rapid and smooth disaster information sharing system at the local government level [2] that is likely to be suitable for the Nepalese context. From the viewpoint of the utilization of disaster information aftermath of the 2015 Gorkha Earthquake, an interview survey was conducted with various stakeholders and victims as a basic investigation to understand the status of the sharing and utilization of disaster information and to suggest improvements [2]. Here, we try to introduce an overview and efforts of the disaster information sharing system and its possible use in Nepal.

2. Initiation in Nepal after 2015 Gorkha Earthquake

The National Research Institute for Earth Science and Disaster Prevention (NIED) organized interviews to assess the utilization status of disaster information such as damage situation and response situation. In order to understand the overall picture of disaster information during and after the disaster, interviews were conducted involving various people, Central government staff, tent life victims, Nepal Police staff assisting the victims, the United Nations staff and many other agencies. This study found that there is no system of information collection and sharing in place at the local government level. This leads to an inefficient response to the disaster.

We discussed with then Lalitpur sub-metropolitan city (Currently metropolitan city, will be referred to as such) and also demonstrated the interface to the officials regarding the adaptation of "Disaster Information Sharing System". Based on the motivation and assurance of support from the officials of Lalitpur metropolitan city, we started to work on this system.

3. Why Disaster Information Sharing System?

In the context of Nepal, at the time of wide-scale disaster, the disaster countermeasures agencies still use conventional i.e paper-based tools and techniques in order to confirm the location of collapsed houses, road, bridge and damage to lifeline infrastructures. Therefore, it is difficult to figure out the potential damages and current damage status resulting in lack of the actual scenario of disaster. As a first step to the immediate, effective and efficient response after the disaster, we need a smart approach to grasp damage situations. Therefore, a holistic mechanism in which all the agencies related to disaster countermeasures need to share disaster information in a single platform. Furthermore, as understood from discussion with the officials and professionals working in this field, considerable time is spent to grasp the damage situations. Present practice is to dispatch the employees and the volunteers to the disaster sites to assess damage situation at the time of disaster. When a large-scale disaster occurs, the stakeholders need to grasp damage situations as promptly as possible. Therefore, for a prompt response to an emergency situation, a proper mechanism to assess the damage status is required. And we propose that the "Disaster Information Sharing System" could be the best possible approach to make the post-disaster rescue and response more effective and efficient.

4. Objectives

- To identify the authorities and responsibilities of local units regarding disaster management and prevention based on existing legal framework
- To configure the NIED system according to Nepalese context
- Modify Web-GIS based platform to collect, store and disseminate disaster information among the stakeholders to promote effective and efficient post disaster emergency response.

5. Methodology

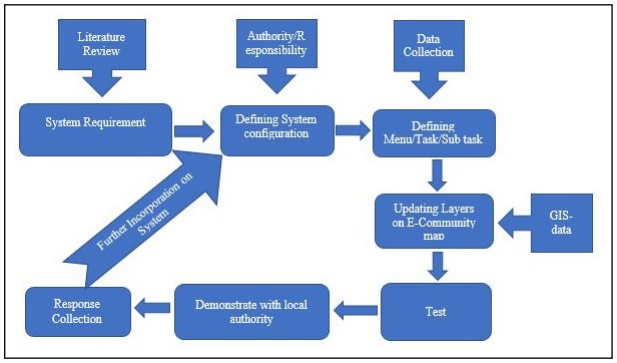

Figure 1: Flow Chart of Study

Various literature reviews, discussions with officials were carried out to identify the system requirement based on authorities and responsibilities of local units.System configuration was defined based on this fact. System demonstration and response collection was the ultimate aspect of this study. Flowchart of study is shown in figure 1.

6. Salient features of NIED System

- Web based disaster response and information sharing platform.
- The system is open source and can be used for disaster or for any other purpose.
- All the tasks of disaster response are categorized into two layers of tabs and task list.
- Tabs and task menus can be edited (add, remove, revise etc.) by a non-programmer.
- Many stakeholders can use the system simultaneously based on user log-in.
- A Map or a table or both are associated with each task. The layers of GIS data visible for each task can be customized.
- An interface is customized for each user. For example, a stakeholder which is associated with shelter management will be able to see only the tasks associated with shelter management.
- Each stakeholder can input data according to the pre-defined settings. For example, each ward can input the building damage assessment data while the city authority will be able to view the overall situation.
- Each stakeholder can communicate with each other based on the pre-defined settings. For example, city authority can ask a shelter management authority to open a shelter based on the situation.

7. Study Area

The Study area covers an area of 36.12 Sq.Km. It is located between (longitude $87°17'41''E - 87°18'24''E$ and latitude $27°36'19''N - 27°41'36.5''N$)

Lalitpur Metropolitan City, popularly known as Patan is currently one of the most vibrant cities of Nepal. It boarders south-east of Kathmandu. With its urban history dating back to as far as 2300 years, Lalitpur Metropolitan City is one of the three major cities located inside the Kathmandu valley, besides Kathmandu and Bhaktapur. (Source: http://lalitpurmun.gov.np/en/node/4)

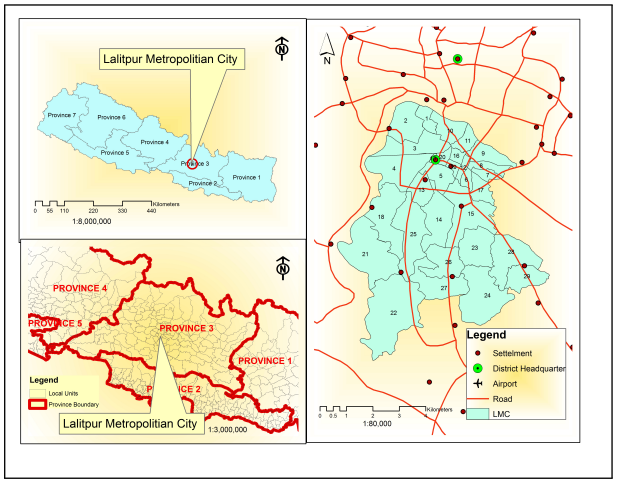

Figure 2: Map of Lalitpur Metropolitan City

8. Configuration of System

Successful implementation of disaster information sharing system is depends on configuration. System is configured with respect to authorities and responsibilities in disaster management of local units and stakeholders responsible for emergency rescue and response. Configuration of System is shown in figure 3.

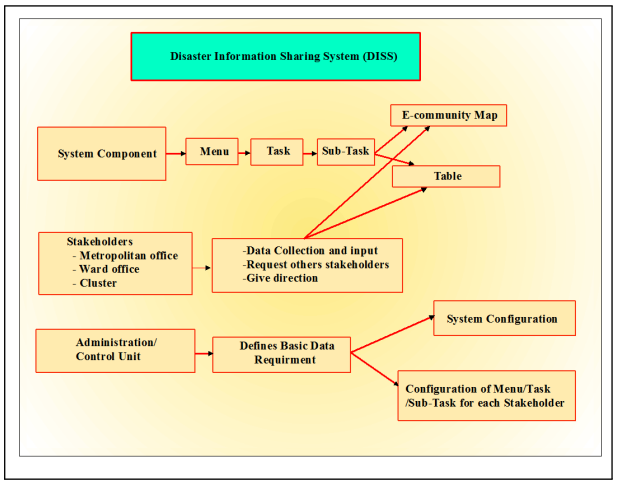

Figure 3: Configuration of System

9. System Components

Menu, Task, and Sub-Task are the major components of this System, which allow the overall operation of the system. This Menu, Task, and Sub-Task allows to input and extract output data. Menus are on the top of hierarchy under which Tasks and Sub-Tasks are incorporated. The system components for each user

are configured through the master control unit of the system. Depending upon the user type, the menu, Task and Sub-Task may vary for each user based on their authorities.

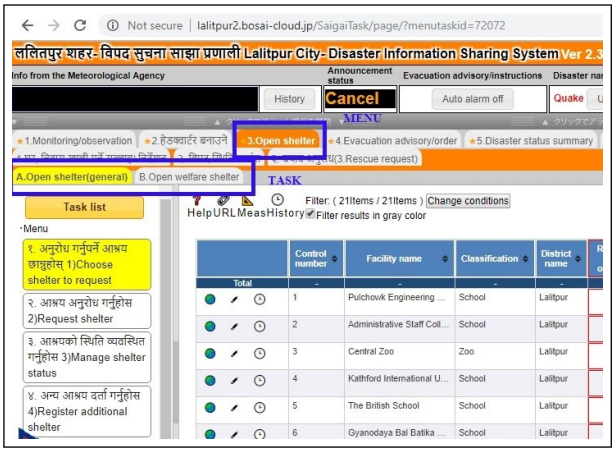

Figure 4: Layout of System Components

9.1 Menu

Each menu is configured based on disaster type and authorities allocated. For example, the ward office could have a typical menu such as:

1. Monitoring/Observation
2. Open Shelter
3. Evacuation advisory/order
4. Disaster Status summary
5. Rescue Request
6. Manage Shelter
7. Road Restrictions/ Re-opening
8. Report to higher level, etc

9.2 Task/Sub-Task

Each menu list has its own task and sub-task. For example, an open shelter menu has two Task menus:

1. Open shelter (General)
2. Open welfare shelter

For example, an open shelter (general) Task has Sub-tasks as follows:

1. Choose Shelter to request
2. Request shelter
3. Manage shelter status
4. Register additional Shelter
5. Send L-alert(media)
6. Send L-alert (Emergency e-mail)
7. Disseminate by twitter
8. Response Status
9. Response History
10. Notification History

Likewise, another Task has its own sub-Tasks

10. Administration/Control Unit

The control Unit regulates the operation of various components of the system. It defines the accessibility of input and output parameters. DISS basically incorporated two control units are :

- Major control Unit (Can access and modify the settings and overall configuration of the system)
- Minor Control Unit (Can only input and view limited data based on the particular settings)

We provided a separate Login window for both the Major and Minor Control Unit.

10.1 Major Control Unit

The major Control Unit has total access and control to the system. The user can make any type of changes to the system and configure the overall setting. The user has access to menu, task, and sub-task and their significant modification. We envisage Lalitpur Metropolitan City, Disaster Management Unit as the major control unit.

Login window for major control unit is shown in the figure 5. HQ is the user name for the Major control unit.

Figure 5: Login window for major control unit

10.2 Minor Control Unit

The minor control unit has limited access to the system and regulated by the major control unit. The user can modify limited system parameters. We assume that the ward level office should have this accessibility. We also provided an independent login interface for each cluster involved in emergency rescue and recovery.

Login window for minor control unit is shown in the figure 6

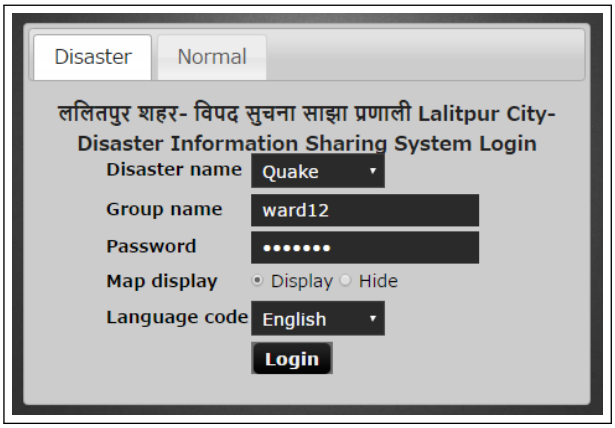

Figure 6: Login window for minor control unit

11. e-Community Map

E-community mapping system is a participatory mapping system developed and released by NIED as an open source platform. It supports collaboration among different stakeholders and can be integrated with e-com groupware, which is a website construction tool.

The following are the features of the E-community mapping system (Source: `https://ecom-plat.jp/index.php?gid=10457`, Japanese).

1. It can be accessed from any computer connected to the internet.
2. It is possible to create maps and GIS data using a participatory approach.
3. Viewing of created feature classes can be enabled or disabled through settings.
4. It is possible to print the maps and data on paper.
5. It is possible to be used or controlled by smartphones.
6. Created maps can be made accessible to the public using standard WMS or WFS protocol.

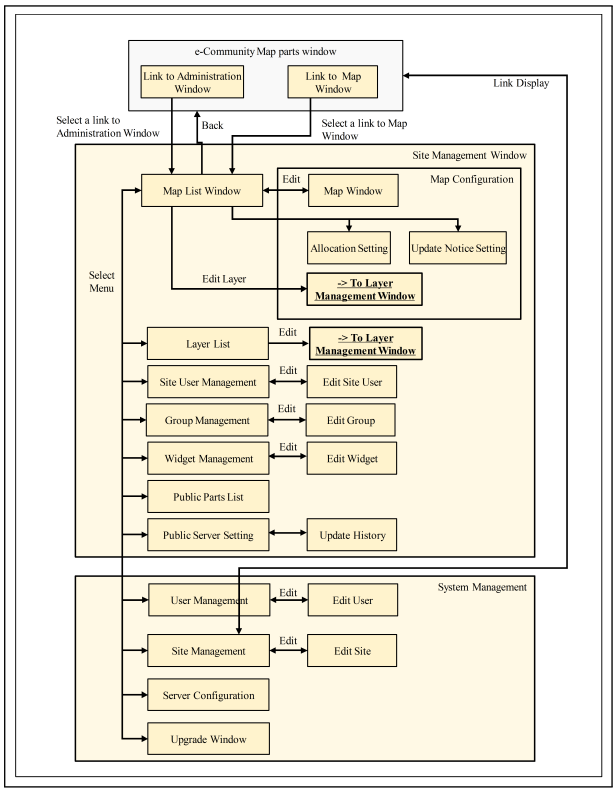

Figure 7: Architecture of e-community Map

Login window for e-Community Map is shown in the figure 8.

Figure 8: Login window for e-Community Map

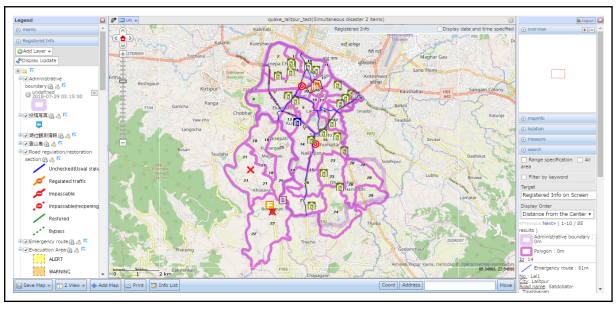

Figure 9: Layout of e-Community Map window

12. System Demonstration and Response Collection from Local Level

In order to collect the response towards the system, we visited four ward offices viz. ward-12, ward-13, ward-21, ward-22 of Lalitpur Metropolitan city. We demonstrated the system to government officials and local representatives. We got positive response from officials and representatives.

On the first day of our visit first, we met with officials of ward-12 including ward chairman Narayan Lal Awala and demonstrated our system after having a quick briefing about DISS. They showed curiosity towards the system and also gave positive response in the first attempt. Next, we visited Ward-13 and met ward secretary, Uday san Napit who had been previously involved in various disaster planning and response in his ward. After having a demonstration, he focused on the scene after the adaptation of this system by Lalitpur Metropolitan city and talked about the sustainability of the system.

Figure 10: System demonstration at Ward-21(Khokna)

Next day, we visited ward-21(Khokna) and ward-22(Bungmati) of Lalitpur Metropolitan city which became part of Lalitpur Metropolitan city after recent restructuring. These two wards are one of the most affected area due to the 2015-Gorkha Earthquake. We met a team of energetic staffs including ward chairman Rabindra Maharjan of ward-21(Khokna). We demonstrated the system with all officials including chairman Maharjan, and they committed for further support from the ward level. Finally, we visited ward-21(Bungmati) and we met with ward secretary Sanat Kumar Thapa and other officials and demonstrated the system and collected responses and suggestions about the DISS. After the completion of the demonstration, almost all the officials and local representatives were optimistic towards the effectiveness of the DISS during the disaster.

Based on the discussion with the officials and representatives, their opinions can be summarized as:

- System seems to be quite useful
- They had some doubts regarding sustainability of the system
- They questioned the availability of internet during disaster
- It would be better if the system can be used for normal day to day activities
- Lack of technical human resources to accomplish the tasks

13. Conclusion and Future Plan

In this paper, we discussed about the adaption of a Web-GIS based Disaster Information Sharing System developed by NIED to the Nepalese context. Well researched visual organization of the web based disaster information sharing system can be used in the Nepalese context. However, some additional technical manpower seems to be necessary. We recommend further research in few more cities to realize the replacement of paper-based information sharing and adapt the Disaster Information Sharing System (DISS). The impact of delay and duplication of information can be significantly reduced during the disaster by which efficient rescue and relief can be achieved. Based on the discussions with the ward officials and representatives, we also recommend to use the system for some day to day activities such as building permit and monitoring which is quite achievable with simple settings.

14. Acknowledgments

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