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# Reviews of disaster risk management using GIS in South Asia

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***Abstract:*** **Many countries in the world are effected by disasters. Because of hazard occurrence people lose their houses, forms even their lives. To decrease the disaster impacts on human lives, many organizations are active on disaster risk management. Disaster risk information is spatial in nature and Geographic Information Systems (GIS) plays an important role in disaster risk management. The use of GIS has become an integrated, well developed and successful tool in disaster risk management. However, there are too many GIS-based systems for new GIS users to identify appropriate tools regardless of the usefulness. So, potential users of GIS can catch up to current and latest trends of GIS-based disaster management systems. The main aim of this research is providing an overview of using spatial information in disaster risk management. This study tells us which organizations use GIS for disaster management in South Asia and which disaster phases GIS is applied. In here is tried to answer which GIS data are used in their projects and what type of GIS technologies are applied for disaster management.**

**Most of the organizations which deal with disaster risk management have projects in pre-disaster phase. Pre-disaster phase is very important and it will be more effective and economical if we pay attention on this phase. Satellite images are used the most of any other GIS data. We compared the GIS technologies, the most of organizations prefer to use web GIS technology. We catch up web GIS may be best choice for new GIS users to apply in disaster risk management. The prepared maps can be available at anytime and anywhere in laptops or mobiles.**

***Keywords:*** **GIS, Disaster Management, International organizations, Latest trends, South Asia.**

## I. INTRODUCTION

Every year many disasters are occurrence in most of countries and people lose their houses, forms even their lives due to disaster occurrence. Some organizations are established for disaster risk management. They use GIS data in their projects for disaster risk management. GIS is a successful and well developed tool to use in disaster risk management. Although, there are too many GIS-based systems for new GIS users to find suitable tools regardless of the effectiveness. This study shows which organizations have project about disaster risk management and which GIS data they used in their projects and determine the type of organizations and which kind of disasters they have projects. So, potential users of GIS can catch up to current and latest trends of GIS-based disaster management systems. The main aim of this research is to provide an overview of the use of spatial information in disaster risk management. This investigation tells us about how we can use GIS for disaster risk management. This paper not only reveals what spatial data is and how it is collected, but emphasizes the use of such spatial data during pre- and post-disaster management, such as during early warning, hazard, vulnerability and risk assessment, damage assessment, as well as in the design of risk reduction measures. The study ultimately hopes that scientific advancement can be utilized for better disaster risk reduction practices. In this investigation is tried to introduce some international organizations that work in disaster risk management. They used GIS in their projects. In this research types of GIS data, types of disasters and phase management of their projects are discussed.

## II. METHODOLOGY

### *A. Page Layout and Font Used*

The chart of methodology are shown in Figure 2.1. There are some activities which are done to reach the above objectives. The activities are:

- List the organization which work on disaster risk management
- Review the organization projects to separate the organizations that used GIS in their activities
- Distribute the questionnaires to organizations to get more information about their projects if it will be necessary
- Divide the organizations according to type of organizations
- List their projects
- Specify used GIS technology and GIS data in the projects
- Specify the disaster management phase and disaster type in their projects


**Figure 2.1 Methodology Chart**

## III. REVIEW OF GIS APPLICATION FOR DISASTER RISK MANAGEMENT

This Chapter tells us about how we can use GIS for disaster risk management. In here is tried to introduce some organizations that manage disasters risk using GIS in their projects. Kinds of GIS data, types of disasters and management phases are discussed in this study that they used in their projects. Most of organizations which introduced are UNs or international organizations. In this survey is emphasized in organizations that have projects after 2010 in south of Asia.

### *A. Projects of UN organizations for disaster risk management*

In this part the UN organizations are discussed that use GIS for disaster management. Table 3.1 shows the UN organizations with their partners which have projects in disaster management. Here the name of projects, covered areas and projects date are written.

***UNISDR, UNEP/GRID-Geneva: Global Risk Data Platform***

The PREVIEW Global Risk Data Platform is a multiple agencies effort to share spatial data on global risk from natural hazards. The users can visualize, download or use the data live in a GIS software. Created and hosted by UNEP/GRID-Geneva. Supported by UNISDR. The Global Risk Data Platform has now evolved following all standards for Spatial Data Infrastructures (SDI) and providing all the web services in compliance with the Open Geospatial Consortium (OGC) [1].

***UNISDR: Global Assessment Report on Disaster Risk Reduction***

This project is a multiple organizations work to share spatial data on global disaster risk. Users can be able to visualize, download or extract data on past hazardous events, human & economical hazard exposure and risk from natural hazards. It covers major hazards, initially tropical cyclones and earthquakes and as it becomes available, information related to storm surges, drought, floods, landslides, tsunamis and volcanic eruptions. [2].

***UN ESCAP: Utilizing space and GIS for effective disaster risk***

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) is the regional development arm of the United Nations for the Asia-Pacific region that established in 1947 with its headquarters in Bangkok, Thailand. This project had 4 objectives: 1. Enables timely access to and use of space-derived products and GIS for effective disaster risk reduction.2.Effective monitoring and early preparedness for drought helps save lives and livelihoods.3. Strengthening capacity to build multi-disciplinary approach, collating and consolidating information system for disaster risk management.4. Understanding the risk: Regional Land Cover Dataset [3].

**TABLE 3.1: Projects of UN organizations for disaster risk management**

| NO | Organization | Type | Partner | Name of project | Area | Year |
|---|---|---|---|---|---|---|
| 1 | UNISDR | UN | UNEP | Global Risk Data Platform | Global | since 2009 |
| 2 | UNISDR | | World Bank, CIMNE, ERN, & etc. | Global Assessment Report on Disaster Risk Reduction | Global | 2015 |
| 3 | UN ESCAP | | ASEAN, SAARC, and Pacific countries & etc. | Utilizing space and GIS for effective disaster risk management | Asia and the Pacific | 2015 |
| 4 | UNOOSA | | JB GIS | Geoinformation for Disaster and Risk Management | China, India, Indonesia, Philippines, | since 2009 |
| 5 | UNOOSA | | UN-SPIDER | United Nations International Conference on Space-based Technologies for Disaster Risk Management | Global | 2013 |
| 6 | UNOCHA | | ACMAD, BOBP, CATHALAC, & etc. | Reliefweb | Vietnam, Philippines, LaoPDR, DPR Korea | 2016 |

***UNOOSA & JB GIS: The Global Disaster Alert and Coordination System GDACS***

GDACS, established in 2004, is a cooperation framework under the United Nations umbrella with the aim to consolidate and strengthen the network of providers and users of disaster information worldwide. In order to provide reliable and accurate alerts and impact estimations after sudden-onset disasters and to improve the cooperation of international responders in the immediate aftermath of major natural, technological and environmental disasters [4].

***UNOOSA & JB GIS: Geoinformation for Disaster and Risk Management***

The project started in January 2009 with an open call for contributions describing best practices and experiences. Disasters in China, Germany, Greece, Haiti, Hungary, India, Indonesia, Italy, the Philippines, Sudan, and the USA are analysed in detail [5]. Three phases of disaster management was focused in this project using all three GIS technology (see Table 3.2 &3.3).

***UNOOSA & UN-SPIDER: GeoSHAPE***

In the year 2013, the United States Southern Command's Science, Technology and Experimentation Division spearheaded the development of the GeoSHAPE tool with the goal of facilitating the generation and sharing of geospatial information among all those involved in disaster response operations [6]. . This tool combines a mobile application for the collection

of data and photographs of affected areas using smart phones and tables, and a web-based application that allows combining, publishing, and distributing geo-spatial information among all actors in response and post-disaster phases (Refer to Table 3.2 &3.3).

***UNOCHA: ReliefWeb***

ReliefWeb is the leading humanitarian information source on global crises and disasters. It is a specialized digital service of the UNOCHA. They provide reliable and timely information, enabling humanitarian workers to make informed decisions and to plan effective response using WebGIS technology (see Table 3.2 &3.3). Also, they collect and deliver key information, including the latest reports, maps and infographics and videos from trusted sources [7].

***B. Disaster management phases of UN projects***

In table 3.2 disaster management phases and types of disasters are specified that the UN organizations focused on their projects. Risk awareness, preparedness (monitoring and early warning), risk assessment, disaster alert, monitoring are the activities of UN organizations in pre-disaster phase. In response phase they work on warning, real-time monitoring, rapid assessment, response maps, maps for emergency operations and map of the ongoing disasters. These organizations have activities in damage assessment and recovery for post-disaster phase.

**TABLE 3.2: Disaster Management Phase and Disaster type of UN projects**

| NO | Organization | Disaster management phase | | | Disaster Type | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre disaster | Response | Post disaster | CYC | FL | DR | EQ | WF | LS | TS | STM | VO | TYP | ENSO |
| 1 | UNISDR | | | Damage assessment | √ | √ | √ | √ | √ | √ | √ | | | | |
| 2 | UNISDR | Risk awareness | warning, real-time monitoring | Damage assessment | √ | √ | | √ | | | √ | √ | √ | | |
| 3 | UNESCAP | Preparedness (monitoring and early warning) | warning, Rapid Assessment | Damage assessment | √ | | √ | √ | | | | | | | |
| 4 | UNOOSA | Risk assessment, Risk awareness(Disaster Alert), Monitoring | Response maps | Damage assessment, recovery | √ | √ | | √ | √ | √ | √ | √ | | | |
| 5 | UNOOSA | | Maps for Emergency Operations | Damage assessment | | √ | √ | √ | √ | √ | √ | | √ | | |
| 6 | UNOCHA | | Map of the ongoing disasters | | | √ | | √ | | √ | | √ | | √ | |

### *C. GIS technology and data of UN projects*

Table 3.3 describes GIS technology and GIS data which UN organizations used in their projects for disaster management. The Global Risk Data Platform (UNISDR) has now evolved following all standards for Spatial Data Infrastructures (SDI) and providing all the web services in compliance with the Open Geospatial Consortium (OGC). The users can visualize, download or use the data live in a GIS software. OpenLayers, Sencha Touch are the mobile apps produced by Global Risk Data Platform. GeoSHAPE tool (UNOOSA) combines a mobile application for the collection of data and photographs of affected areas using smart phones and tables, and a web-based application that allows combining, publishing, and distributing geo-spatial information among all actors in response and post-disaster phases (Refer to Table 3.2 &3.3). Global Assessment Report on Disaster Risk Reduction (UNISDR) and ReliefWeb (UNOCHA) was used web map. UNESCAP applied Desktop GIS using real-time satellite imagery. UNOOSA applied all of GIS technologies in its projects. GIS Mobile applications are used for the collection of data and photographs of affected areas. Elevation, river, land cover and satellite images are the GIS data used in the projects.

**TABLE 3.3: GIS technology and data of UN projects**

| NO | Organization | GIS Technology | | | GIS Data |
|---|---|---|---|---|---|
| | | Desktop | Web | Mobile app | |
| 1 | UNISDR | | OpenGeo Suite, PHP, amCharts, Open Street Map, OGC Web service, | OpenLayers, Sencha Touch | population distribution, GDP per capita, elevation, land cover, rivers, lakes, National parks |
| 2 | UNISDR | | base map(Bing map, MapQuest, OpensteetMap, Google Physical, Google streets | | Risk map, Satellite images |
| 3 | UN ESCAP | ArcGIS, QGIS, HEC GeoRAS, HEC RAS | | | real-time satellite imagery, damage maps, Cultivated land, Forest, Grassland, Shrub land, Wetland, Water bodies, |
| 4 | UNOOSA | ground sensors, satellite products and GIS, remote sensing, sensor networks | Web-based mapping services | iGDACS, UN-ASIGN, GDACSmobile, GEOPICTURES, ACRIMAS | Spatial Data Infrastructures and Disaster-specific data layers, Thematic data on terrain and natural resources, Near-real-time satellite data and thematic maps |
| 5 | UNOOSA | Crowdsourcing/VGI, Desktop GIS, Desktop image processing | webGIS, GeoSHAPE, ArcGIS map viewer, ArcGIS online, BeeldBlad Web Mapping Service, | Mobile application for the collection of data and photographs of affected areas | Global datasets, Landsat imagery, Baseline data, Elevation, Land use, land cover |
| 6 | UNOCHA | | web map | | GIS map |

## IV. DISCUSSION

According to the Tables 3.2 most of the organizations that work in disaster risk management have more activities in pre-disaster phase. These activities include risk assessment, risk awareness, preparedness, and mitigation. Some of them have activities on post disaster risk management like rehabilitation, recovery, and reconstructions and some of them have activities during a disaster such as response, emergency operations and warning. We can realize from the results of this paper that pre-disaster is most important in disaster risk management. If the organizations have more activities in this phase it will be more effective and economical. Because ''one dollar investment in disaster prevention saves seven dollars in recovery." [World Bank]. Table 3.2 shows flood and earthquake are the disasters that these organizations had more activities than other disasters. Because flood and earthquake occurs in most of countries and have more effects in their people lives. El Nino &Lanina, volcano and forest fire are the disasters that organizations had less activities than other disasters. These disasters occur in some countries, not in all.

According to the Table 3.3 the organizations used satellite images, land cover, land use, water body, river, elevation and etc. as GIS data for making a map like hazard maps, risk maps, and other maps. Satellite images are used the most of any other GIS data in projects. Satellite images has more usefulness in disaster risk management activities. If we compare the GIS technologies together, we will see the most of organizations prefer to apply webGIS for making web maps. These organizations apply OpenGeo Suite (PostgreSQL, PostGIS, GeoServer, OpenLayers, GeoExt) PHP, amCharts, Open Street Map OGC Web service (WMS, WFS, WCS, WMTS), KML (Google Earth) GeoWebCahce and etc. to produce web maps. Some of organizations use ArcGIS, QGIS and other desktop GIS software in their projects. Mobile GIS apps (OpenLayers, Sencha Touch) are made by some organizations. Mobile GIS apps is very useful for disaster awareness and response. Because the mobile phone is more accessible for the people anywhere. From the result we found out webGIS may be best choice for new GIS users to use it in disaster risk management. It is accessible for users in anytime and anywhere in their laptops or mobiles.

## V. CONCLUSION AND RECOMMENDATIONS

Each year many of countries are effected by disasters events. People lose their houses, forms even their lives. So the organizations are made for disaster risk management. In this investigation, international organizations that used GIS for disaster risk management are United Nation organizations. All types of disasters we discussed in this study are natural disasters and the study area is south Asia.

Most of the organizations which deal with disaster risk management have more projects in pre-disaster phase. These activities contain risk assessment, risk awareness, preparedness, and mitigation. Some organizations worked on post disaster risk management such as rehabilitation, recovery, and reconstructions and some of them have activities during a disaster like response, emergency operations and warning. We can say from the results of this study that pre-disaster is most important in disaster risk management. If the organizations have more activities in this phase it will be more effective and economical. Flood and earthquake are the disasters that these organizations had more activities than other disasters. Because flood and earthquake occurs in most of countries and have more effects in their people lives. El Nino &Lanina, volcano and forest fire are the disasters that organizations had less activities than other disasters. They effect in some countries, not in most of the countries.

These organizations used satellite images, land cover, land use, water body, river, elevation, etc. as GIS data for making a map like hazard maps, risk maps, and other maps. Satellite images are used the most of any other GIS data. We compared the GIS technologies together, we saw the most of organizations prefer to use web GIS technology. Because of internet accessibility, anyone from anywhere in any time can use the maps. They apply OpenGeo Suite (PostgreSQL, PostGIS, GeoServer, OpenLayers, GeoExt) PHP, amCharts, Open Street Map OGC Web service (WMS, WFS, WCS, WMTS), KML (Google Earth) GeoWebCahce, etc to make web maps. Some of organizations use ArcGIS, QGIS and other desktop GIS software in their projects. Mobile GIS apps (OpenLayers, Sencha Touch) are made by some organizations. Mobile GIS apps is very suitable for disaster awareness and response. Because the mobile phone is more available for the people everywhere. From the result we catch up webGIS may be best choice for new GIS users to use in disaster risk management. It is available for users in anytime and anywhere in their laptops or mobiles.

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