Geospatial Framework for Multi Hazard Disaster Information, Response and Mitigation

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ABSTRACT

In the modern age, the role of geo-information technology is vital in a country's critical infrastructure, especially for 'Disaster Management' and 'Emergency Response'. Recently, experts in the field have tried to contribute in specific domains within their capacity and area of interest. However, there still exists a need for a central standardized framework, which can act as a holistic one-go access platform for all the disaster specific information of a particular geographical area. The use of GIS technology for developing such systems is pivotal, as the basis of crisis management lie in the availability, characterization and analysis of real time data, in a visual form most intelligible for human decision-making. In this paper, we propose the development of a geospatial system at national/state level, which will incorporate all the baseline data (basic infrastructure and facilities), data pertaining to local hazards and past disasters, geological features etc., in a unified single framework. Furthermore, the system allows centralized visualization, along with analytical capabilities, to retrieve meaningful information, which can re-inforce the decision-making process. Such a mechanism can serve as a backbone for the complete disaster management cycle starting from response to mitigation.

KEYWORDS

Disaster Management, Geospatial, Crisis Management

INTRODUCTION

The world has already witnessed many Disasters including floods, tsunamis, earthquakes, hurricanes and other emergencies which has resulted in terrific harms and damaged millions of humans and infrastructure almost every year. There has been an alarming increase in the severity and frequency of these disasters (Schryen, 2016). Natural disasters have turned great in frequency with increasing human interventions to natural phenomenon. Natural disasters of any kind affect both, materials and people lives. This constant vulnerability to be exposed to a natural disaster is itself horrible but when combined with socio-economic vulnerability poses a great challenge for authorities and sufferers in every form imaginable (Ahmad, 2011).

Disasters worsen when governments and authorities lack in emergency support and it gets complicated with breakdown of communication structure. 90% of Natural Disasters and 95% of disaster related deaths worldwide occur in developing countries (Mundial, 1995). It takes months if not year for people to rise again from such devastating impacts.

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Disaster management issues are complex and time taking involving all the stakeholders with different preferences and less compromise (Levy et al., 2007). For the purpose, it is becoming a common practice to involve all participants for decision making and submit disaster management plan to public for participatory discussions with research on public perception of disaster and its management (Francisco, 1998). It can be reminded here that United Nations conference on Disaster Risk Reduction (2005) provided commendations to decision makers for disaster risk reduction, including flood disaster and also delivered The Hyogo Framework of Action (2005) which emphasized on improved compilation of information on disaster risk.

With the advent Geographical Information Systems (GIS) & Remote Sensing (RS), statistical studies were further carried forward with the integration of location of data, hence a better visualization of data in terms of maps. GIS add greatly to the field of disaster management as it is famously said as 'Picture' captures more information than thousands of words. Similarly RS data helps greatly in quick analysis of affected areas and response measures. The introduction of these fields has changed the dynamics of disaster management. (Chowdary et al., 2008) suggests that coupling of geographical Information Systems and Remote Sensing provides an exceptional substitute to conservative ways of disaster mapping as well as its monitoring and damage assessment that leads to significant disaster management.

As an example for "Flood" disaster; satellite monitoring is a technique useful for obtaining data for real time flood forecasting, suggesting that the web based GIS system required for flood forecasting system should have real time rainfall data, a user friendly interface and easily available at different web platforms. Flood Information System extended to Web GIS based geospatial framework can provide up-to-date data and real time information prior to and after the flood disaster in order to illustrate vulnerable and affected areas respectively (Raltman et al., 2011). This will help the concerned authorities to take precautionary measures in time to avoid further loss.

RATIONALE

All this background information illustrates that timely surveillance of everything involved is of paramount importance in solution to problems such as disaster or emergency. This is a time for some much-needed integration among all stakeholders. Shan et al., (2009) defines the timely provision of disaster extent, progress and impact information directly to all stakeholders as of prime significance and suggests that 'Web' can help providing platform for developing quick response strategies, planning rescue operations and placing relief efforts.

The study aims to provide an idea of a facility where all the stakeholders are combined at a single platform, assessing what is required to them and using it for operations and services through an information portal for multi hazard support facility prototyping disaster management and rescue services using geospatial technology.

There is a wide implementation in the form of spatial mash-ups, crowd-souring web platforms and dedicated software platform available for use by the global community. Disasters ranging from that of Chernobyl, tsunamis in Indonesia (2004) and Japan (2011), Hurricane Katrina (2005) and the Denube floods (2013) are some of the examples of where geospatial webs have played a vital role in disaster management and mitigation. The US FEMA HAZUS and FEWS

are another set of valuable examples of geospatial technologies in disaster management and mitigation. Gupta and Knoblock (2010) suggested that there can be more economic implementations of geospatial technologies possible in the form of geospatial framework. The use of web and GIS coupled with GIS/RS technologies or simply the geospatial web has been advocated by Mioca et al., (2008) and Chan (2011) for flood disaster management and mitigation. Karnataka et al., (2011) believes that all three technologies know to the user and developers of distributed GIS i.e. WEB, GIS/RS and spatial mashups can effectively help in visualization, management and mitigation of floods and all other types of natural hazards.

METHODOLOGY

Effective information, response and mitigation relating to a disaster event, require information from multiple sources and working in the domain of Geographical Information Systems and Sciences, everything is centered on location and spatial extent. To combine information from different sources of spatial nature and integrating it with the relevant non-spatial data results in a product, that can efficiently support disaster management.

Our approach, towards a system for *Geospatial Framework for Multi Hazard Disaster Information, Response and Mitigation*, follows the development of a Geospatial Mash-up, which integrates heterogeneous data, form heterogeneous data sources and presents them on a common scale.

The portal will have below listed domains of data which can be initiated from selected districts in the first phase and after a successful implementation lead to a nationwide implementation.

- Historical Overlook *(past events and their studies/products)*
- Base Data *(all related available data on a standardized system)*
- Real Time Observations *(integrated sensors, participatory GIS)*
- Analytical Framework *(GIS, Databases and IT applications for users)*

Historical Overlook (past events and their studies/products)

- Records of Previous Events - Simulations based on Past Events
- Already completed products and studies

Base Data (all related available data on a standardized system)

- Topographic Records - Census Records - Satellite Imagery

Real Time Observations (integrated sensors, participatory GIS)

- Sensor Networks - Newsfeeds - SMS based distress calls

Analytical Framework (GIS, Databases and IT applications for users)

Historical Outlook, Base Data and Real Time Observations are required to be analytically integrated within a frame work through connectivity between Spatial Databases, GIS servers, and a web interface. Open Source technology can be used which will make the overall product Cost Effective and easy to use for all stakeholders.

Geospatial Framework will be hosting the discussed domains of data in a form of analytical framework with different Views and Privileges for each end user depending on their requirement. Idea is to have a geographical system where all spatial and non-spatial data can be available in a single pop-up based on location. There can be more products related to simulations, multi viewing, overlaying, and geostatistical analysis with the using of Mapping APIs (Application Program Interface).

An idea is provided with bibliographic references that solution for disaster management is not just to be of a GIS kind, but also of Web and Mashup nature. Details of product and its systems can be augmented through participatory approach of related stakeholders, financial and technical capacity and capability of project owner and availability and limitations in terms of data and administration

CONCLUSION

World has been a home to some of the most devastating disaster events in the history of mankind. Undoubtedly, much work is being done on early warning system and disaster management during the previous few years. But there lies a major lack of coordination between all these organizations working on disaster management with mostly overlapping roles and responsibilities. This research is an initiative, prototyping an idea to integrate all that it takes to build an effective solution for disaster management, equally beneficial for all the stakeholders, from qualified spatial analysts, rescue service provider, disaster management bodies, to general people. It needs much more refinement and has a room for further extension based on time specific needs.

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