

Web based Geographic Information Systems for a Flood Emergency Evacuation

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ABSTRACT

The main goal of this research is to create a web based Geographic Information Systems (GIS) application, which would help to people living in flood plains, who may at one point be vulnerable due to their proximity to the river and the amplitude of the flooding. The main result of our research is a web based GIS system that provides appropriate information to the relevant authority and general public in a timely manner and easy to understand. Relevant authorities in this case may include flood managers, flood warning practitioners, professional partners and emergency services. The easy to use interface we developed also allow non-GIS experts to be in a position to interactively view and explore, as well as query the data base, to select different data variables and to view maps at several levels of detail.

Keywords

WebGIS, Flood evacuation, Emergency measures.

INTRODUCTION

The main goal of our research is to create a web based Geographic Information Systems (GIS) application, which would help to people living in flood plains, who may at one point be vulnerable due to their proximity to the river and the amplitude of the flooding. There are many factors that may lead to floods, and people living in flood plains are most likely to be affected. A flood plain is whereby a flat or gently sloping land adjacent to a stream, during high stream flow conditions, caused by excessive rainfall or snowmelt or a combination of the two, become inundated by water (Summary Report, 1983). A large number of people in the Fredericton area reside along the Saint John River and its tributaries. We wanted to create a web based GIS application (Plewe, 1997) that will provide timely flood information to emergency managers and general population, and the main functionalities of this application are to help identify people within certain distances within the floodplain, that may be affected by a particular flood. Web based GIS (Zipf and Leiner, 2004) is a methodology of building distributed GIS applications on the internet (Shea, 2001). Web GIS has the possibility of query on the website that can help to identify the properties and the people who might be affected by the floods, who may then be contacted to have ample evacuation time.

STUDY AREA

It has been identified that more than 58% of the incorporated municipalities in the region of New Brunswick, reside within the Saint John River System (Report I – 8001, 1980). The reason being that the waterways, during early settlement years, served not only as a source of major transportation for the early settlers, it also served as a source of livelihood for them as well. As the New Brunswick communities grew, so did occupation of flood plains to the point where substantial damages, human sufferings and indeed, loss of lives occurred during major floods (Summary Report, 1983). Nation wide surveys have been made in the past and they clearly show that New Brunswick area is one of the highly vulnerable areas to floods. Flooding has also been identified as the leading natural disaster in terms of property damage, which leads to immeasurable costs to individuals. Furthermore, a publication by Jeanne Andrews (1993) on Flooding, highlighted the fact that flooding in Canada was a common phenomenon, resulting from an increase in streamflow beyond the point where the normal stream channel could contain the water. However, in most cases flood prone areas are often very attractive to the developer.

Flood control structures have been put up in the past, like building of dykes and creation of upstream storages. However, this has in a way indirectly encouraged the further encroachment upon river floodplains, thereby raising the potential for flood damage and leading to requests for greater levels of protection ([Andrews, 1993]). It is also understood that mapping programs were also put in place to help delineate and designate flood risk areas.

The idea is to use design floods, defined by Jeanne Andrews' publication on floods, (1993), to be extreme flood events selected and used for the design of structural measures such as dykes, spillways and floodways, as well as used in the delineation on topographic maps of flood hazard areas adjacent to rivers, lakes and the sea. The design floods used are of 1 in 20 year flood, that is a flood having a return period of 20 years on average or having a 0.05% chance of occurring in a given year. Other design floods are 1 in 100 year and 1 in 200 year flood. These are intersected with land use classification layer that include industrial areas, offices, parks, shopping areas and residential blocks of people residing within the flood plain. Furthermore, data showing the streams and rivers around the Fredericton area, as well as data showing road networks are used to calculate available evacuation routes.

PROTOTYPE APPLICATION DESIGN AND IMPLEMENTATION

The main goal of our research was to create of a web based GIS system which could provide appropriate information to the relevant authority in a timely manner and easy to understand. Relevant authorities in this case may include flood managers, flood warning practitioners, professional partners and emergency services to those affected, (Butts and Khatibi, 2003). Furthermore, we wanted the flood warnings available online and readily accessible to a broad audience to increase the level and quality of services provided (Gibson and Erle, 2006).

The easy to use interface (see Figure 1) should also allow non-GIS experts to be in a position to interactively view and explore, as well as query the data base, to select different data variables and to view maps at several levels of detail. We used ArcIMS to develop web based GIS system (Osborne, 2007). When creating this website, it was taken into consideration that the provision of a map based information system in an easily accessible manner presents many challenges and as such, most search results displayed on the map would also be accompanied by textual sections below the map.

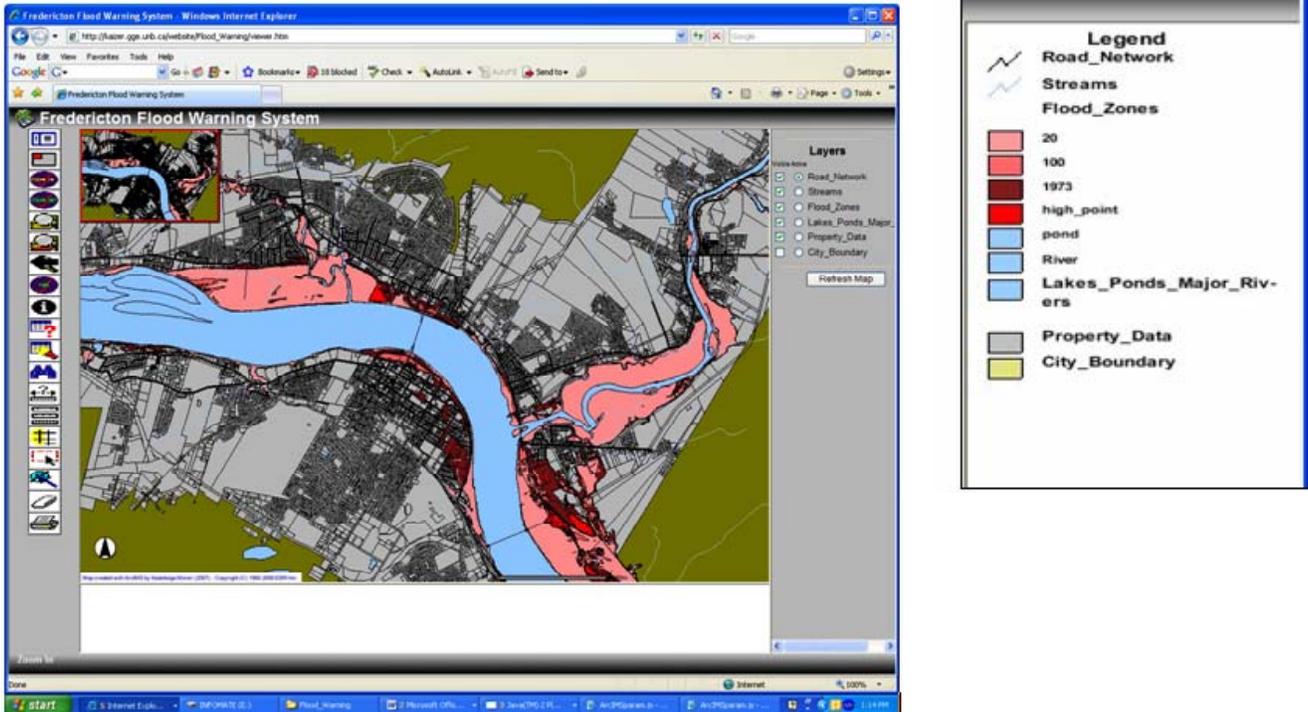


Figure 1. Prototype of Flood Warning Website for Fredericton

Our other objectives included:

- To assist flood warning practitioners as well as general public to be in a position to query the website, for flood evacuation routes, as such the website would allow them to identify evacuation routes as well as to have an idea of the water levels on flooded roads (see Figure 2).

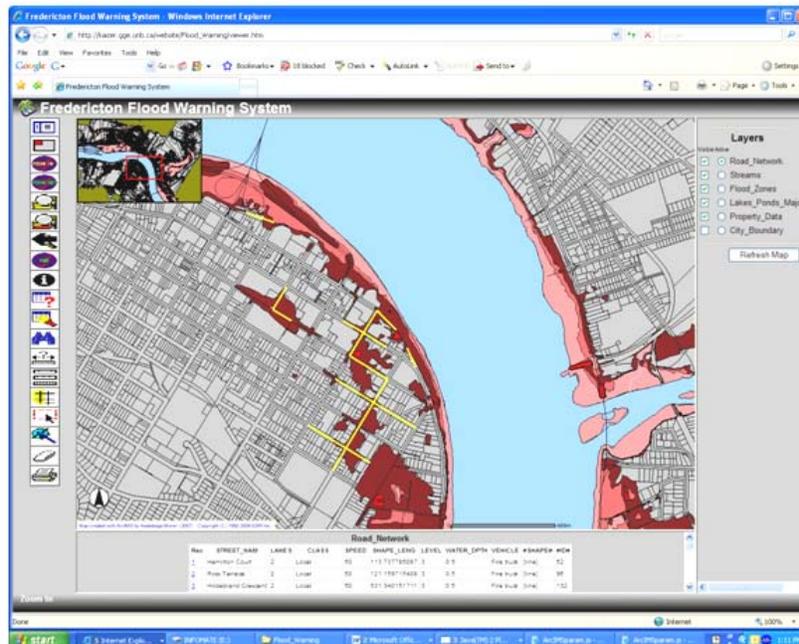


Figure 2. Output of a manually entered query

- Design floods have also been utilised, for the system to have the capability of producing property data of properties that may be affected by a particular design flood. This can be very helpful to flood practitioners to have an idea of the properties likely to be affected by such a flood (see Figure 3). Furthermore, city planners may also utilize the data when planning for future developments on flood prone areas to have an idea on the extent flood coverage of a possible maximal flood (shown on Figure 1).

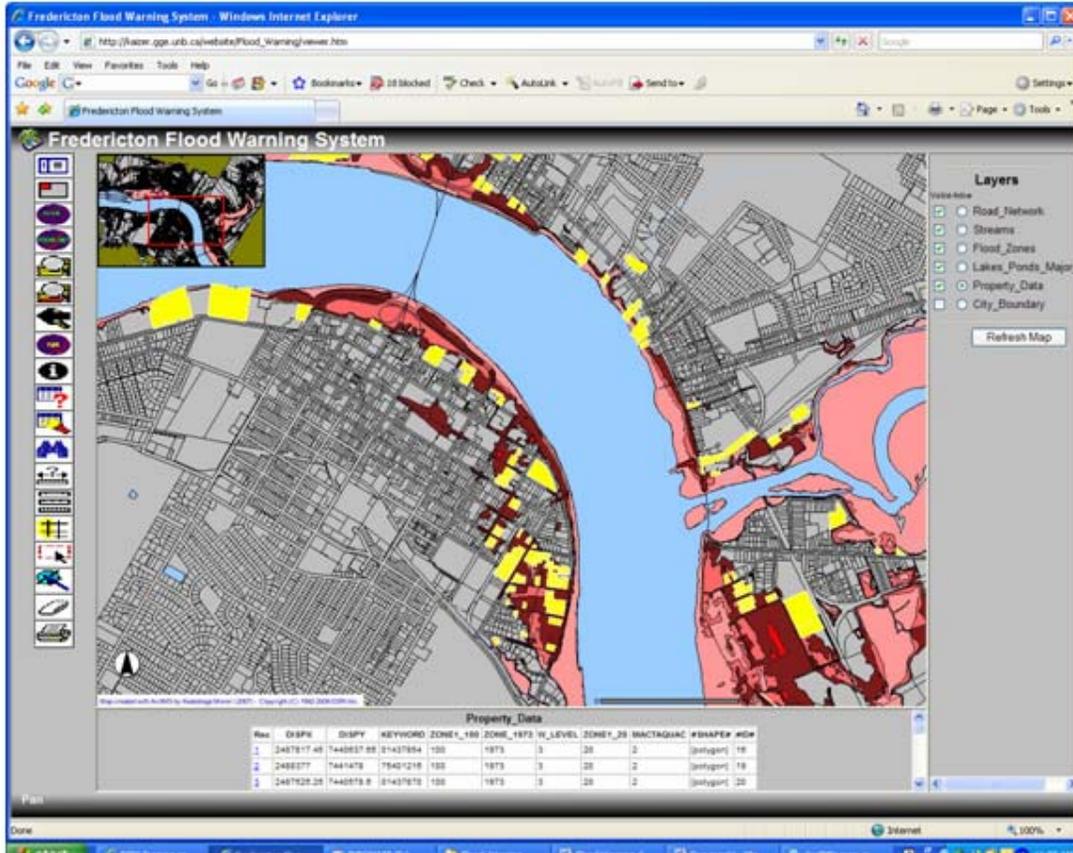


Figure 3. Properties affected by a particular flood water depth (Stored Query: An emergency manager would like to identify properties likely to be affected by a particular water level, for example 0.5 meters)

Areas highlighted in yellow show the properties likely to be affected by a water level of three, which is up to 0.5 meters. In total, 243 properties would be affected by this water level rise (shown in Figure 3 and in the table below):

240	2487100.8	7441993.85	01413871	100	1973	3	0	2	[polygon]	17488
241	2487144.05	7441996.15	01413384	100	1973	3	0	2	[polygon]	17564
242	2487176.95	7442030.8	01415140	0	1973	3	0	2	[polygon]	17618
243	2486935.05	7441933.5	75237180	100	1973	3	20	2	[polygon]	17787

[Previous 25 Records](#) [Zoom to these records](#)

- The Mactaquac Dam burst flood scenario has also been incorporated, for users to have an idea of the extent of the flood in the city as well as the houses likely to be affected by such a scenario (see Figure 4).

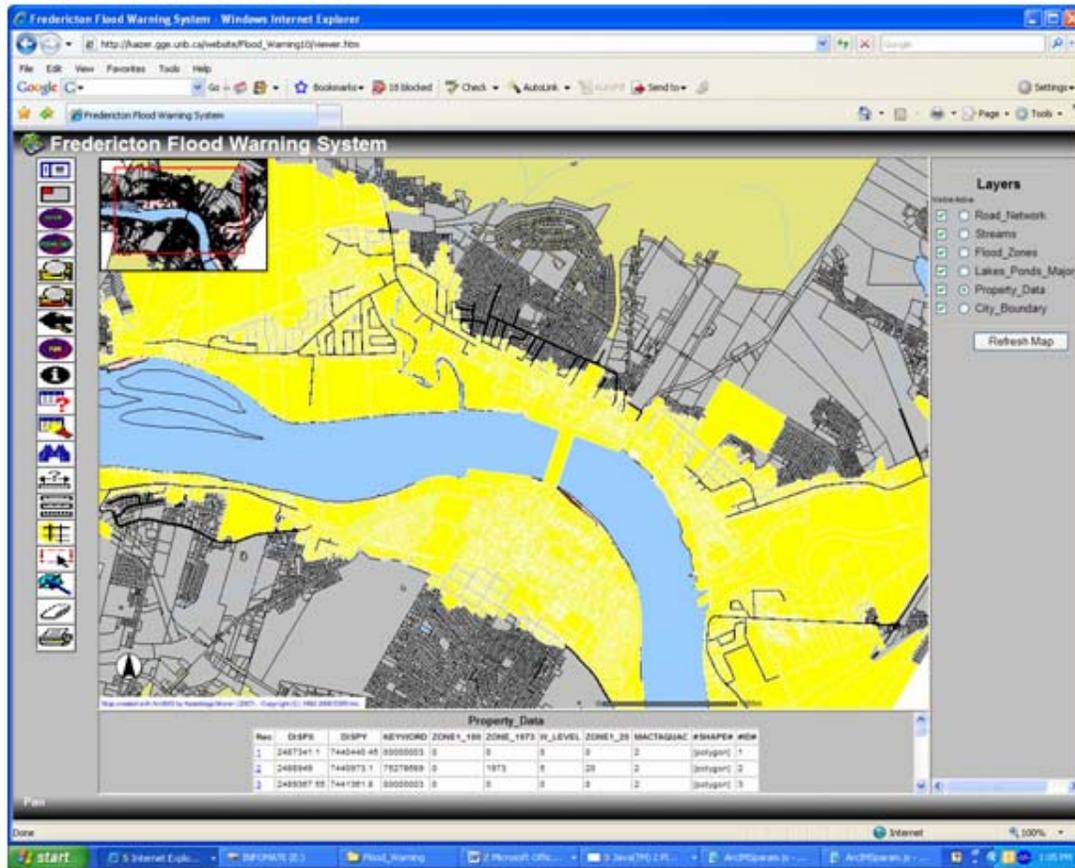


Figure 4. Flood extent of the Mactaquac Dam break. Stored query: When emergency officers or would planners would like to have an idea of the houses likely to be affected by the Mactaquac Dam Break. In total 7560 properties would be affected by this dam break.

RESULTS AND CONCLUSIONS

The results of this research provide a prototype of the web-based application for Fredericton flood warning system, where accurate and timely warnings can be achieved, and thus maximizing the response time for flood plain residents and emergency managers and to provide a powerful planning tool for flood prone areas. Furthermore, proper evacuation routes can be planned well on time, when water depths on several streets likely to be affected by the floods are known. The idea was to bring about results that would show the inundation at a particular level, represented by a color code, for example having to represent the selections of a particular water level with a particular color for clear distinction.

The developed WebGIS application can assist flood warning practitioners as well as individual people to query the website, for flood evacuation routes; as such the website would allow them to identify evacuation routes as well as to have an idea of the water levels on flooded roads. The flood warnings application is available online and readily accessible to a broad audience to increase the level and quality of services provided.

Using the results of hydrological modelling the system has the capability of identifying the properties that may be affected by an upcoming flood. This can be very helpful to flood practitioners to be in a position to have an idea of the properties likely to be affected by flooding. Furthermore, city planners may also utilize the data when planning for future developments on flood prone areas to have an idea on the extent flood coverage of a possible maximal flood.

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