An Overview of the Application of Geographic Information Systems (GIS) in Crisis Management with an Emphasis on Flood Zoning

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Abstract:

Early warning is one of the main causes for disaster risk reduction. This will prevent the loss of life and reduce the negative economic and material consequences of accidents. This case study becomes more important when it comes to the geographic conditions exposed to many natural and severe natural disasters such as floods, storms and earthquakes. In order to mitigate the negative effects of facing such a situation, the need for crisis management is absolutely necessary. One of the strongest tools for optimizing crisis management is GIS geographic information systems. Using the GIS software and the use of hydraulic software such as HEC-RAS, it can be used to determine the flood zoning and, consequently, management measures to reduce the risks, with an appropriate precaution before the occurrence, Simulated.

Keywords: Crisis Management, Flood, HEC RAS, GIS, HEC-GeoRAS

1 Introduction

1.1 Background and Definitions

The purpose of early warning systems focused on individuals is to be able to reduce the risk of injury, damage to property and the environment in an adequate and appropriate manner. A complete and effective system consists of four interdependent factors, namely, risk identification, monitoring and warning services, communication systems, and accountability. To better understand this discussion, it is necessary to become more familiar with the early definitions of these discussions.

- **Disasters:** An urgent need is a disaster and disaster that local resources do not have the ability to manage it.
- **Human Causes:** Incidents involving human activities or the advancement of human societies. (Explosions, stops due to hardware or software failures)
- **Natural disasters:** Includes unplanned occurrences that occur due to natural processes such as floods and so on
- **Risk:** The potential for an emergency.

- **Monitoring and warning services:** Services that are at the center of the system and must be actively and continuously used to predict and prioritize their hazards.
- **Communication systems:** Clear messages contain simple, useful information to pursue appropriate responses that save lives and property.
- **Accountability:** A comprehensive understanding of the risks we are exposed to and providing alert services for its responses.

1.2 Crisis Management:

Managing the crisis focuses on three basic principles, including protecting human lives, protecting their property and assets, and preserving the environment. Also, crisis management can be achieved in 5 stages, depending on the time of occurrence and the type of emergency emergencies. The following chart shows the various stages of crisis management:

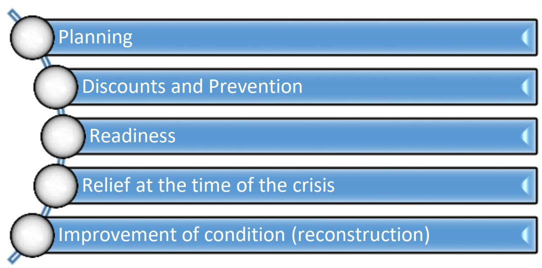

Figure 1: Diagram of various crisis management stages

1.3 Geographic Information System (GIS):

The GIS is a modern database that distinguishes it from a typical database, is inclusive (including spatial, descriptive, quantitative) and intelligent (including its composition and analysis). Geographic information systems are a powerful tool for working with data. This tool allows you to enter a variety of information in various shapes and formats such as text, maps, satellite imagery, aerial photos, movies, audio, etc. Also, complex analyzes with a variety of spatial and non-spatial data sets are one of the most important GIS capabilities. Also, updating maps in GIS is easy and fast.

The origins of the GIS are virtually the period in which the cartography fan began to develop, and the roles came to the conclusion that a single map could not contain all the required data. Before the computer came on, Earth image information was displayed in the form of dots, lines, and areas along with signs, colors, or short texts on paper maps. Using different maps to conduct an analysis through the overlapping of those maps was a kind of GIS manual (Figure 2). These data included statistical reports, aerial photos, and so on. Geographical information systems were introduced in Canada in the early 1960s and became global in the 1980s. The GIS has been blasting in recent years. As stated above, GIS is a related set of hardware and methods that can be used to import, store, integrate, analyze, and retrieve multiple geo-referenced information to solve planning and management issues.

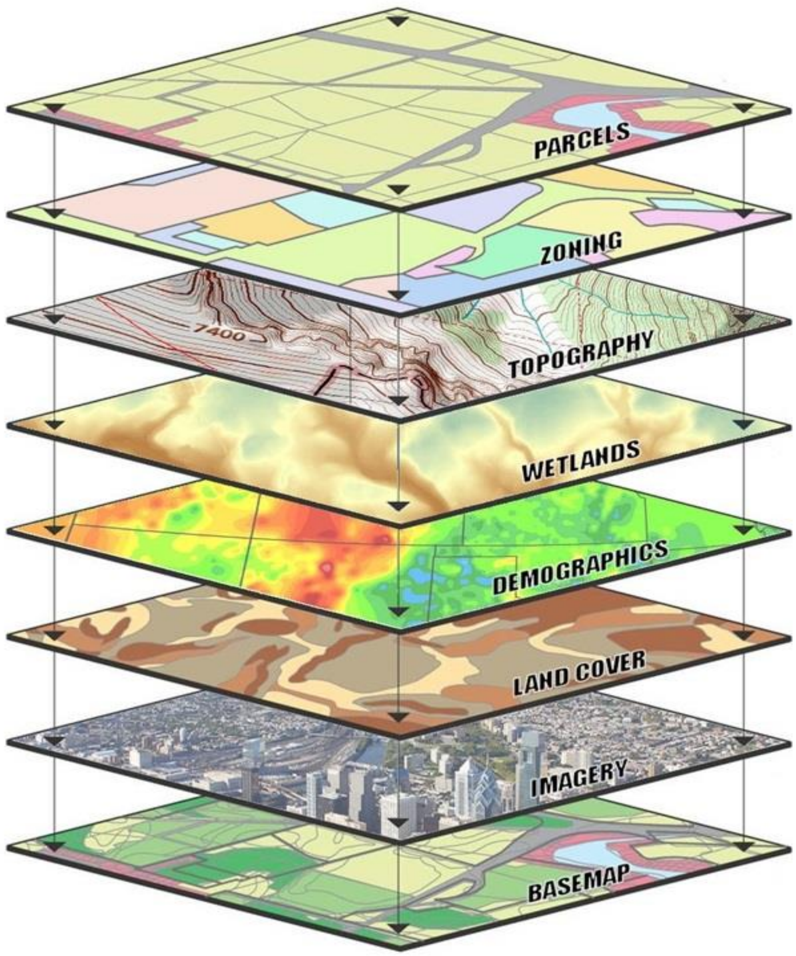

Figure 2: Different layers used in a GIS file (Retrieved from: http://basin.ir/1394/08/09/GIS-data)

1.4 GIS applications to reduce natural disasters:

In many crises, there is no time to collect information from resources, which will respond to the crisis based on the guesswork and decision-making process without proper and comprehensive information, which leads to the loss of capital and, in some cases, Life and soul of people. The GIS provides a mechanism for collecting and displaying vital data at the time of the crisis (relief groups) and when the emergency situation ends (reconstruction). GIS can be used to display damaged facilities, severity and the number of failures and the resulting damage estimation has a crucial role to play.

Given that the GIS is a computerized system for managing spatial information that can collect, store, analyze and display geographic information, it can be used before various disasters such as earthquakes, floods, fires, and ... Identify and model crisis management needs.

Fire: For example, GIS will help us identify areas at risk of fire and identify vegetation information, meteorology and fire domain as a result of fire exposure to vegetation.

Earthquake: Using GIS, faults can be easily displayed on the map, as well as the location of the electricity network near high-rise buildings, the passageways, thus, from the adverse effects of earthquake in the pre-crisis power industry And using the information collected in this system and consequently making the correct decisions about the amount of damage significantly reduced.

Water Resources: So far GIS has been repeatedly used in various water resources such as water management and management, watershed management, water resources allocation, planning and modeling of water distribution, hydrologic modeling, determining the optimal location for dam construction, water management Groundwater and pollution prevention, optimal design of water distribution networks, and determination of the optimal route of water pipelines, sewage networks management, analysis of water and sewage networks and power lines and [1].

1.5 GIS applications in flood zoning:

In international culture, the flood is said to be a high water flow, in which water floods and floods around the surrounding land, which is usually not under water. On a global scale, flood events are considered to be the most devastating natural disasters, with the highest mortality rates due to natural disasters (annual flooding in the world averagely reaches 26,000 people and lives on 75 million people Others have a very bad economic impact). Only a small number of countries do not face the issues of destruction and damage caused by the occurrence of large floods [2]. In recent years, the growth of rivers in the rivers has been increasing. Urban floods occur due to phenomena such as heavy rainfall, impenetrable levels of city surface, rising groundwater levels, or floods in the upstream watershed. Hence, the first step in flood management plans and flood plains is to provide a flood mapping plan. The use of geographic information systems and remote sensing enable geometry of earth to be simulated with high accuracy and speed. In some studies, the method of distributing floods on aquifers is used to control and optimize the use of flood and artificially feed the groundwater in arid and semi-arid areas.

The purpose of this research is to introduce GIS as a powerful tool for optimizing crisis management and to apply this method to solve water resource system issues, especially in the area of flood zoning.

2 Review of Literature:

The use of Geographic Information Systems and remote sensing have made significant progress in hydrologic operations. This system is used with great precision in geometry simulation of a catchment area with a geographical range as well as river bed simulation. Several studies have been carried out in recent years on flood zoning mapping. In recent years, some researchers have used cluster hacking software [5-3] to model them. In Iran, good research has been done in the same areas as described above [11-6]. Several studies have recently been carried out on the application of Geographic Information

Systems in flood zoning .[28-12 ,10 ,7 ,3 ,1]. Similar studies have also been conducted on reservoirs ‹[35-29], the environment and climate change ‹[39-36 ,6], droughts [38].

3 Methodology:

3.1 Collecting data:

The first step is to collect the information needed to conduct the analysis. This information should be collected according to their type from a different center. The information can also be presented in various ways (documents and maps available, terrestrial surveying, global positioning system, aerial photos or satellite imagery ...), all of which must be under a specific format Applicable to software used for GIS analysis.

One of the most important and essential information is the need for topographic information from the area. Understanding the complications, poses and heights of the area, the position of the valleys, plains and heights, etc. All of them are possible with the topography of the area. Also, one of the important factors in selecting a site is the issue of gradient of the earth, because if the gradient of a land is greater than or greater than the altitude, cost and time can be spent on leveling and land operations.

One of the most important issues to be included in the land use discussion is that of agricultural lands, forests and groves, fruit gardens, vineyards, etc. Each of these complications should be considered in consideration of their importance. Taken.

3.2 Hydrology and Hydrogeology:

Here is a discussion of the rain, water and drainage of the surface and underground. In the discussion of hydrology, the status of permanent and seasonal rivers, the location of watercourses and streams, plains that are subject to flood and so on. For example, international standards suggest that we keep distance from flood areas with flood or 100 year return periods. In the context of hydrology, the location of groundwater, aqueducts and wells should be investigated. It may therefore be more important to provide these resources with a volume of 37 billion cubic kilometers (22% of the world's fresh water) 40] or, for example, the disposal site can cause pollution of groundwater resources.

3.3 Flood zoning in the HEC RAS and GIS environment:

Considering that flood damage with life and with regard to the fact that floods with significant financial and financial losses are threatening various areas of Iran, many investigations have already been conducted in this regard regarding the determination of the bedding and the freezing of the river and the identification of flood-threatened areas and damage caused It is done. Among the simulator tools used in this regard, numerical models can be used based on mathematical methods, such as the HEC RAS model.

HEC RAS: This model has been developed by the US Army Corps of Engineers (USACE). This software is for simulating river flow and simulates longitudinal profile changes of river bed for long periods. When using this software, the continuous series of streams are divided into steady and unsteady streams of two dimensional (version 5) based on time and time variables. For each part of the flow, the half-wells of the water surface are calculated and using it, the velocity, gradient of energy, depth, and other parameters are obtained at each of the cross sections. The same computational process will be repeated for the next period. This model is developed on the basis of flow equations and conjugation equation in one-dimensional and two-dimensional conditions.

In the analysis of continuous flows, this system has the ability to consider a complete network of channels, a branch system or an interval of the river, and the ability to model surface water profiles in sub-critical, supercritical, and Combination, such as conducting hydraulic bridge calculations and evaluating profiles in the river divides, has flood spreading calculations.

The HEC RAS software has the ability to enter the river schematic design in 3D and cross section data created in the GIS system. After completing the hydraulic analysis, the user can send the calculated water level profiles to create and display the flood plain map to the GIS or CADD system. An ArcView GIS program called HEC Geo RAS by HEC is specifically designed to process geospatial data for use in HEC RAS.

The basic information required to simulate flood zoning using the HEC RAS model are as follows:

• Hydraulic information (roughness coefficients, river route status, etc.)

• Topographic information (longitudinal and transverse profiles of the river and marginal lands ...)

• Flood Information (Flood Intake Hydrograph, Discharge-Elevation ...)

4 Results and Conclusions:

- Use the capabilities of Geographic Information Systems and remote sensing to conduct basic design studies. Using these techniques, good results can be achieved with high accuracy in a short time with the ability to display results in the form of a map, such as determining the urban areas and their runoff coefficient. In addition, the preparation of all maps in this simpler environment is easier and easier to maintain, archive and transfer.
- When using digital topographic files, making the DEM digital elevation model is much easier. Meanwhile, DEM files with different scales for different regions of the planet can be bought and acquired by sensors.
- Combining the use of Geographic Information Systems and remote sensing while providing optimal results in a short time, in contrast to conducting research routines, is traditionally prevented from scrolling through the area.
- As a result of applying the condition and weighted average and the overlay analysis, a layer of type of lattice called Final Site Selection is obtained, whose pixel values are between one and three, and a Suitability map is provided. It is also possible to define classes and areas in the form of GIS analyzes.
- Investigating and analyzing the zoning maps of the potential for flood production and its overlap on soil maps, vegetation cover and topography and topography indicate that under forest basins whose soil has good or fairly good permeability, the least Flood potential.
- Researches show that changes in land use and increasing unstructured structures along rivers and rivers cause changes in runoff coefficient, roughness coefficients, and permeability, and can be a major factor in increasing the peak flow rate and consequently increasing the depth and depth of the area Flood captures [42-40].

5 Suggestions:

- The realization of crisis management programs is possible through data analysis. Often this information has spatial attributes and can be mapped. Given that the lives and assets of humans and the environment have always been accompanied by various disasters. Crisis managers are about to prepare their plans for prevention, preparedness, relief and reconstruction. They can identify the possibility of a different disaster using GIS and then take the necessary measures to deal with it.
- Governments, communities, people at the focus of the alert should be aware of the risks that their societies are exposed to, and can actively and effectively contribute to the design and maintenance of the early warning system.
- In the context of reducing the impact of hazards, regional institutions and organizations (public and private sectors), international delegations and academic and academic communities are among the key actors in this field, which should be managed by a leading institution.
- The warning chain will be strengthened through government policy or legislation, and the two-way communication system for alerts and communications will be considered for all hazards in advance.
- Rebuilding or demolishing and renovating bridges that do not have the capacity to pass high-flood seals.
- Modification of the user and the creation of appropriate capacity channels in the underpasses, as well as the construction of drainage channels with adequate capacity at the ports of entry to the city, in order to control the flow of flood into the city.
- It is better to use the Log Pearson Type 3 distribution in the stage of flood analysis and Fluid Estimation in different return periods (this distribution is principally used for maximum values).

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