

# Application of Geographical Information system (GIS) in urban water of Amol in Iran at Time of Natural Disaster

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## Abstract

For the management of urban disaster risk, periodic updating of geo- databases of urban water is crucial, particularly in developing countries where urbanisation rates are very high. However, collecting information on the characteristics of buildings and lifelines through full ground surveys can be very costly and time-consuming. This article has done operationally in Amol city which is located in Mazandaran Province of Iran and it tries to represent by using rules and data of collected from different maps, urban designing and capabilities of Geographical Information system (GIS) in urban water management at the time of natural disasters. Structure of this article is like that in first we established a comprehensive data base related to water utilities by collecting, entering, saving and data management, then by modeling water utilities we had practically considered its operational aspects related to water utilities problems in urban regions.

**Key words:** *Geographical Information system (GIS), Urban Designing, Modeling and network analysis, Disaster Management.*

## 1. Introduction

Cities are particularly vulnerable to natural hazards because of higher densities of population, property and economic activities but also due to the interplay that exists between people, buildings, and technological systems. According to United Nations [20], in 1975 approximately 38% of the world's population lived in urban areas and they estimate that this figure will reach 60% by the year 2025.

Natural hazards are thought to be of divine nature, the willingness to adopt prevention and reduction measures is limited. The multidisciplinary nature of disaster management implies that the process is slow and not problem-free, as it requires a great deal of co-ordination. Urbanisation also plays an important role as human beings

are both victims and contributors (in the case of human-induced natural hazards and technological hazards).

The most effectiveness factor of natural hazards which threaten people and damaged persons is water. This problem threatens people's safety before and after the fracture. Damaging water source such as spring, wells, aqueduct's breaking ground source and aerial, breaking the source of drinking water and sewage tubes, damaging constructions and pumps that always confront with cutoff electricity and have been discomfoting for habitants and can create environmental problems for government. Moreover, cause of water shortage and penetrate unclean water and sewage to the water source which has hygiene efficacy on the (watery animal) so the (trauma) obliged people refer to septic water which derives to broadcasting fatal and contagious watery diseases in the region. Because water plays an important rule to bail the bacterial diseases directly and indirectly such as: paralysis or palsy, cholera, chemical venom and etcetera. In periods that natural hazard occur one of the problem in urban water management in tend of the expanses of the networks and water and sewage utilities is to be unreachable to correct tender, confident information.

In order to the importance of reachable data also cause of the oldness of the utilities of the water and sewage companies which done not have any reachable, accurate and reliable information in this case. So, it is necessary to schematize data according to GIS data base and collecting needful data as their precedence. [13].

## 2. Case Study

Amol is a city in and the capital of Amol County, Mazandaran Province, Iran. The Amol city located in 36°23'N latitude and 52°20'E longitude. At the 2006 census, its population was 197,470, in 55,183 families [2]. Amol and the old part of town is the first of the four towns that populate the world in which there is Nzamyh. Amol is

a city of strategic accounts from beginning to end. Amol is located on the Haraz river bank. It is less than 20 kilometres (12 mi) south of the Caspian sea and less than 10 kilometres (6.2 mi) north of the Alborz mountains (Fig. 1).

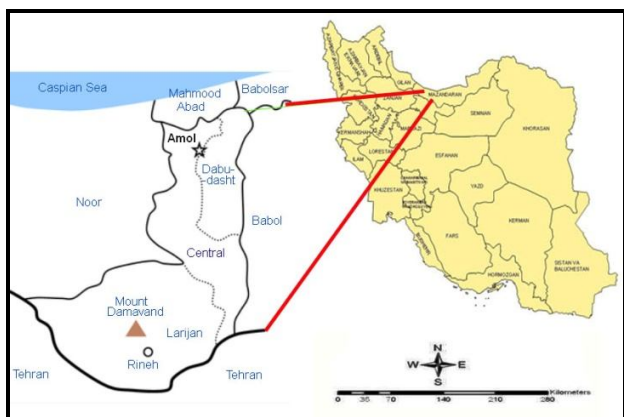


Fig. 1 Geographical position of study area

### 3. Material and Methods

The procedure for obtaining a database that can be used in a GIS environment varies depending on the software used. In the case of Garmin’s Map Source, the data have to be first exported into tab-delimited text format; it can be next stripped down from any unwanted characters and finally saved as DBF since this format is compatible with most GIS software. In other cases such as in ESRI’s Arc Pad, it is straighter forward as it can automatically generate a file in DBF format, as well as saving point files in the widely used SHP format. The still images can be automatically displayed alongside the map by the GIS software through hyper linking [7].

In this research after collecting unpractical data which relates users relation and distribution networks and maps related to water network distribution, we have to import format and enter data to system and after managing database process with modeling in GIS, it is time to analysis the various parts of the water distribution network. Modeling process of water distribution network is shown in Figure 2.

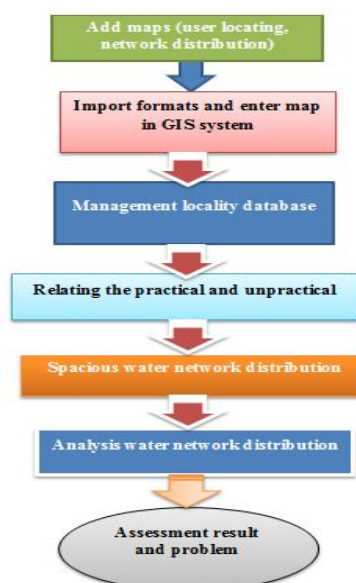


Fig. 2 modeling process of water distribution network

At first those maps which were paper sheets scanned, thus maps digitalized in Auto CAD area. In order to the high precision accuracy that Auto CAD software has, this process will be done in this area. Then the prepared map should correspond with the current city map and be georeferenced. After gathering information about network components such as valves (which have identity), pumps (which have catalogs), tanks and pipes, the information entered in a software database area such as Access. It is mentioned that in the digitization of paper maps, all features were coded according to the coding system then, the maps for final corrections were entered in Arcinfo8.1 and the network topology was built on it. It is mentioned that if there were no mistakes on maps there is no need to make topology. So, for making objectionable network graphical area will be used. After that the current map putted on Arc View 3.3 area as the current tables from the base information to make relation between them. For making hydrological network base on maps of distribution city network sump, pumps, tubes, tabs, ties placed on their own layer and the essential describable information for each of the above features entered in its table to make a model.

DWG file city that was provided on old base map edited on new city map with scale 1:2000. Information layers preparation an descriptive information the first step to water and sewage companies for improve system ability and water distribution is product a georeferenced database. The aim of designing database system is the management of awful data , data management conclude definition structure of save information and represent methods for verify information [18, 8] after scrutinizing maps and information situation of city water and sewage and

products, the primary installation of water and sewage affair related GIS was done. The maps of water and sewage prepare to enter the area.

These data have been used in this research:

- 1) Base map of the city in scale of 1:2000 that provides with the topography organization of Iran
- 2) Maps of the water distribution in scale of 1:2000
- 3) Paper map's of the users locality that provides with the sewage company of the Mazandaran.
- 4) Map of the refinery
- 5) Map's of sump
- 6) Map's of pomp's station, tube and continuity

#### 4. Discussion and Results

The scope of disaster management can be best understood by means of a tridimensional matrix. Describing the three types of elements involved (levels of government, management phase, and implementation measure) and the resulting range of possible implementation strategies [9]. Implementation strategies consist of structural measures which involve the modification of the environment while non-structural measures involve activities such as co-ordination and communication (e.g. emergency drills, warning systems).

Disaster management involves a cycle which should consist of an organized effort to mitigate against, prepare for, respond to, and recover from a disaster [10, 15]. The following definitions describe each of the

Phases of this cycle:

- ❖ Mitigation relates to preactivities that actually eliminate or reduce the chance or the effects of a disaster.
- ❖ Mitigation activities involve the assessment of risk and reducing the potential effects of disasters as well as post-disaster activities to reduce the potential damage of future disasters.
- ❖ Preparedness consists of planning how to respond in case an emergency or disaster occurs and working to increase resources available to respond effectively.
- ❖ Response refers to activities that occur during and immediately following a disaster. They are designed to provide emergency assistance to victims of the event and reduce the likelihood of secondary damage.
- ❖ Recovery constitutes the final phase of the disaster management cycle. Recovery continues until all systems return to normal or near normal (Fig. 3).

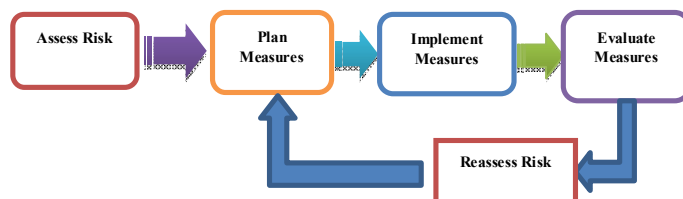


Fig. 3 Steps of risk management process [21]

In order to importance of the concept of data, the explanation of them will be study firstly. Data is the explanation of quantity of phenomena's characteristic. Also, information mentioned as the result of the processes that we do on the data to gain the communication which is depending in the data structure. In order to these definitions, information provided from processing data. The auxiliary instruments that have been used for selecting and processing systems are idiomatically known as information system. Ordinary information system is inclusive the continuum of different stages, in gaining data to analyze an use of them in decision processing [6]. basically information is the first element in the any planning but, nowadays by the tremendous increase of the information mass the problem of their order is in discuss [10]. Nowadays it is clear to all of the managers and urban designers that constructions management and managing the various part of the city is impossible with traditional tools. The importance of GIS in urban planning with the speedy extension and vast decrease of information that should be processing in urban management is apparent [19].

##### 4.1 GIS definition

Geographic information systems (GIS) have considerable potential for improving urban disaster management since they offer more efficiency and speed in the input, management, manipulation, analysis and output of data/information, but also because of the value of better decisions. GIS works effectively in all four phases of the disaster management cycle. Whether analysing consequences, projecting and predicting, disseminating information, allocating personnel, equipment and resources, getting from A to B, or picking up the pieces in ways that help rather than hinder stricken families, businesses and regions [22]. It is important to keep in mind that GIS does not come without problems. One important aspect is the acceptance of the tool by decision-makers as it somewhat implies decentralization of functions and a more bottom-up approach to data management.

In the early engender of geographical information system, cause of the play information and different usage in other fields. Different definition of this system represented which some of them are geographical information system that for ace, maintains and also usage of cartographic data is delighted. Geography information system is collection of powerful instruments for saving and retrieval of information in future commutation and display space data in real global [5] more of GIS activity began in 1980. In this period GIS appears as a dynamic knowledge with speedy growth. In the analyse processes, displaying palatial space data and displace (map, static data) have had great progression [14].

#### 4.2 Urban and GIS

Geographical Information Systems (GIS) are among the relatively young software technologies which are rapidly finding a role in the management of urban drainage systems. GIS provides an excellent platform for facility management and planning. Aim of GIS urban system gain the comfortable and claw in use of urban facility and available relative and landform usage in two teaching: inner dispelling teaching with harmony with external system in environment. GIS systems are useful tools for visualizing the projected developments in Metropolitan areas, in terms of changes in population, industrial patterns, infrastructural utilities, etc. One very interesting aspect in this context is the expected future load and behavior of sewer systems, which convey the foul and industrial waste-water flow to sewage treatment plants.

Keeping the information updated and consistent at these two different levels of detail is no trivial task. Normally, the responsibility lies within different departments, and there are no formal procedures established to ensure that changes in the layout or dimensions of the sewer system are implemented both in the asset management systems and in the models. Hence there is a great risk that further evaluation of the existing, but recently changed, system's capacity and performance will be incorrect.

In the latest decade GIS have roll in urban effects works in the world. specially in French (urban planning in Lion) in urban planning locality and urbanity transportation in Holland , in field planning usage .fire station office urban firms in take main USA are samples of using of the GIS in planning .Choosing a place to create a store , choosing route for driving to gone the work station and home transportation infrastructure find solution for increase

spatial problem decide to land use , locate product center and activities , choose economic an environmental solution and choose urban and regional solution is some of GIS usage [16].

#### A. GIS information source

Entry information to geographic to geographic information system can be divided to two parts.

- A) Spatial information spatial information are the entire geometric information reality to the locality, place or point coordinate that will be distinct by geographical longitude and latitude (y,x,z).
- B) Unspatial information: the spatial information are the entire information about vilifies, characterizes and trait's of exist elements in the earth, this information composed static list, exploitation: picture and film's of phenomena [12] more of than 80 percent of information in the geographical locate toward others phenomena. the component of GIS is shown in figure 3.

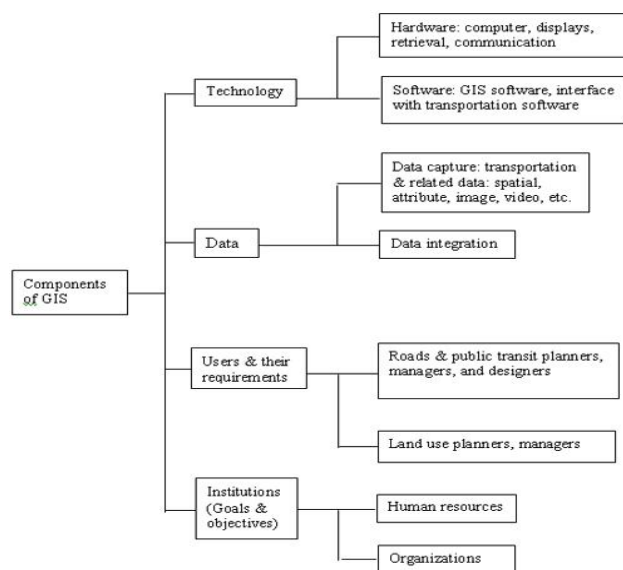


Fig. 3 component of GIS [11]

#### 4.3 Process of the analyze information in GIS

GIS is an computer system that provide four basic ability in relation to dereference data

- 1- Data input
- 2- data management
- 3- process and analyze
- 4- output data (Fig. 4).



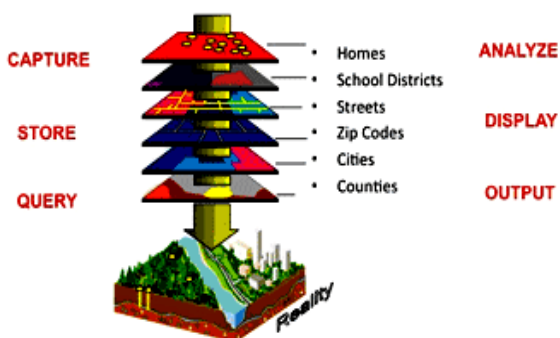


Fig. 4 Process of the analyze information in GIS

GIS composed of some hardware and software and users that the end of use GIS should be clearly distinct because of this system requires so much cost and facilities for use of GIS. This system should be capable to receive all of necessary information and so produce information completely [17]. Output and input environments are the relational way to connect GIS with real global. The companies of water and sewage have two sorts of information: the underground information and the information about users. So this concept that management of this mass of information with a handling and various methods is very difficult because of this necessity of a codified system to collect information and maintain and update them is and cause of the awful relation of the companies and units they should have a database bank [3].

#### 4.4 Making topology

Topology is making of spatial relations between geographical phenomena in real global in a database back with use of mathematical relations and the ordinary method is cottage spatial relation in GIS. Topology is the mathematical method for defining spatial relations. One of the advantages of making topology is that the spatial analysis problem without using the coordinates. Some of the spatial analyses as neighborhood, proximity, and continuity can be done just with the topology data. This character stops the time-consuming calculations for obtaining spatial relation data. These are saved without using the topology model. This is more of this operation and spatial analysis in GIS based on topology is more effective. But making topology structure costs more energy and time because of the new map entering. Change the topology should be changed [1]. Though the topology has so much premium but must indicate this that in water network modeling because of too changing in network and so specific structure network (for example in some cases the tubes pass over other without ever crossover) using of topology structure is not

convenient and useful further use of graphical model with snap space for joining the borders (fig. 5).

Object Dimension	Geometry	Topology
zero dimensional (0D)	point	node
one dimensional (1D)	line	edge, chain
two dimensional (2D)	face, shape	polygon
three dimensional (3D)	volume	polyhedron

Fig. 5 topology structure

#### 4.5 Network analyzing

One of the important extensions of GIS software is network analysis. This extension makes the possibility of analyzing geographical phenomena that have network models (street, telephone network, water and electricity). Analysis like water network analysis and finding the nearest to the place of junction is available by network analysis [4] (figures 6, 7, 8, and 9).

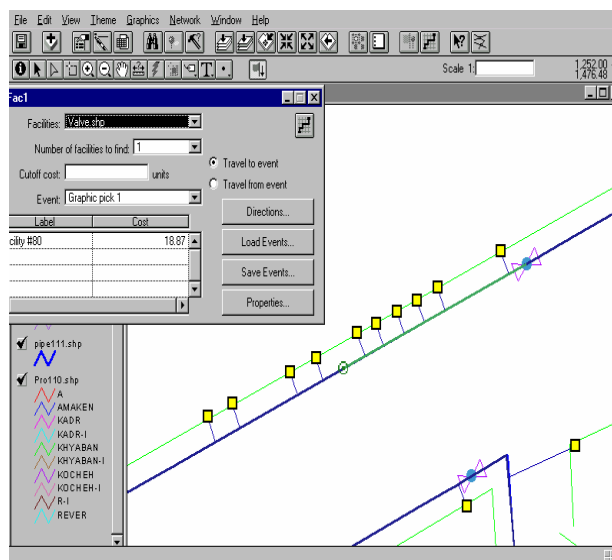


Fig. 6 nearest to the place of juncture

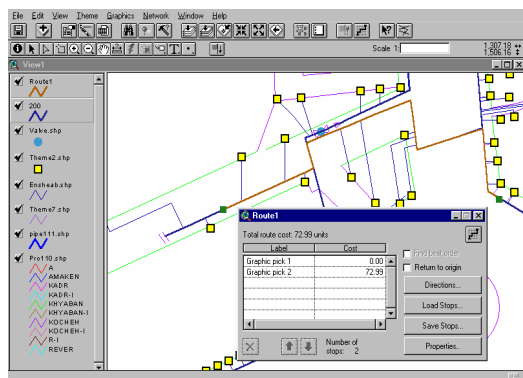


Fig. 7 shortest route between to spot from network with display distance

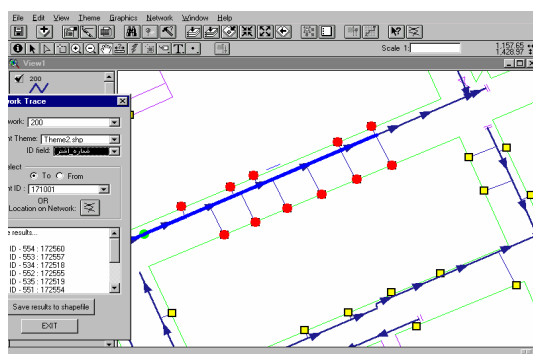


Fig. 8 users that because of incident in water network rapture their water with name and distance the incident place will be display

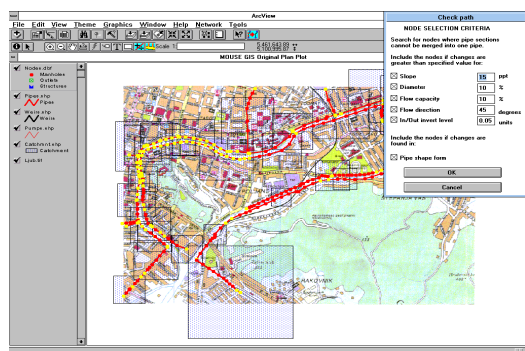


Fig. 9 process of node selection criteria and test of model

## 5. Conclusion

The decade of the 1990's, designated as the International Decade for Disaster Reduction, has not resulted in a reduction of the losses due to natural disasters. The decade of the 1990's also showed a rapid increase in the technological capabilities and tools that can be used in

disaster management. Some of these tools deal with the collection and management of spatial data, such as remote sensing and Geographic Information Systems.

Mitigation of natural disasters can be successful only when detailed knowledge is obtained about the expected frequency, character, and magnitude of hazardous events in an area. Many types of information that are needed in natural disaster management have an important spatial component.

The aim of this article is to provide the inputs for a cost-benefit analysis of counter-disaster measures it ought to be of a quantitative nature. The method proved very flexible and it can be used for many applications, even in non-urban contexts. In the case study, the initial stages of data manipulation proved very time consuming. However, the greatest strength of GIS proved to be its ability to handle the "what if" type of scenarios. Moreover, user-interfaces can be designed, thus allowing the decision-maker himself to interactively model and view the consequences of the various mitigation alternatives across the area of interest. With respect to data collection it was found that it is possible to produce a spatially referenced building inventory for conducting a risk assessment. This research has conclusively demonstrated how a risk assessment carried out using GIS technologies is a very valuable tool as the cost-benefit scenarios produced increase the transparency of the decision-making process and as such they can constitute an important contributor to good governance. The ability of GIS investigated as a capable instrument and some of its ability that are used in water management in the time of natural hazard occurring is explained.

## Acknowledgements

We are thankful to the Department of Urban and Regional Planning in Universiti Teknologi Malaysia and International Doctorial Fellowship (IDF), UTM for providing the facilities for this investigation.

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