RISK MANAGEMENT PLANNING AND VULNERABILITY ANALYSIS OF WATER SYSTEMS IN BIG CITIES OF IRAN

Mahmoudreza Mivehchi[1]

[1] *Ph.D of Civil Engineering & Project Manager, Mahab Ghodss Consulting Engineering Co. ,Tehran ,Iran*
Email: mich72184@yahoo.com , mivehchi@mahabghodss.com

ABSTRACT:
The main purpose of securing of hydraulic installations against earthquake is to guarantee efficient performance of water distribution network during and after earthquake. For achieving this goal, a comprehensive design should be prepared in three different levels; before earthquake, after that and in the reconstruction phase.
Before earthquake a rough estimation from type of possible damages and their magnitude should be made and strengthening designs based on seismic regulations for weakness points of hydraulic structures should be prepared and implemented in all stages of design, development and reconstruction. Regarding this matter and for evaluation of earthquake damages, as well as providing remedies for minimizing the effects and danger of earthquake, some fundamental concepts should be considered; this includes: Determining elements which are threatened by the earthquake, earthquake scenarios and threats, failure models and structure of risk management model.
In this paper, analysis of vulnerability as well as definition of risk management regarding water systems in one of the most important cities of Iran, Tabriz city has been discussed.

KEYWORDS: Risk management, Vulnerability, Water systems

1. BACKGROUND OF WATER SYSTEMS IN TABRIZ CITY

Tabriz city is located in North-west of Iran and East Azerbaijan province, which is shown in figure 1.

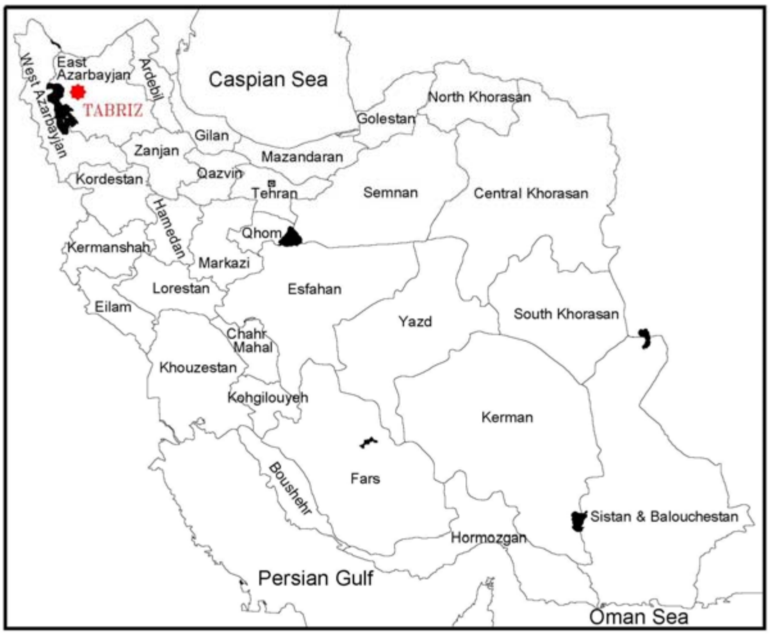

Figure 1. Map of Iran and location of Tabriz city

The first central drinkable water facility in Tabriz was established in 1947 with the aim of providing water from Hayat aqueduct and urban piping. The drinkable water of the people in Tabriz is provided from the aqueducts, deep wells, Mehran-rud and Zarineh-rud river and Nahand dam. The main water source in Tabriz city is underground sources which include Heravy, Ghezelche, Saeed Abad, Kurjan and Goozel zones. The drinkable water of Tabriz is taken from 87 wells, old aqueduct and Mehran-rud river. The water taken from these sources is transferred to the main storage tank which name Ill-Goli with the capacity of 166000 cubic meters and two high storage tank 10000 and 5000 cubic meters by two aqueduct of Nemune and Ghdim as long as 23 and 27 kilometers and 5 transmission lines with diameter of 200 to 800 millimeters . Of the 16 small and medium aqueducts, only nine of them are active due to the decrease in the water level and some of these aqueducts are used as the transfer canal for water. Water transfer canals of Tabriz are divided into these two categories:

- Main Pipes
- Aqueducts

Water distribution system of Tabriz with diameters of 60~90 millimeters is made of cast iron , ductile cast iron , concrete and cement asbestos , galvanized pipes with diameters 0.75~3 inches wide and with two pumping stations . Also, in the recent years, polyethylene pipes with the diameters of 1~2.5 inches have been used. At present the drinkable water of Tabriz is provided from these three sources as follows:

- Deep wells, aqueducts and Mehran-rud river with discharge of 1.3 m^3/sec
- Nahand dam with discharge of 0.7 m^3/sec
- Zarineh-rud river with discharge of 1.8 m^3/sec

The main available storage tanks inside the city are:

- High Ill-Goli , main Ill-Goli and Kurjan
- Valiasr, Yousef-abad, Sorkhab, High Sorkhab and Koshtargah in the north of city
- Central office, Ghoorkhaneh, Hyrut, Artesh and Manzariye in the south of city

Also, the active pumping stations are:

- Valiasr
- Ahmad-Abad

Total capacity of Tabriz storage tanks are 466750 m^3 and the length of transmission lines are 148 kilometers. Distribution network in the whole of Tabriz is 2395 kilometers and the numbers of members is 284448. In figure 2, the general view of the water systems in Tabriz is shown.

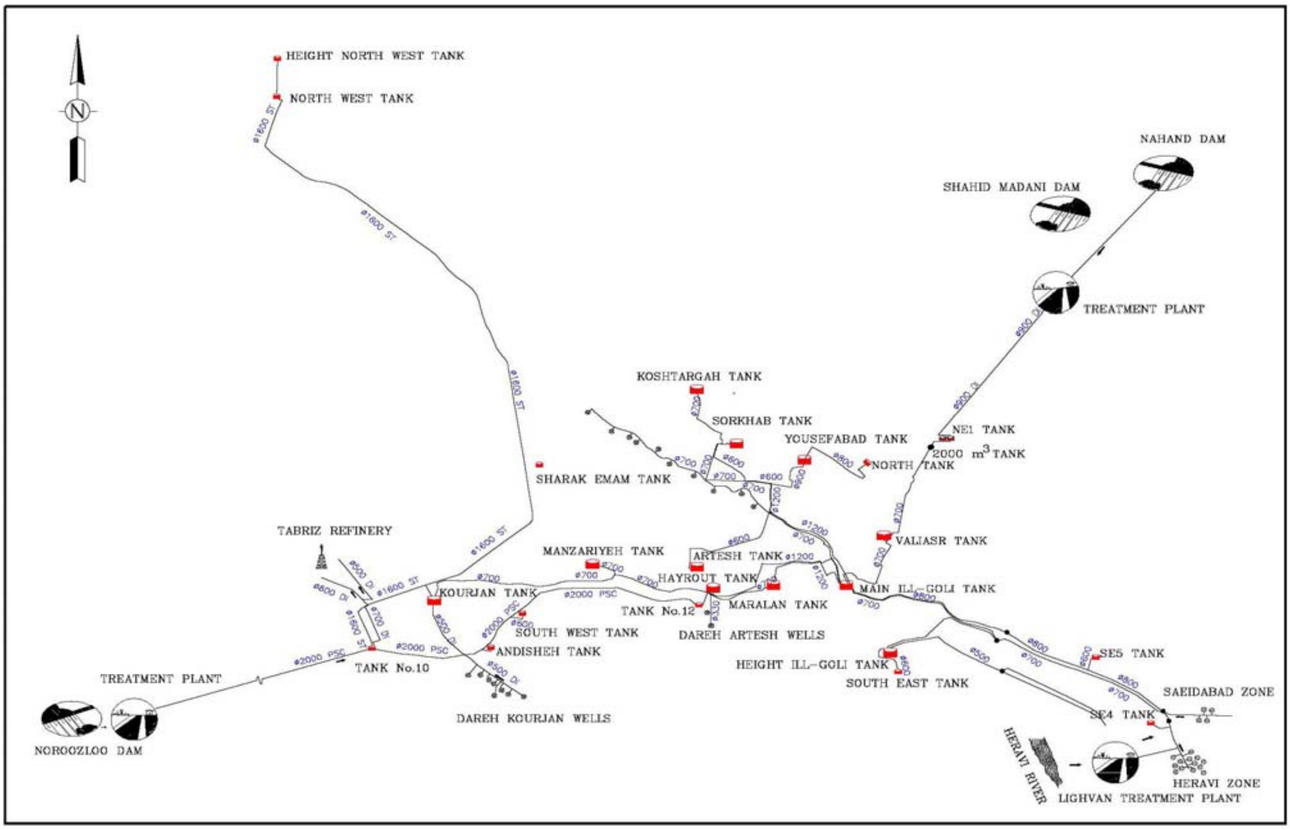

Figure 2- General view of water systems in Tabriz city

2. WATER SYSTEMS OF TABRIZ , EARTHQUAKE AND RELATIVE PROBLEMS

Access to healthy water is possible through a secure water system and its compliance with natural disasters. Good quality and permanent distribution of water is the ultimate aim of every secure water system. so all of the elements such as collection , treatment , storage and transfer including the machines and the people deciding about it , must be tested against the natural events and every fault that may lead to delay to providing and distributing the healthy water must be identified .
This study has explored the crisis of earthquake and has made an informative checklist so that every part of the network would be tested. Studying the each part of the water system has 3 phases:

- Phase 1: analyzing the structure
- phase 2: watering hardware (machines and physical parts of the water system)
- Phase 3: software of the labor – official and management and the control over the water system

3. WATER SYSETMS BEHAVOIR UNDER THE EARTHQUAKE

Due to the importance of water systems and the possibility of earthquake , it is necessary to explore the possibility of damage and the ways to decrease that.
At present, water systems are the inevitable parts of human's life. These systems take the water from its source, which is usually far from the consumption area, and after improving the quality, transfer the water to the city and in the city by the distribution systems and provide the water for the consumers.
Designing, implementing, and providing the necessary security of this system is the vital thing for the continuation of humans' life in the cities.
Damaging consequences of earthquake, affect this system in different forms. Considering the mutual relations among the parts of the water system, a minor disturbance in one part, could cause the inefficiency of the other parts. It is possible that the earthquake would not damage the system directly but the indirect consequences like lack of access to healthy water or its pollution could be disastrous. In addition, there must be water to put out the fire after the earthquake. The fires after the earthquakes of San Francisco in 1906 and 1923 in Tokyo have taught us an unforgettable lesson.
The necessary parts of a water system includes water sources like underground water or storage tanks , transfer canals like canals , tunnels , pipes , treatment plants and other facilities related to the quality of water , distribution networks , pumping stations and decreasing the pressure , storage facilities like underground , on the ground and height tanks and the official controlling facilities and the effect of earthquake on each of these could disturb the performance of all the system . Earthquake can cause the underground waterbeds to moves, the dams to break the water behind them to be wasted. These effects would eliminate the sources required for a water system.
Damaging the water tanks of Rasht and Astane-e-Ashrafiye in the earthquake of 1990 is the explicit example of the consequences of earthquake on these systems. Breakings in the main pipe , pressure separation and tearing in the connection points of the distribution network pipes and the breaks in the firefighting pipes due to the earthquake of 1994 in North-ridge is another example of the consequences of earthquake on the water systems .
The water systems must be buried due to their function and must be in a good depth of the earth. The fact that these systems must be buried has some negative and some positive impact on their reaction against the earthquake. . The pipes of the network exist in all streets, avenues, and allies in a way that is possible to draw the map of the pipes from the streets. The material of the pipes is different due to some reasons and due to urban expansion; the material of the pipes in the newer parts is different from that of the older parts. And due to the fact that the materials are old, the new materials are being used in the repairing. The dangers that may cause damage to the water systems from the earthquake are as the following:

- Trembling waves of earthquake
- Permanent movement of the earth such as faulting. land sliding , liquefaction …

The investigation shows that the damages form the second group in the distribution networks has a far greater effect on the system than the first group.

4. CRISIS MANAGEMENT AND ITS SOULOUTIONS

The object of this paper is to model the deciding systems required for dealing with the crisis of the water system of Tabriz city and presenting solutions for managing the data with the collaboration of anti-crisis sources. This subject has two items: modeling the crisis management and implementing it.
Models are the physical or mathematical representation of an event or process. During modeling, the main factors of the system are identified and the way of their connection will be decided. During implementing, the factors of the system will be identified thoroughly and will be introduced to the system. The main elements of implementing the system are as follows:

- Stable foundation
- Storage, searching and information marketing
- Accordance with the frames
- Making information of sharing center

5. ANALYZING OF CRISIS MANAGEMNET

Identifying and defining the conditions in a crisis, or another words, getting to know the aftermath of an earthquake is the fundamental key in crisis management. Although different natural events have different natures and affect the society in different aspects, the term "crisis" has one definition.
Crisis manager is the one who knows the requirements of the area, and guides the sent helpings to the area and on the other hand, meets the needs that have not been fulfilled and try to provide these needs. These helps could be clothes, foods and water to the rescue team.
Crisis is lack of harmony between the source and the requirement. In other words, under normal conditions, there is a balance between the requirements and the sources of a society. With the occurrence of a crisis due to unprecedented and unpredicted natural or unnatural events like flood, earthquake, storms and war, due to the conditions, there would not be the same balance. In the crisis time, due to the decrease in the fundamental areas, the abilities would decrease too and in most cases, by sending help to the area, they try to make up this lack. From the other aspect, the amount of requirements decrease but the demand for this requirement increases which is a heavy burden on the society. Figure 3, shows the relation of demand and requirement in normal and crisis conditions. Crisis management is bringing back the balance between the demand and the requirements. As seen in figure 3 , there are 3 tools for bringing back this balance : increasing the sources , decreasing the demands and rules , the above picture shows the normal conditions , balance between the needs and the sources and the below picture shows the crisis conditions , increase in the demands , decrease of sources and as a result rebalance of requirement and demand .

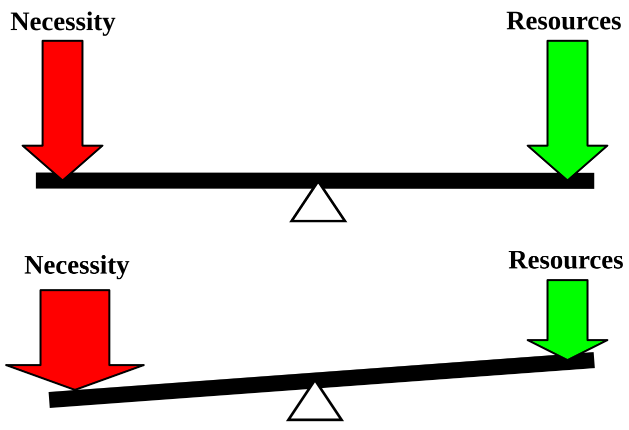

Figure 3 - Relation of demand and requirement in normal and crisis conditions

There are about 24 identifiable crisis after the earthquake that we will mention only the names due to the limitation of pages : implementing the management , informing , security , unloading and distribution of

the helpings , lack of skill of the helpers , hard road , accommodation and sending the injures , accommodation of the survivors , burying the corpses , finding the survivors , lack of coordination between the forces , sanitary , machines , facilities and tools , without parents kids , girls and women after the earthquake , water systems , sewage network , fuel system , energy transform , telecommunication systems , special buildings , vital buildings , buildings with high potentiality of damage , fire . The thorough and exact framework for solving and analyzing each crisis are as follows:
Exact identifying of danger, determining the level of damage of the society, facilities and properties against the crisis, determining the loop and the danger of crisis. The main rules for dealing against crisis are classified as follows:

- Planning, proper use of the sources
- Using the required skills

6. USING GEOGRAPHICAL INFORMATION SYSTEMS

Geographical information systems and remote sensing provide a powerful tool for the managers , geographical information systems is one of the best management solutions due to its facilities of hardware , software , place information , analyzing algorithm and the related experts . this science has provided this opportunity of getting , storing , regretting , processing and presenting and implementing the information about the reference place as a focused system and during the last decades , has made a revolution in the geomatic filed all over the world . There comes one example of the geographical information of Tabriz in figure 4.

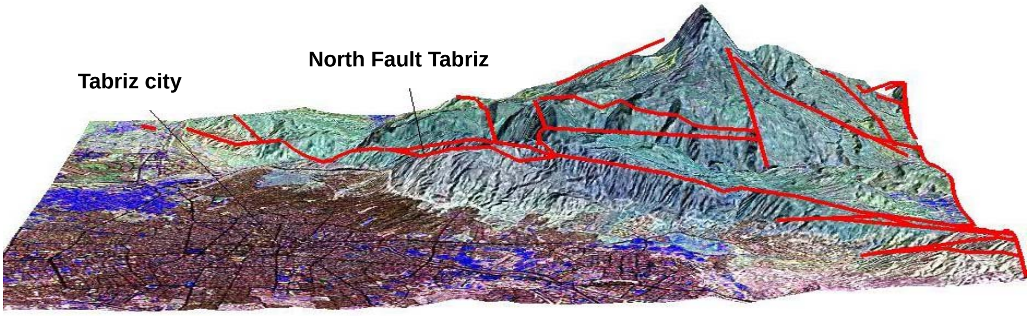

Figure 4 - 3D map of Tabriz city and adjacent faults using DEM shape

7. VIRTUAL MANAGEMENT OVER CRISIS

At the time of crisis, natural or unnatural, fast and proper informing is one of the most important factors in good management of crisis. Crisis management with out having the access to the information about the area is impossible and the quality and speed of the data has effect on deciding. This process needs high carefulness and depends on the ability of the virtual manager and way of using this management in case of using them correctly; there would be great success in the project. The advantages of this kind of management are as the following:
Getting the best forces independent of the place, no need for replacing the forces, flexibility, decrease in the costs and the transfer time. The planning for crisis management for water systems in Tabriz has been shown in figure 6, which has been conducted through providing maps of GIS, building crisis management rooms in the area. Education and parade. Determining the exact location of the area and the rooms needs further study but the areas suggested above are for covering the whole area and on the account of parameters like the intended area, the main pipes and the least cost.

8. LOCATION OF THE WATER SYSTEM IN TABRIZ COMPARED WITH THE FAULT AND THE SEISMIC ZONE

Looking at figure 5 , shows that the North fault of Tabriz passes through the city, which has been expanding in the last decade.

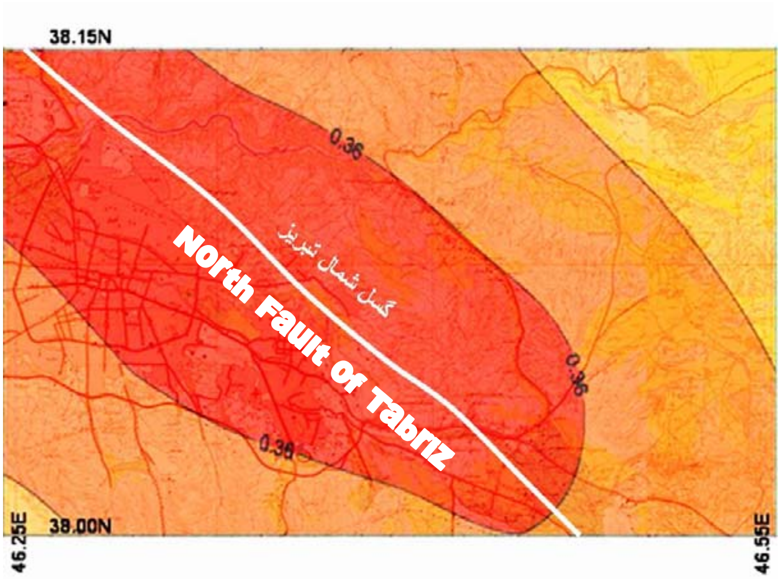

Figure 5 - The North fault of Tabriz passes through the city

This is near the water system. Below there is a brief explanation about the location of tanks and their position in the danger zone and the area with higher risk of increasing in the soil.
Considering the location of the fault and seismic zone of Tabriz, also the location of the tanks which is shown in figure 6, the following approximate statistics are presented:
3 out of 26 tanks are located at one kilometer off the north fault, that is to say that 11.53 % of the tanks are in danger of direct separation and extreme movements of the earth. 13 tanks are located at 3 kilometers off the fault and that is 50% of the tanks are located in this area. Considering the soil of south of Tabriz, which is soft soil, and the danger is more out there, eight tanks are located there , means that 31% of the tanks are in the area with high earthquake waves.

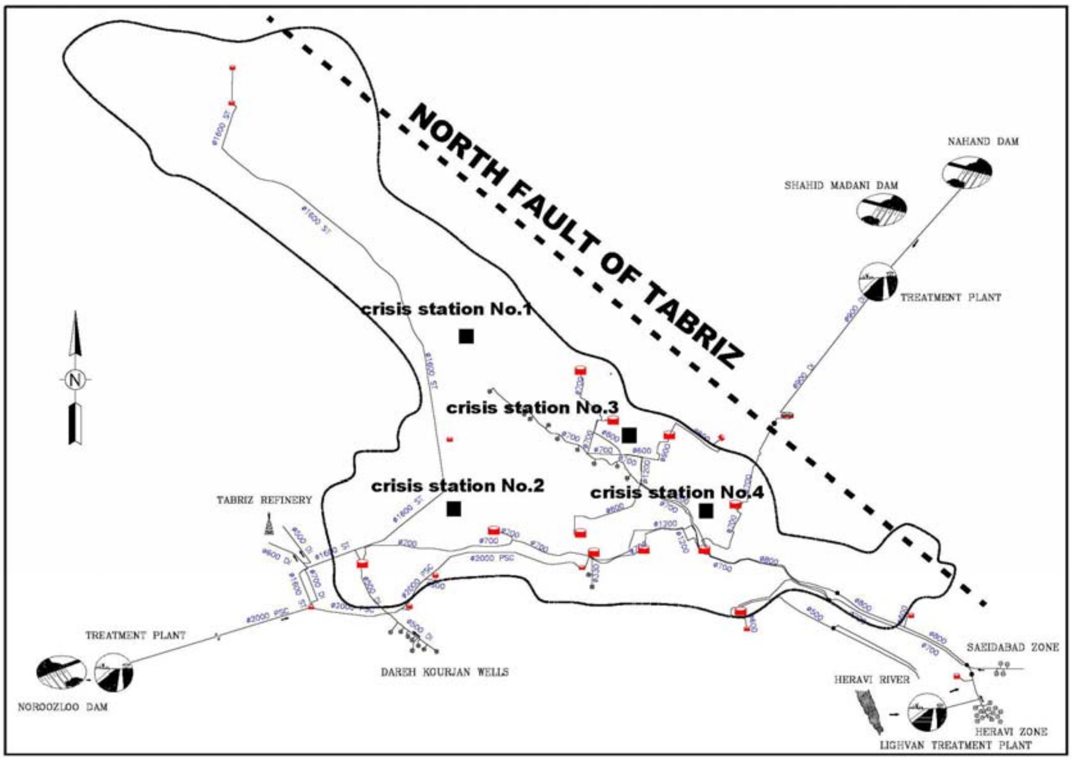

Figure 6 – Location of water system and the North fault of Tabriz

9. CONCLUSIONS

As mentioned above, the conclusions of this investigation are as follows:

- Earthquake is an inevitable event that in case of occurrence would bring a lot of problems and damages and casualty for the economic, environment and people of this historical city. Therefore, for protecting the lives and property of people, it is necessary to make use of the latest technological advances for crisis management. Among all these, utilizing the geographical information and virtual management in crisis management is necessary.
- Crisis management is a complex subject and has tight relation with other organizations. Therefore, for crisis management after the earthquake, cooperation of all organizations is required and at the same time that each organization calculated the damage done to it, should take into account the supporting of other organizations as well.
- Using the damage models, one could evaluate the damage done different parts of a water system, which its ultimate aim is to protect the water systems and to provide the situation so that in the time of earthquake, there would be access to healthy water. So in this case, it is possible to estimate the probable damages and try to have strengthening programs for weak parts and in the expansion and repair programs, we could meet the guidelines of designing with consideration to earthquake.

REFERENCES

Mivehchi. M.R., (2007). The Final Report of Vulnerability and strengthening for water systems of Tabriz city, Mahab Ghodss Consulting Engineering ,Tehran, Iran

Goncalves, M. (2004) , Managing Virtual Projects, McGraw-Hill,U.S.A

Shao, Y. P. and Liao, S. (1996) . A New Organizational Model: Implications on Virtual Organizations

Ellingson, J.E. and Wiethoff, C. (2001) . From Traditional to Virtual: Staffing the Organization of the Future Today , In R.L. Henemann & D.B. Greenberger (Hrsg.)

Lau, F.; Sarker and S.; Sahay, S. (2000) . On Managing Virtual Teams", Healthcare Information Management & Communications