

## The Selection of The Best Choice of Providing No-Nitrate Drinking Water in Arak City by Analytical Hierarchy Process (AHP)

M.S. Moghadasi<sup>1</sup>, A. Moghadasi<sup>2</sup>, M. R. Alavi Moghadam<sup>1</sup>

<sup>1</sup>Department of Civil and Environmental Engineering, Amirkabir University of Technology (AUT), Tehran, Iran

<sup>2</sup>Arak University of Technology, Arak, Iran

---

### ABSTRACT

One of the important pollutants of underground water in Iran and most parts of the world that use this source for drinking water is nitrate. According to the researches, it is determined that about 80% of drinking water supply network in Arak has reached the high concentration of Nitrate over 10 mg/lit (Based on Nitrogen unit). Drinking water with this concentration of Nitrate is recognized as un-drinkable according to most of world valid standards and it can have adverse effect on human being health and other creatures. The research aims to solve the problem at existing condition of Nitrate pollution of drinking water distribution network by applying short-term methods of pollution management: 1. Construction of drinking water purification at small scale in different parts of the city 2. Using drinking water purification machines. 3- Purchasing mineral water. 4. Providing drinking water of the resources in the suburb. To facilitate the comparison and selection of best choices based on different criterions (social, environmental), problem-solving model in multi-criterion decision making use Analytical Hierarchy Process (AHP).

**KEYWORDS:** Drinking water; Nitrate, Arak; Management strategies; Analytical Hierarchy Process (AHP)

---

### INTRODUCTION

The recent half century was unprecedented development of water in the world, today it is widely accepted that increasing use of water had environmental consequences and although some of them are not compensated. Increase and improvement of production and consumption resulted into increasing use of chemical materials and development and variety of domestic and industrial sewages and finally their seepage into water resources, water resource quality is decreased considerably in urban regions. Among various pollutants of water resources, Nitrate is one of important materials. Today, among industrial and semi-industrial societies involved environmental pollutions, hardly a country is found in which a part of its potable water including surface water and underground water is not contaminated to nitrate ion. Considerable decrease of the quality of limited resources of drinking water supply, consumers' health is threatened seriously[1]. Considering the development of effective methods of water purification in advanced countries decrease sanitary risks of water contamination. But currently, in most of the developing countries, purified water is not available for all people and still the problems of outbreak of water-based diseases are not solved. As in the analysis of a place of surrounding nature, in holistic approach, all social, economical and environmental affairs are considered life support. Interaction of water and human being components as a part of this fragile unit is so that imposing any change on each of these two components change the balance between these two considerably and create adverse reactions on other existing components. Thus, in general trend of decision making about solving an environmental problem, public participation of the people in the society in different stages of decision making, collaboration for formation of the active organizations and committees in related specified fields, group pressure on decision making organizations for solving existing problems, considering financial and social benefits are essential.[2]

### MATERIALS AND METHODS

To facilitate the comparison and selection of best choices based on different criterions (social, environmental), problem-solving model in multi-criterion decision making use Analytical Hierarchy Process (AHP) after the study of scientific articles in the fields related to the research subject [3]. It is explained in the following. At first, it is attempted that according to the data of the first and second step, also the investigation of the comments of experts

---

\*Corresponding author : M.S. Moghadasi, Department of Civil and Environmental Engineering, Amirkabir University of Technology (AUT), Tehran, Iran ,Email: moghadasi1390@yahoo.co.uk.

and decision- makers in the next state of the choices and effective criterions in decision making, the best choice is selected.

After determination of the criterions, they are compared in pair and they are weighted. Weighting and pair comparison process is done based on previous chapters' studies and the comments of experts and decision makers. The comments of experts and managers are used based on the study of the reports of national conferences reports and thesis in the related field and final weight of each parameter is estimated of the integration of the different comments. The next stage is prioritization of the choices with the related criterions and these criterions are weighted based on the results of the assessment studies of environmental information and they are weighted in the second step of research method and studies of experts' opinions (The study of national conferences reports and thesis in the related field).

The obtained information was analyzed in Expert Choice (EC) software. By this software and by entering collected data, the criterions and choices are reviewed. The advantages of this software are its simplicity and the possibility of using system sensitivity.[4]

## RESULTS AND DISCUSSION

As it was said, 4 methods are selected to remove the problem of high concentration of Nitrate pollutant in drinking water distribution network of Arak city:

- Drinking water purification units in small scale in different parts of the city.
- Using home water filtration system.
- Purchasing mineral water.
- Providing drinking water of the sources in the suburb

These four alternatives with the choice of direct use of drinking water distribution network should be prioritized under comparison criterions (Social, environmental). The above decision making criterions form Hierarchy Process of the problem.

### Weight process of choices based on different criterions

For better comparison of the choices, Weight process of decision making choices are done in two Weight stages based on social criterions and Weight is done based on environmental criterions.

#### • Scoring of the choices based on social criterion

In this stage, scoring to the choices is done based on the results of the second stage of the research (environmental information assessment studies). The results of the calculations of EC software is presented in chart (4-5).

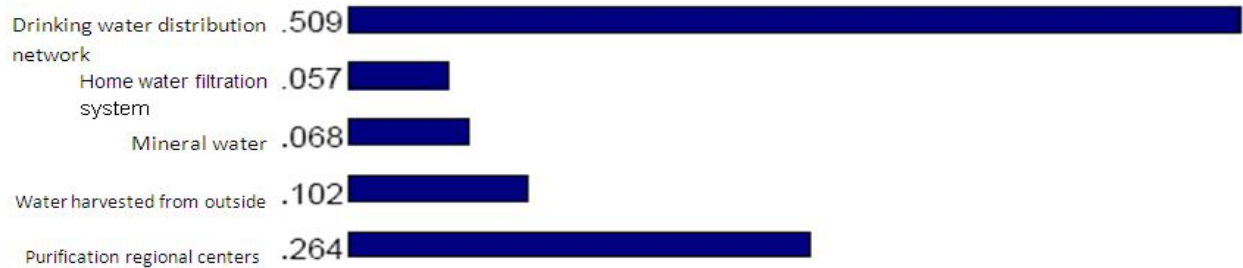


Chart (1) - Weight of decision making choices based on social criterions

#### • Choices scoring based on environmental criterion

Choices' scoring is done based on the studies and investigation of the comments of the managers and also the study of the various conferences reports and students thesis in the related field.



Chart (2) - Weight of decision making choices based on environmental criterions

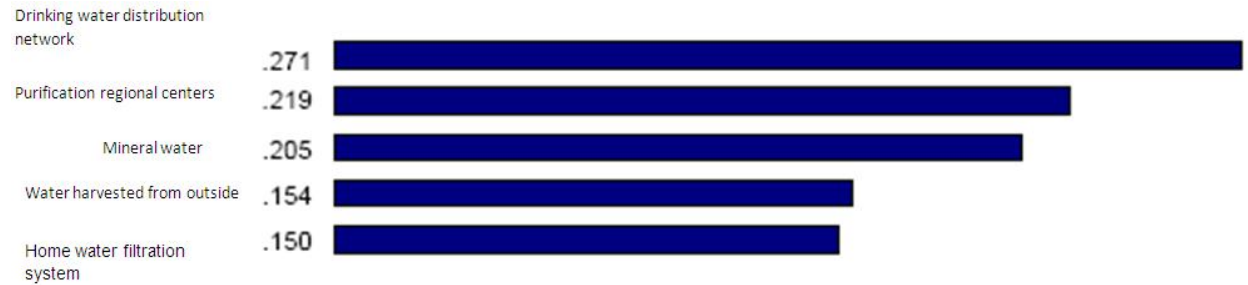
### 2.3.4 Prioritization of the choices in comparison with decision making criterions

In this section the results of the hierarchy analysis process were analyzed in three different states. The importance of social and environmental criterions is changed and the prioritization of the decision making choices are defined in the created states.

- **First state: The importance of environmental criterions is more than social criterions.**

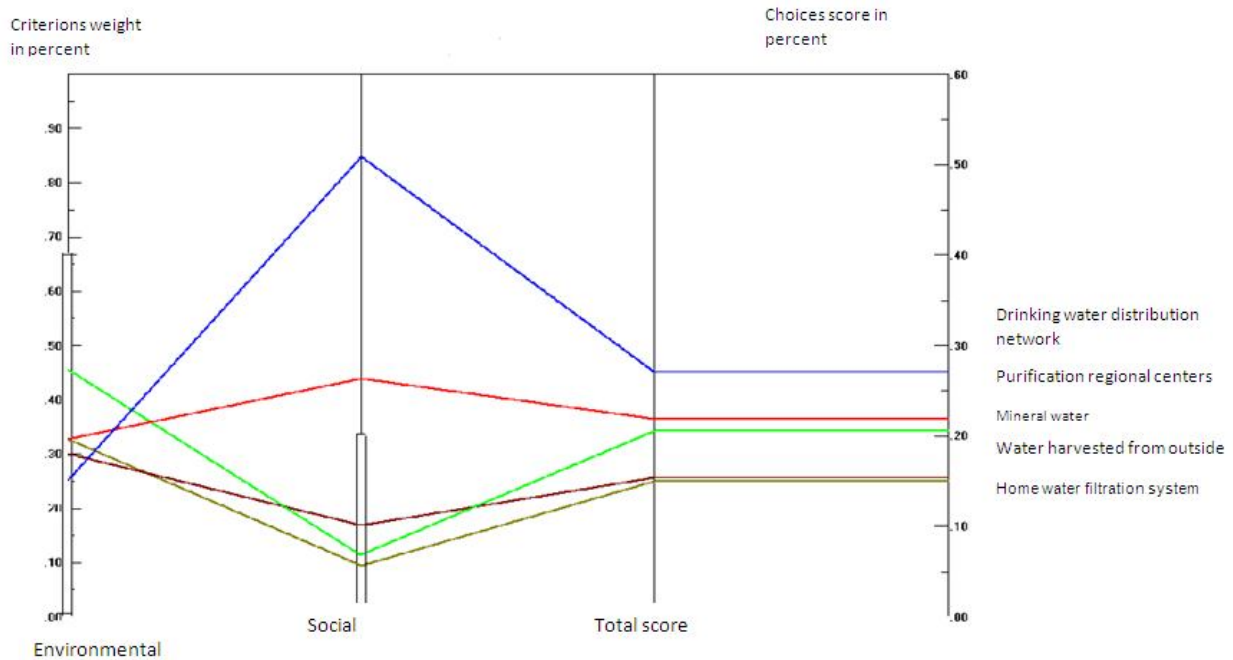
If by reliance on environmental principles when the value of environmental criterions values are two times the social criterions, the selection of healthy drinking water choices are considered.

Among four alternatives to provide healthy drinking water, the centers of water purification are in the first priority.



**Chart (3) - Final score of decision making choices considering more importance of environment criterion**

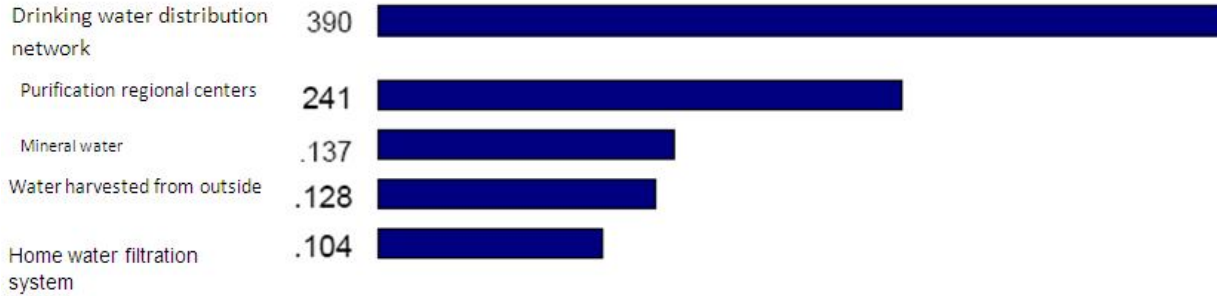
Sensitivity analysis chart of the choices are as the followings:



**Chart (4) - Ranking of the choices considering the more importance of environment**

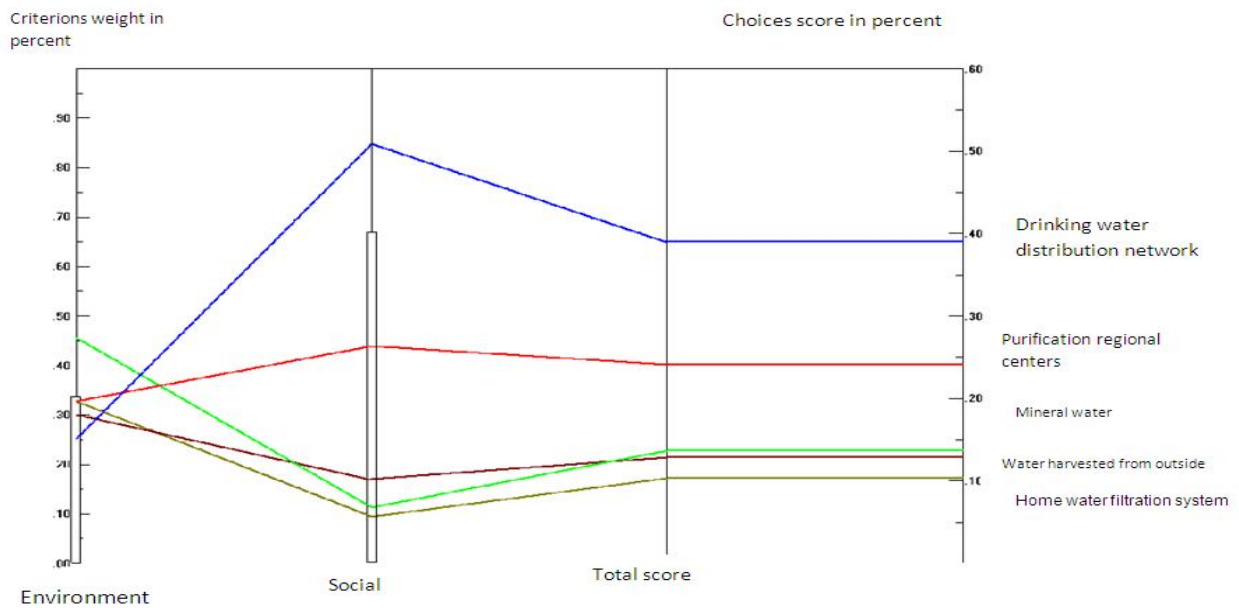
- **Second state: The importance of social criterions is more than environmental criterions.**

In this stage the importance of social criterions is assumed two times the environmental criterions. The results of this assumption are shown in charts (4-9), (4-10). Based on public social orientations of the people in the society, direct use of drinking water distribution network in the city is in high priority in comparison with four problem solving choices. Also there is considerable increase in the weight of this state in comparison with the previous state. This shows that decision makers should focus their activities more on improving the quality of water public distribution network in the city. Among for choices of providing healthy drinking water, purification centers give purification services as regional and they are in the priority with the difference that they have more weight than the previous state. But about the next 3 priorities (bottle water, water harvested from outside and home water filtration system) the order of the priorities are like the first state (more importance of environmental criterion) with the difference that the weight of choices are decreased.



**Chart (5) - Final score of decision making choices considering more importance of social criterion**

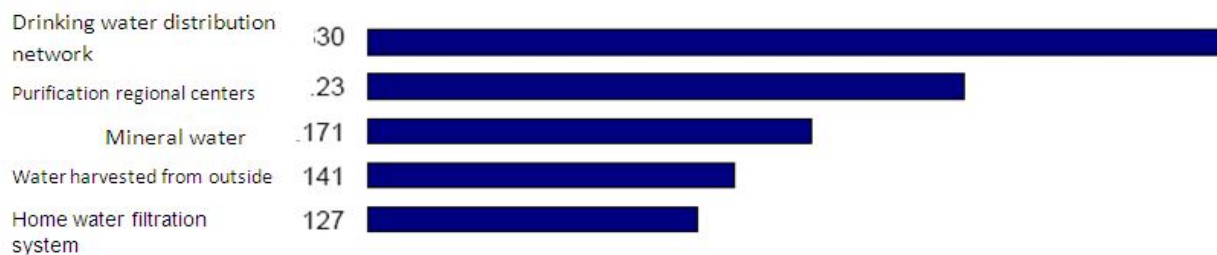
Also the sensitivity analysis chart is shown in the following figure:



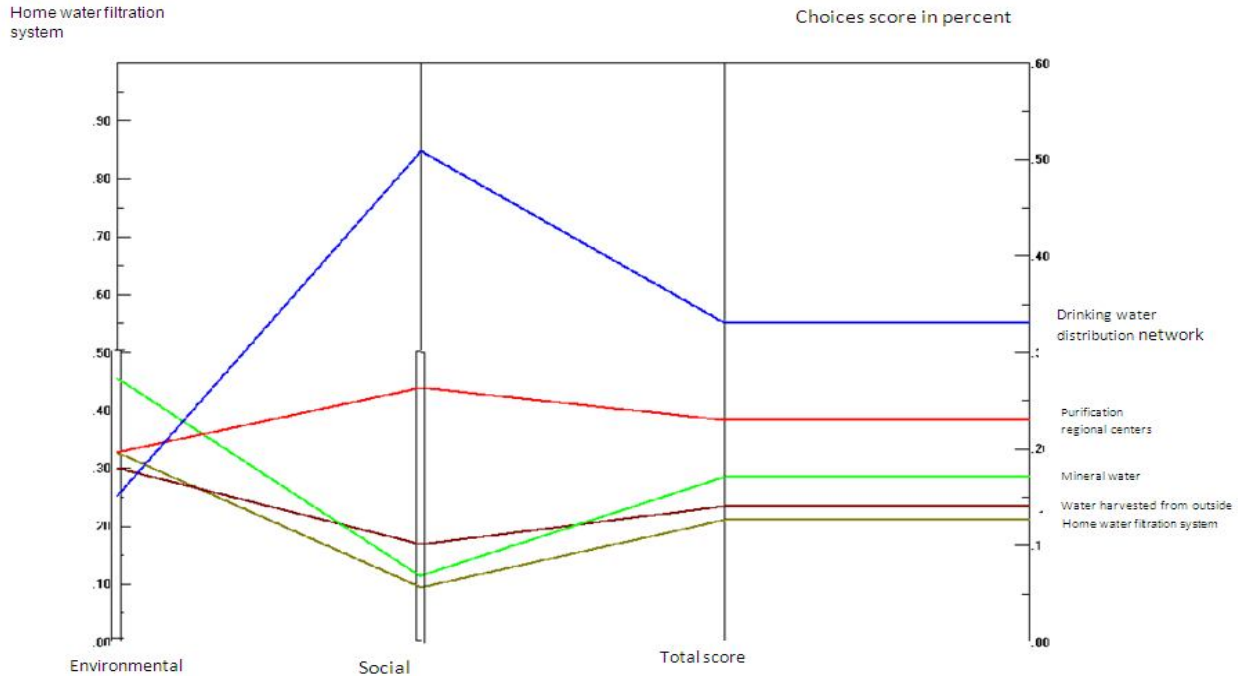
**Chart (6) - Ranking of the choices considering the more importance of social criterion**

• **Third state: Similar importance of social and environmental criterions**

In this state the order of the priority of the choices is like the two stages with the difference that the weight of the choices is more than the second state (more importance of the social criterion) and less than the first state (more importance of environment criterion). Regarding mineral water when environmental criterion importance is increased, the weight of the choice is increased and this is while regarding the choice of regional purification centers, when the importance of social criterions are increased, its weight is increased. The result of this state is shown in scoring charts of the choices and sensitivity analysis chart.



**Chart (7) - Final score of decision making choices with the similar importance of social and environmental criterion**



**Chart (8) - Ranking of the choices considering the similar importance of social and environmental criterion**

In hierarchy process by considering social and environmental criterions, using direct use of drinking water of distribution network approach has great priority in comparison with the four choices of problem solving (mineral water, springs and *Qanats* water around the city, water purification units in different parts of the city, home water filtration system). This shows that decision- makers should focus their activities more on improving the quality of drinking water public distribution network. Among four choices of providing healthy drinking water , purification centers providing purification services at regional level are in the first priority and the next 3 priorities are (mineral water, water harvested from outside of the city and home water filtration system). Regarding mineral water choice when the importance of environmental criterion is increased, the weight of the choice is increased and this is while regarding the regional purification centers, when the importance of social criterions are increased, the weight is increased.

### Results and recommendation

1. According to the results of this research by considering the social and environmental criterions, in pollution reduction management, generally direct use of potable water distribution network is of great importance in comparison with four problem solving choices. Thus it is proposed that the decision makers should focus their activities more on improving the quality of drinking water public distribution network.
2. The results of the studies showed that in hierarchy process selection the best choice of providing healthy drinking water among the four existing choices is water purification centers choice providing purification service at regional level. So, it is proposed that these centers should spread in different parts of the city and more supervision should be on them in terms of management and applying scientific environmental operation.

### REFERENCES

- [1] Investigation of Nitrate Concentration in Tap Water of Arak City, Iran” Proceedings of 6th International Symposium on Southeast Asian Water Environment, 29-31Oct. 2008, Bandung, Indonesia (Shortlisted for the book, it will be published by IWA publishing, London, UK).
- [2] A Survey on people Awareness about Nitration pollution of Tap Water in Arak City, Iran”, Proceedings of 5th International Symposium on Southeast Asian Water Environment, 7-9 Nov 2007, Chiang Mai, Thailand.
- [3] M. Hajeih, A.Al-Othman, (2004), "Application of the analytical hierarchy process in the selection desalination plants"
- [4] Ghodsi-Poor, SH, (2005). “Process of AHP”, Amirkabir University of Technology, Tehran, Iran