**Journal of Iran Futures Studies**
**Print ISSN:** 6365-2423
**Online ISSN:** 2676-6183

# Scenario planning for drinking water crisis management in Kerman city

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## Abstract

Objective: Kerman metropolis is one of the developing and rapidly growing cities in Iran that witnesses a lot of migrations to it every year. This migration has doubled the pressure on underground aquifers, including drinking water. On the other hand, Kerman city is considered one of the desert and desert areas of Iran that always struggles with water shortage and water crisis. In this regard, the present study deals with the scenario development of drinking water crisis management in Kerman city.

Method: The present study is descriptive-analytical in nature and method and applied-developmental in purpose. The information was collected through library and field studies. The statistical population of the study includes experts in the relevant field, 35 of whom were selected as the sample size by the two-stage Delphi method. The data were analyzed using the Mic-Mac software, Scenario Wizard, and the SWOT technique.

Results: The results of the environmental survey indicate 30 key factors in drinking water management, of which 12 drivers and factors were selected as key factors, including a high level of public awareness of water consumption, proper use of water by citizens, prevention of excessive migration from surrounding villages and cities to Kerman city, equal use of water resources by citizens, a coherent water pricing system, elimination of illegal branches, replacement of worn-out water transmission pipes, use of non-potable water in green spaces, development of large-scale and long-term water-related programs, proper water management, and media advertising. In the Scenario Wizard software, 3 scenarios (warning, golden, and disaster) were selected, and the golden scenario, as the desired and intermediate scenario, can help manage drinking water in Kerman city.

Conclusion: Kerman citizens, with low culture and excessive greed, have fueled the water crisis without considering the importance and scarcity of water. These citizens have the least cooperation with the city administration. However, the city administration of Kerman has not fulfilled its role and duty in the field of sustainable water supply.

**Key Words:** Drinking water crisis, drinking water management, scenario writing, futures studies, Kerman city.

**Cite this article:** Soleimani Damaneh Mojtaba. Rakhshaninasab, Hamid-Reza. Nazaripour, Hamid (2025) Scenario planning for drinking water crisis management in Kerman city,Volume9, NO.2 fall & winter 2025,153-186
**DOI**: 10.30479/JFS.2025.21266.1590
**Received on:** 30 December 2024 **Accepted on**: 1 February 2025

**Publisher**: Imam Khomeini International University
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## Introduction

Studies and research show that water resources in Iran are not in a good and suitable condition. Because Iran, with limited water resources and one-third of the world's average rainfall, is in a dry and water-scarce situation. On the other hand, migration to cities and their rapid population growth, widespread need for food products, increased public health, pollution of water resources, limited and scarce financial resources, and deterioration of infrastructure (water supply and distribution networks), have also challenged the exploitation of these limited water resources. For this reason, the water issue in Iran is an important and strategic issue that requires a solution-oriented strategy. In Iran, like most regions of the world, drinking and fresh water is becoming scarcer every day due to drought, population growth, increased per capita consumption, and irreplaceability. Therefore, the efforts of Iranian citizens to use water resources optimally seem more necessary.

Kerman city is located in a desert location, and its climatic factors such as (temperature, precipitation, humidity, and evaporation) are not in a suitable condition, which has led to water shortages and crises in this city. On the other hand, the failure to observe water consumption patterns by citizens (such as excessive use, use of drinking water in washing cars, yards, and air conditioners, etc.) and not so desirable management have intensified the shortage of drinking water. Citizens who use drinking water to irrigate their gardens have caused significant water waste. Considering the research problem, the present study seeks to identify key drivers and effective scenarios for drinking water management in Kerman city with a futures research approach.

Considering the purpose and nature of the research, the research questions are stated as follows:

What are the key drivers affecting drinking water management in Kerman city?

What are the desirable scenarios for drinking water management in Kerman city?

Materials and Methods

The present research is an applied research and is descriptive-analytical in nature and method. The research information was collected in two ways: library and field. In the library, theoretical framework information was collected by referring to books, articles, documents, etc., and in the field, the opinions of experts about drinking water in Kerman city were sought through a questionnaire. For this purpose, the statistical population of the research consists of relevant experts (water and wastewater, governorship, municipality, agricultural Jihad, and university), of whom 35 were selected as

the sample size through a two-stage Delphi method. The research data were analyzed through Miq-Maq and Scenario Wizard software, as well as the SWOT technique.

## Results and Discussion

The scatter plot of variables affecting drinking water management in Kerman city indicates that most of the variables are scattered around the diagonal axis of the scatter plot and the system is in an unstable state. For this purpose, four categories of variables can be identified in this system, each of which is referred to below.

Influential variables

These variables are those variables whose impact is significantly greater than their impactability; therefore, these variables, as input variables, have the greatest impact on drinking water management in Kerman city. Also, considering the identification of the system as an unstable system, these variables are located in the northwest part of the diagram, which indicates their major impact on the entire system. Most of these variables are in the socio-cultural dimension and include the following:

• Social and cultural: low level of public awareness regarding water consumption, migration from surrounding villages and cities to Kerman city, higher consumption of water resources by citizens than their production capacity

• Economic: lack of a coherent water pricing system

• Physical: illegal and unauthorized branching of houses, worn-out water pipes

• Environmental and geographical: use of drinking water in green spaces

• Management: lack of development of large-scale and long-term water-related plans.

## Bimodal variables

Bimodal variables refer to those variables that have a high impact and influence; so that any action on these variables also affects other variables. These variables are divided into two categories: risk and target variables. In the diagram, the risk variables are located around the diagonal line of the northeast area, which have a very high capacity to become key factors. In contrast, the position and location of the target variables are below the northeast diagonal area of the page, which express the goals and evolutionary results of the system. By making changes to these variables, the evolution of the system can be achieved based on the determined programs and goals. In this study, bimodal variables are scattered in the risk section and are located in different dimensions, which include the following variables:

• Social and cultural: inappropriate use and efficiency of citizens' water
• Physical: use of water in construction
• Management: lack of media advertising, lack of proper water management

**Independent variables**

These variables have low impact and impactability and are located in the southwestern area of the graph. The largest number of variables are in this category; in other words, out of a total of 30 variables, 4 variables are in this group, which are mainly related to socio-cultural, economic and physical dimensions and are as follows:
• Social and cultural: Failure to comply with the rules of the water and sewage company by citizens
• Economic: Failure to pay attention to water economy in locating new settlements
• Physical: Environmental-geographic: Water evaporation and transpiration,
• Management: Inappropriate exploitation of water structures by officials

**Affected variables**

Affected variables are variables whose most important characteristics are low impact and very high impact. These variables are also considered as outcome factors and are located in the southeast area of the diagram. Due to the instability of the system, a set of all variables and different dimensions are collected in this category of variables. These variables are as follows:
•Social and cultural: Religious beliefs of citizens in the proper use of water
•Economic: Failure to calculate the exponential price of water, income level of citizens, low price of water
•Physical: Broken meters in homes, non-standard plumbing in homes, water-consuming industries in the city
•Environmental and geographical: Geographical location of Kerman, reduced rainfall, quantitative and qualitative decline in water, contamination of water resources by industrial wastewater
•Management: Lack of separation between drinking water and other water resources, weak support for water projects, lack of urban and industrial treatment plants

**Grouping and Analysis of Selected Scenarios**

In total, 33 plausible scenarios can be categorized into three groups: golden, warning, and disaster. Each of these groups includes several scenarios with

almost common characteristics. The golden scenario, which describes the improvement of infrastructure and efficiency, the reduction of waste, and the sustainable management of drinking water resources in Kerman city, will be realized when the state of social, cultural, and managerial factors is facing a positive and growing trend. In contrast, the disaster scenario occurs in exactly the opposite situation of the golden scenario and is in contrast to the golden scenario, and in this group of scenarios, a critical situation prevails. The warning scenario, which refers to the continuation of the existing trend of drinking water management in Kerman city, is located in an area with a slight improvement in social and cultural factors and a decline in managerial factors.

## Conclusions

The results of the research show that the variables affecting the management of drinking water in Kerman city in the social and cultural dimension include (high level of public awareness of water consumption, proper use of water by citizens, prevention of excessive migration from surrounding villages and cities to Kerman city, optimal consumption and citizens' ability to produce water resources), in the economic dimension, including a coherent pricing system; in the physical dimension, including (removal of illegal branches and replacement of worn-out water transmission pipes), in the environmental dimension (use of non-potable water in green spaces), and in the managerial dimension (development of large-scale and long-term water-related programs, proper water management, and media advertising). The results also indicate the existence of three scenarios (disaster, warning, and golden) in the horizon of 2035, where the disaster scenario seems pessimistic due to the crisis conditions. The disaster scenario also does not lead to any results due to the continuation of the current situation and the lack of change in conditions. Finally, the consensus of experts is on the golden scenario, which has been named as the optimal scenario of the research. Considering the golden scenario and its sub-sets, it can help in the management of drinking water in Kerman city. In this regard, all the conditions of the golden scenario must be fulfilled. The results of the present study are in line with the research of Taheri Demneh et al. (2022), who believed that the most important factors determining the future status of water in the city of Isfahan are not environmental factors, but factors related to human decisions. It is also not in line with the results of the research of Beheshti et al. (2020), who believed that environmental and economic factors have the largest share as the main variables in this set and will have a greater impact on the future of water resources and are expected to be the driving force for the development of the city's water resources among the environmental and economic components.

## Conflict of Interest

This research has no conflicts of interest.

## Acknowledgment

The authors would like to thank the National Science Foundation of Iran (the Fund for Supporting Researchers and Technologists) for supporting the doctoral thesis and the article extracted from it (project number: 99030274), with the guidance of the second author and the advice of the third author.

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