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Assessment of the environmental condition of Lake Urmia by combining DPSIR framework and productivity model (Ishikawa)

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Abstract

As one of the most important and valuable aquatic ecosystems of Iran, Lake Urmia was announced as a national park in the early 70's, and as a biosphere reserve by UNESCO in 1976. Also this lake is considered an internationally important wetland, and in 1975 was introduced to (1971-Ramsar) convention of wetlands preservation as a vital area for birds. It is necessary to note that Lake Urmia is the second largest salt water lake in the world after the Dead Sea. Studies warn of serious threats to the lake's ecosystem and signs of reduction of ecologic mechanisms due to human activities. Adjustment and storage of the river water behind dams, and channeling the water from rivers that flow to the lake for agricultural and drinking purposes and hence reducing the water entering the lake, flow of urban and industrial untreated sewage and agricultural wastewater to the lake, and construction of Shahid Kalantari highway affecting the water circulation. In this article, first with the use of Ishikawa technique, the important and determining factors in drying of Lake Urmia were identified. Then with the help of DPSIR model, they were analyzed and the impacts and responses caused by these pressures were explained. In the end the important and effective factors contributing to drying of Lake Urmia (human activities including agriculture and planting with high water consumption, and construction of numerous dams in the water basin of the rivers flowing to the lake) were identified.

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Introduction

According to the latest statistics released by West Azerbaijan environmental conservation organization, with 40 centimeter drop compared to 2005, the water surface has reached 1273.5 meter above sea level.

The long-term average water level of the Lake Urmia is 1277 meters, and currently it is four meters less than the average long-term level. Due to reduced water level, the salinity level of the water in the lake has increased from 160 grams per litter in the time of abundance to 350 to 400 gram per litter; in some areas huge and thick layers of salt have covered the lakebed. Also due to the retreat of the shoreline, more than 150000 hectares of the lakebed has turned to salt-white barren land and has endangered the life of Artemia, the only living creature in this lake.

This is the lowest surface level in the recorded history of Urmia Lake. With disappearance of the living conditions for water birds and shore birds, the natural and human habitat will also suffer. As the Lake Urmia dries, a vast surface of mud and moving salt will be exposed on the lakebed causing the largest environmental crisis. With every blow of the wind the salt molecules will spread around farms, gardens and prairies and even the people living in the vicinity of the lake will have respiratory problems.

This model is suggested by UNEP (the United Nations' environmental program) and is employed in assessments by the European environmental agency. In this model, apart from classification of economic, social and environmental information, the causal relations between them are also identified.

The term DPSIR is consisted of the initials of the words driving forces, pressures, state, impact, and responses, which explain the cycle of cause and effect respectively. Although this model is mainly used in environmental evaluations, it seems it also has a high capacity for analysis of habitat and climatologic phenomena. The aim of this paper is first with the use of Ishikawa technique, the important and determining factors in drying of Lake Urmia were identified.

Materials and methods

Method of Fish Bone Diagram

The method or technique of fish bone diagram is known by many names such as Ishikawa diagram, cause and effect diagram, fish bone diagram fish skeleton diagram and a few more names. This technique was developed by the Japanese professor Ishikawa of Tokyo University and eventually found its place among managers and intellectuals.

Software programs

So that even software programs were produces for designing conceptual plans based on this technique, programs such as Mind Mapping, Mind Meister, Mind Manager, Free Mind and X-Mind. The results obtained by Ishikawa fish bone analysis of the Lake Urmia Ishikawa diagram (Lake Urmia fish bone diagram)

* Use of 4M1E method for categorization
* All the primary and secondary causes relating to human impact on Lake Urmia are divided into categories: Man, Machine, Material, Method, and Environment.

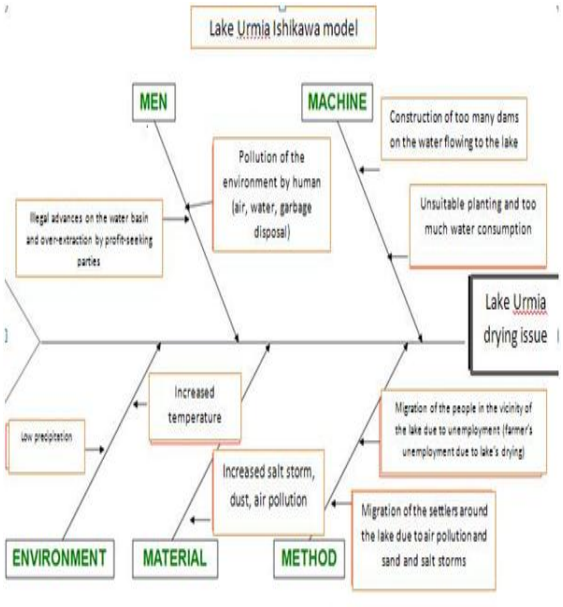

Fig. 1. Ishikawa Diagram.

Table 1. Causes of the Drying of Lake Urmia usually include the factors bellow:

Sub-criteria	Criteria
Unsuitable planting and high water consumption in the Lake basin areas	Machine
Construction of too many dams on the waters flowing to the lake	
Increased regional temperature	Environment
Reduced precipitation	
Increased salt and dust storms, and air pollution in the region	Material
Different man made pollutions (air pollution, water pollution, waste disposal)	
Illegal advancements on the lake basin and too much extraction by profit seeking individuals	Man
Migration of settlers around the lake due to air pollution, regional salt and sandstorms	
Migration of settlers around the lake due to unemployment (farmers; unemployment due to lake's drying)	

*DPSIR model

* For collected information to be bale to answer the rising questions, a consistent assessment must be presented in the form of a concept model.

Result and discussion

DPSIR model

Among the methods and models at hand, DPSIR is considered a most consistent one. This model is suggested by UNEP (the United Nations' environmental program) and is employed in assessments by the European environmental agency. In this model, apart from classification of economic, social and environmental information, the causal relations between them are also identified.

The term DPSIR is consisted of the initials of the words driving forces, pressures, state, impact, and responses, which explain the cycle of cause and effect respectively. Although this model is mainly used in environmental evalua-tions, it seems it also has a high capacity for analysis of habitat and climatologic phenomena. Since most of the current researches in the country are based on academic methods, the suggested model has the capacity to become a useful assistance in decision-making and planning of management and executive programs with an applied approach.

In fact, this method identifies and analyzes factors varying from the causes of a phenomenon to measures and policies taken or even need to be taken; an issue that is crucial for programming and planning strategies for encountering or adapting to certain phenomena. Considering the consistency and capacities of this model, it is suggested that it is used in assessment of phenomena such as dust, city's air pollution, floods, soil erosion, climatic changes etc. the bellow picture demonstrates the relation between the chain links of this model.

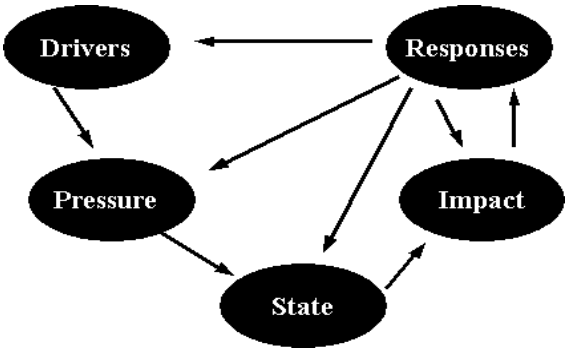

Fig.2. DPSIR model

DPSIR model analysis of the Lake Urmia DPSIR model analysis of the Lake Urmia

By combination of the two Ishikawa and DPSIR models in this article, it is concluded that the Lake Urmia is in a critical condition. Over-salinity of the lake's water is one of the factors in this crisis, and its destructive impact on the life of Artemia, the only living creature in this lake is obvious. Conducting further and expansive researches about this valuable water reserve and national park is strongly recommended.

Table 2. The results of DPSIR model analysis of the Lake Urmia are explained in the table below:

1	Driving force	Explaining the cause and the factors contributing to the drying of the Lake	Planting unsuitable vegetation in the vicinity of the Lake Urmia water basin Planting high-water-consuming vegetation around the lake's water basin Pollution of the wetland caused by leisurely activities in the area Climatic change and global warming The role of profit-seekers and opportunists in the region Advancement on the wetland's territory and over-usage of water from the lake
2	Pressures	Lake Urmia's drying pressures	Destruction of sensitive vegetation, animals and aquatic species in the area Disruption of the regional moderate weather condition caused by the over-heat and disappearance of the local Faun-e-Flore different impacts on the area and the local tourism Destruction of local agriculture due to the aridity of the region Farmers' unemployment due to lack of water
3	State	The current state of the Lake Urmia	Drying of Lake Urmia due to the recent drought, high evaporation, high temperature, low precipitation Farmers' unemployment due to drying of the wetland Formation of dust due to the drought of Lake Urmia
4	Impact	Impacts of the Lake Urmia drought	Increased salt storms and air pollution due to spread of dust in the air Immigration of endangered species such as the Siberian crane Farmers' unemployment
5	Response	Responses of the resulting state	Immigration of the settlers around the Lake Urmia due to air pollution, sand and salt storms and unemployment Immigration of the people settling in the vicinity of the wetland to nearby cities to find job and carry out other activities Immigration or extinction of endangered species such as the Siberian crane

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Suggestion

Solutions for productivity and revival of the Lake Urmia

Among executive solutions such as changing agricultural and plantation patterns, the following issues are suggested:

1. Turning from growing plants with high water consumption to plants with less water consumption
2. Changing the patterns of growing plants
3. Reduction and deceleration of dam construction
4. Opening some of the dams

Conclusion

Flow of urban and industrial untreated sewage and agricultural wastewater to the lake, and construction of Shahid Kalantari highway affecting the water circulation and saltiness and life of Artemia, are the factors which pose a serious threat to the lake. Since any solution without consideration of the role of native population is deemed impractical the process of public participation needs to be facilitated by granting authority to local communities and reinforcement of the roles of native population and NGOs in order to achieve a stable local and regional

growth. In this article, first with the use of Ishikawa technique, the important and determining factors in drying of Lake Urmia were identified. Then with the help of DPSIR model, they were analyzed and the impacts and responses caused by these pressures were explained. In the end the important and effective factors contributing to drying of Lake Urmia (human activities including agriculture and planting with high water consumption, and construction of numerous dams in the water basin of the rivers flowing to the lake) were identified.

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