

## Quality Zoning of Chalous River in Different Landscapes Using Fuzzy Sets Method

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**Abstract**—Increasing the rivers' pollution notifies on their proportion management. The Chalous river which is taken into account as one protected river in the Caspian sea-northern Iran- flows through variety ecosystems. Therefore, for the management of this river, assessing the quality of this river related to the present ecosystems surrounding its basin is the basic task which this research presents. First, employing landscape ecology approach, three major landscapes were distinguished which result in river zoning. Those are consist of the Mountain, Kandowan and the Chalous lowland landscapes. Sampling was carried out in the discharge at the strategic locations of each landscapes. Consequently, eight stations were selected and fourteen parameters including water temperature, PH, DO, B.O.D, C.O.D, EC, Turbidity, NO<sub>2</sub>, NO<sub>3</sub>, NH<sub>4</sub>, Caco<sub>3</sub>, CL, T.S.S, T.D.S and four toxic metals (i.e., Fe, Ba, Pb) were measured. The fuzzy sets theory was employed for the analysis of the data related to each landscape in order to doing river quality zoning.

Results show that the river's quality is affected by each ecosystem and its water quality. But in human landscapes, quality is associated with the intensity of human activities. River quality in the Mountain landscape is the best, in Kandowan landscape is moderate, and the Chalous lowland landscape has poor quality.

**Keywords:** Chalous river, landscape ecology, ecosystem, fuzzy sets

### I. INTRODUCTION

Water resources not only have an important role in providing with the natural and acquired needs of man, but also root in human history. Multiple healthy and clean rivers are the major factors for the social and economical development. Then, having intact water resources is urgent pre-necessity in order to maintain the environment quality and cover the socio-economic development [1].

Today, in water resources management, notable role of water quality beside its quantity is increasing. Rivers via

passing through Landscapes, are affected by their surrounding ecosystems and even connect them to each other. Till 1980 the, ecosystems were considered as vertical layers and independent of other ecosystem; moreover, human influence was evaluated aside from assessing ecosystems. After that, when Landscape ecology was developed, distinguishing ecosystems were based on both natural and artificial features. In fact, man is seen beside the nature and interacting between ecosystems is considered seriously. Land use change is one principal component which determine the water quality [2,3], and totally causes the structure, function and changes in landscapes.

The relationship between Land use with water quality and quantity is complicated [4,5]. In different Landscapes include agriculture, managed forest, urban and almost virgin environments, this relations were assessed well. [6] consequently. Landscape ecological assessments can be applied efficiently because of low amount of virgin ecosystems and interaction between mature and artificial structures. Because of issues mentioned above, Landscape ecology method was used for rivers classification.

Complexity in relations between water quality parameters and little data due to Low frequency in sampling cause difficulties in quality assessment of running waters. For instance, Weston (1947) remarks that 18 parameters are effective in determining BOD at least. Because of these issues, it has been preferred to use fuzzy sets in investigating the water quality.

Fuzzy sets theory [7,8] is a mathematical tools for recognition and quantization of uncertainty and un-accuracy in data and their relations. Since 1990, using fuzzy set theory has been considered widely for the sake of solving ambiguous problems in management of the environmental [9,10,11,12,13] fuzzy sets unlike classic sets can explain the knowledge and experience of mankind in real world in the form of mathematics.

## II. METHOD

Different major Landscapes were eliminated in this basin using landscape ecological approach. Therefore three major Landscapes were defined through indices which had been considered as Landscape distinguisher which were mentioned above (e.g climate physio-graphy etc.). Water sampling was carried out at station and strategic points (places with high pollutants) of each Landscapes. As a result, sex samples were collected in polythene bottles from different stations during four seasons. At the sampling site temperature and PH were measured directly. The other parameters were measured by standard methods.

In continues the samples were classified using fuzzy interface system (FIS) from the qualitative point of view. In this system, first, all input parameters were fuzzified using three simple triangular membership functions (MF) in their ranges called as “Low”, “medium”, and “high” amounts, Similarly, a fuzzified output ranges from 1 to 0 known as “very good”, “good”, “moderate”, “bad. And “very bad” quality degrees were built. After that, “if – then” rules were written on the basis of experts discussions by which the relations between inputs and outputs were determined. In the above fuzzy system is mamdani requiring, method Aggregation via maximization and centroid defuzzification method. Is used to produce the outputs. These all preformed in Matlab software.

## III. RESULTS

Results of river quality classification in three different landscapes are shown in **table [1]**.

Mountain landscape: The quality in this part of river is from almost very good to good. This is because, human impact is the least and because there are special ecological conditions. High elevation, low temperature, high density of drainer, steep slope and roughness of river-bed cause the river to maintain its quality. Another reason for the good water quality is neighboring to sources. Kandowan landscape: the fuzzy analysis predicated the quality of river in this region about moderate. Urban landscapes of chalous lowland: this landscape is destroyed vigorously. Domestic and industrial sweges, fertilizers, pesticides, Atmospheric contaminants due to human practices all increase the pollution of river. Besides, some ecological conditions such as high temperature, short path of river, and gentle slope increge the effects of pollutants.

TABLE 1: RESULTS OF WATER QUALITY ANALYSIS BY FUZZY METHOD

Description of Fuzzy quality	Score 0-1	Description of Fuzzy quality	Name of landscape
Very good	0.865	Very good	Mountain
Very good	0.877	Very good	Mountain
moderate	0.54	moderate	Kandowan
moderate	0.51	moderate	Kandowan
Very bed	0.098	Very bed	Chalous plain
Very bed	0.045	Very bed	Chalous plain

## IV. RESULTS AND DISCUSSIONS

Results endorse the point that more than any other factor what reduces the water quality is ecosystem degradation by human and pollution resulting from man-kind presence and activities. Determination of the number of samples and stations in water sampling are so important in water quality assessment. As is seen in this research the river classification is based on landscape ecological approach and sampling in outputs and strategic points of each landscape is a suitable method in solving the sampling problems. Using fuzzy sets in analyses specially about the water quality parameters investigation that have low frequency, high uncertainty and complex relation ships, is so appropriate.

At the end, It can be stated that managing rivers via landscape management is an acceptable method which facilitates achieving preservation goals.

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