Evaluation of Spatial Pattern of Land Uses in Urmia Lake Basin towards Conservation of Urmia Lake

Introduction

Regarding the analytical capabilities of GIS in environmental planning, we can consider many study fields, in different geographical environments, for post-doctoral research. The study under the title of "Evaluation of Spatial Pattern of Land Uses in Urmia Lake Basin towards Conservation of Urmia Lake" has been considered as a proposed subject for my post-doctoral research. Proposing this subject for a study was firstly based on taking consideration of Urmia Lake restoration and conservation priorities at local and national levels and being focused on the lake tragedy at international levels, and then on the researcher interests about this study. Due to the failure of many practices, especially from the local and national organization, for the conservation and restoration of Urmia Lake, the researcher believes that achievement of this goal requires establishing cooperation between local researchers and international scientists and using their valuable viewpoints and contributions. To use the supervisor professor precious comments and experiences, this subject has proposed based on our common studies interests. Naturally, justifying and altering or even proposing other relevant subjects will be warmly welcomed by the researcher.

Problem Statement

Urmia Lake Basin (ULB), in the northwest of Iran, is extended in 44˚ 14' to 47˚ 53' East longitude and 35˚40' to 38˚ 20' North latitude (Kakahaji, Banadaki et al. 2013, Fathian, Dehghan et al. 2016), (Fig. 1). This closed basin, with a total area of approximately 51800 km^2 (3.15% of Iran total area), is one of the six large hydrological basins in Iran. The ULB landforms encompasses mountainous, plains and foothills, and the lake and its surroundings wetlands with the area of 35150 km^2 (67.85%), 9000 km^2 (17%) and 7310 km^2 (14%), respectively (Kakahaji, Banadaki et al. 2013, Fathian, Morid et al. 2015, Fathian, Dehghan et al. 2016, Malekian and Kazemzadeh 2016, Sadeghi, Kia et al. 2019). The altitude of the region varies from 1260 meters above mean sea level in Urmia Lake to 3710 meters in Sahand Mountains. The climate of the ULB is semi-arid, the average of annual precipitation is between 300 to 400 mm and the mean annual temperature vary from 6.8 to 14.8 ˚C (Shadkam, Ludwig et al. 2016, Haghighi, Fazel et al. 2018). There are many permanent and seasonal rivers such as Zarineh Roud, Simineh Roud, Mahabad Chay, Gheder Chay, Aji Chay, Zoula Chay, Barandoz Chay, Ghale Chay and Nazloo Chay, with the length of 20-60 kilometers, in the ULB (Fathian, Dehghan et al. 2016, Shadkam, Ludwig et al. 2016, Khazaei, Khatami et al. 2019).

Nearly 6.5 million people, from 3300 rural settlements and 115 cities, settle inside the ULB and more than 76 million people live within a radius of 500 km (Iran 2011, UNEP and GEAS 2012). This unique and valuable aquatic ecosystem is also one of the most important agricultural and industrial poles in the northwest of Iran (Feizizadeh and Blaschke 2013, Sadeghi, Kia et al. 2019).

Urmia Lake (UL), in the northwest of Iran, is the second hypersaline permanent lake in the world (Karbassi, Bidhendi et al. 2010, Sima and Tajrishy 2013, Fathian, Dehghan et al. 2016, Nourani, Mehr et al. 2018). Regarding the unique natural and ecological characteristics of the UL, it is considered as one of the most important and valuable aquatic ecosystems in Iran (Zarghami 2011). The lake is a destination for many migrant species, including flamingos, pelicans, spoonbills, ibises, storks, avocets, stilts and gulls, and also has been a natural habitat for brine shrimp (Artemia Urmiana), which is a major nutrient for migratory birds (Sima and Tajrishy 2013, AghaKouchak, Norouzi et al. 2015). Additionally, the lake islands are the shelter of two very rare species: Yellow Persian deer and a variety of sheep (Sima and Tajrishy 2013). Due to the importance of this national park in various aspects, it was added to the Ramsar List of Wetlands of International Importance in 1971 and designated a UNESCO Biosphere Reserve in 1976 (Zarghami 2011, UNEP and GEAS 2012, Nouri, Mason et al. 2017).

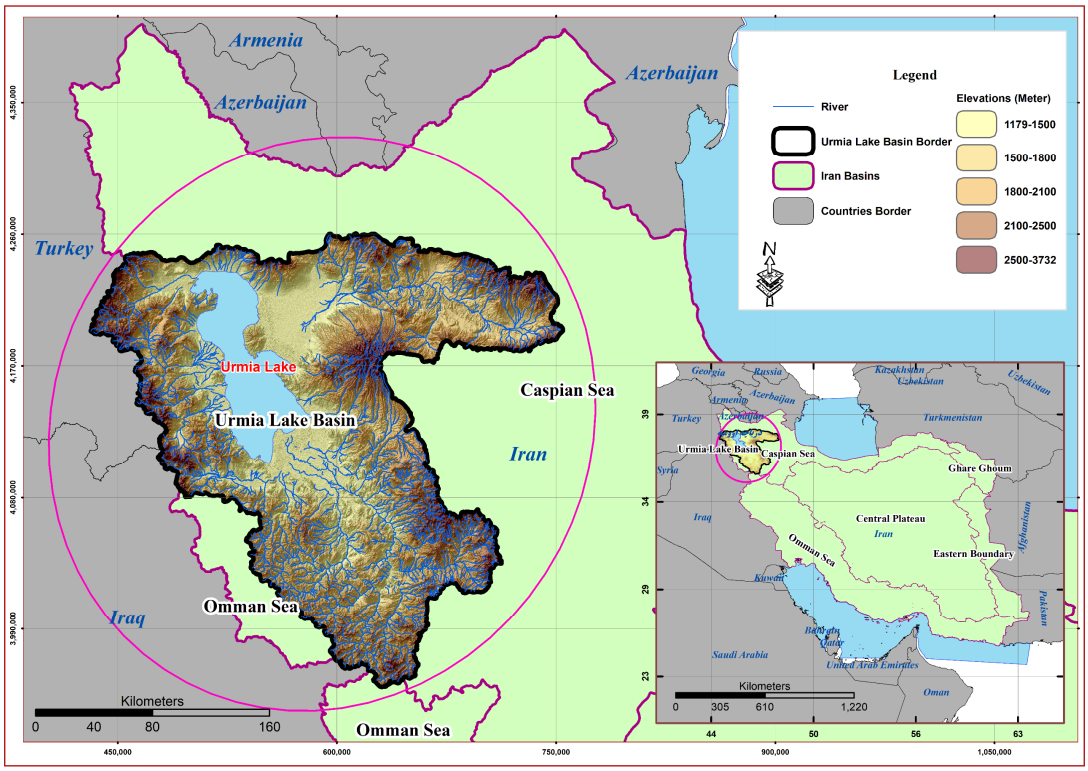

Fig 1: Location of Urmia Lake in Iran & ULB

During more than two decades, as a result of various factors, the area of UL water level has declined dramatically. Thus, the water level of UL has decreased 7 meters and more than 80% of the lake area, which was nearly 6100 km^2 in its pre 1995 condition, has desiccated and become to salt flats (UNEP and GEAS 2012, Sima and Tajrishy 2013, AghaKouchak, Norouzi et al. 2015, Shadkam, Ludwig et al. 2016, Jeihouni, Toomanian et al. 2017, Nouri, Mason et al. 2017, Haghighi, Fazel et al. 2018, Nourani, Mehr et al. 2018, Khazaei, Khatami et al. 2019). Drying of UL and continuing its current trend, as one of the primary environmental tragedies in the Middle East, has become to an environmental crisis and has faced total ULB ecosystem and its surrounding areas with serious problems (Zarghami 2011, AghaKouchak, Norouzi et al. 2015, Fathian,

Dehghan et al. 2016, Shadkam, Ludwig et al. 2016, Jeihouni, Toomanian et al. 2017, Khazaei, Khatami et al. 2019). As a result of UL desiccation and the retreat of shorelines, subsided salts can cause salt storms, and subsequently blowing them away to surrounding agricultural lands can jeopardize agricultural activity, the main and most important activity, in the region (Zarghami 2011, Hassanzadeh, Zarghami et al. 2012, Azarnivand, Hashemi-Madani et al. 2015, Fathian, Modarres et al. 2016). Moreover, accumulating toxic materials through industrial pollutants and heavy metals and also large quantities of pesticides to control parasites and weeds in groundwater and surface water that inflow to the lake has doubled worries about this problem (Hassanzadeh, Zarghami et al. 2012). Negative consequences of this problem have not only affected on agricultural activities, various plant and animal species, including Artemia Urmiana, migratory and native birds and Yellow Persian deer, in a large area of this region, but also has imperiled industrial activities, residential land uses and public health, as was experienced in one of the largest environmental disasters of this kind, around the Aral Sea (Zarghami 2011, Hassanzadeh, Zarghami et al. 2012, UNEP and GEAS 2012, Sima and Tajrishy 2013, Fathian, Morid et al. 2015, Fathian, Dehghan et al. 2016, Fathian, Modarres et al. 2016).

Though the role of natural factors such as climatic variables and drought in bringing about significant negative impacts on UL is undeniable, relevant researches indicate that anthropogenic factors, including demographic changes, development of unnecessary projects and mismanagement of water resources, have played a determinant role in UL desiccation (Zarghami 2011, Hassanzadeh, Zarghami et al. 2012, Sima and Tajrishy 2013, Fathian, Morid et al. 2014, Jeihouni, Toomanian et al. 2017, Arkian, Nicholson et al. 2018, Haghighi, Fazel et al. 2018, Nourani, Mehr et al. 2018, Khazaei, Khatami et al. 2019, Sadeghi, Kia et al. 2019). As mentioned previously, the ULB is located in a semi-arid region; it means that the development of agricultural activity is highly dependent on irrigation (Shadkam, Ludwig et al. 2016). In 1980, the total cultivated area within the ULB was 150,000 ha (Nouri, Mason et al. 2017). During the last 15 years, the area under irrigation around the lake has increased over seven times (Shadkam, Ludwig et al. 2016). Based on the statistics, there are nearly 510000 ha of irrigated lands, with 33 modern and traditional irrigation networks, in the ULB (Shadkam, Ludwig et al. 2016); this is included only around 10% of the total ULB area, while more than 90% of the total renewable water resources in the ULB is consumed by this sector (Haghighi, Fazel et al. 2018). Of the total cultivated lands, 70% are farms and 30 gardens. Irrigation efficiency is reported quite low in the basin: 37% for farming and 45% for gardening (Shadkam, Ludwig et al. 2016). Development of irrigated agricultural lands and infrastructures, such as dams and reservoirs to control and overuse water resources, through low-efficiency agriculture have put high pressure on surface water resources. Additionally, excessive pumping from legal and illegal wells have decreased the underground water level to a dangerous level (Fathian, Morid et al. 2014, Jeihouni, Toomanian et al. 2017, Arkian, Nicholson et al. 2018, Khazaei, Khatami et al. 2019). Subsequently, it can also increase the land subsidence in the region.

In recent years, many researchers have addressed the rapidly declining of Urmia Lake in different studies fields (Ghaheri, Baghal et al. 1999, Abbaspour and Nazaridoust 2007) (Karbassi, Bidhendi et al. 2010, Zarghami 2011, Abbaspour, Javid et al. 2012, Hassanzadeh, Zarghami et al. 2012, UNEP and GEAS 2012, Kakahaji, Banadaki et al.

2013, AGH 2014, Fathian, Morid et al. 2014, Noury, Sedghi et al. 2014, Zeinoddini, Bakhtiari et al. 2014, AghaKouchak, Norouzi et al. 2015, Azarnivand, Hashemi-Madani et al. 2015, Fathian, Dehghan et al. 2016, Fathian, Modarres et al. 2016, Malekian and Kazemzadeh 2016, Shadkam, Ludwig et al. 2016, Jeihouni, Toomanian et al. 2017, Arkian, Nicholson et al. 2018, Haghighi, Fazel et al. 2018, Nourani, Mehr et al. 2018, Khazaei, Khatami et al. 2019, Sadeghi, Kia et al. 2019). These researches have mainly focused on studying and identifying the factors and reasons of declining Urmia Lake, negative consequences of the problem, trend of the lake changes in different periods, water resources management and so on. In this research, with a different perspective, it is aimed at evaluating of spatial pattern of problematic land uses in Urmia Lake basin towards conservation of Urmia Lake. Thus, it is an attempt to address the following questions:

Which land uses do have considerable adverse impacts on the lake in Urmia Lake basin?

How the present patterns of problematic land uses are playing their roles in declining of the lake in Urmia Lake basin?

How the problematic land uses are spatially distributed within Urmia Lake basin and how the Lake is affected by these spatial patterns?

It is assumed that spatial identification of problematic land uses, which have had serious negative impacts on Urmia Lake and its ecosystem in Urmia Lake basin, and mapping risky zones can play a determinant role towards restoration and conservation of the lake.

Data and Methodology

In this study, spatial data, including various land uses layers, which are imperiling Urmia Lake ecosystem and its surrounding areas, will be used. To provide and analyze the parameters, Geographic Information System (GIS) software and remote sensing techniques and also other planning models are required. To evaluate the environmental suitability of land uses in ULB, the following steps will be followed:

I. Identifying and extracting problematic parameters in the ULB based on a comprehensive literature review, regions characteristics and interview with experts.
II. Collecting required data through relevant organizations and some present resources, including satellite images.
III. Providing effective parameters by producing Geodatabases and executing required tools in GIS environment.
IV. Identifying and analyzing how the problematic land uses affect on Urmia Lake.
V. Defining and building data processing model.
VI. Running the model to produce the map of environmental suitability of land uses and subsequently identifying risky and problematic zones in Urmia Lake basin.

Also worth noting is that the final framework of the research will be provided based on the final viewpoints of experts and supervisor professor and also the requirements of the study.

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