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Changing Geomorphosites in a Changing Lake: How Environmental Changes in Urmia Lake Have Been Driving Vanishing or Creating of Geomorphosites

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***Abstract*—**Any variation in environmental characteristics of geomorphosites would lead to destabilisation of their geotouristic values all around the planet. The Urmia lake, with an area of approximately 5,500 km^2 and a catchment area of 51,876 km^2, and to which various reasons over time, especially in the last fifty years have seen a sharp decline and have decreased by about 93 % in two recent decades. These variations are not only driving significant changes in the morphology and ecology of the present lake landscape, but at the same time are shaping newly formed morphologies, which vanished some valuable geomorphosites or develop into smaller geomorphosites with significant value from a scientific and cultural point of view. This paper analyses and discusses features and evolution in several representative coastal and island geomorphosites. For this purpose, a total of 23 geomorphosites were studied in two data series (1963 and 2015) and the respective data were compared and analysed. The results showed, the total loss in geomorphosites area in a half century amounted to a loss of more than 90% of the valuable geomorphosites. Moreover, the comparison between the mean yearly value of coastal area lost over the entire period and the yearly average calculated for the shorter period (1998-2014) clearly indicates a pattern of acceleration. This acceleration in the rate of reduction in lake area was seen in most of the southern half of the lake. In the region as well, the general water-level falling is not only causing the loss of a significant water resource, which is followed by major impact on regional ecosystems, but is also driving the most marked recent (last century) changes in the geotouristic landscapes. In fact, the disappearance of geomorphosites means the loss of tourism phenomenon. In this context attention must be paid to the question of conservation. The action needed to safeguard geomorphosites includes: 1) Preventive action, 2) Corrective action, and 3) Sharing knowledge.

***Keywords*—**Changing lake, environmental changes, geomorphosite, northwest of Iran, Urmia lake.

I. Introduction

ANY variation in environmental characteristics of geomorphosites would lead to destabilisation of their geotouristic values all around the planet. These disturbances could jeopardize the conservation of geoheritage and the sustainability of socioeconomic systems. Geo-heritage features, too, could be exposed to the unfavourable effects of changing environment and this is particularly the case with Urmia lake, which rank among the most fascinating elements of northwest of Iran (Fig. 1). Because of therapeutic properties of the coastal sludges (Fig. 2), it has long been regarded as one of the tourist destinations and now also with regard to the existence of multiple geomorphosites and geosites around it, is in the focus of all tourist groups particularly geotourists.

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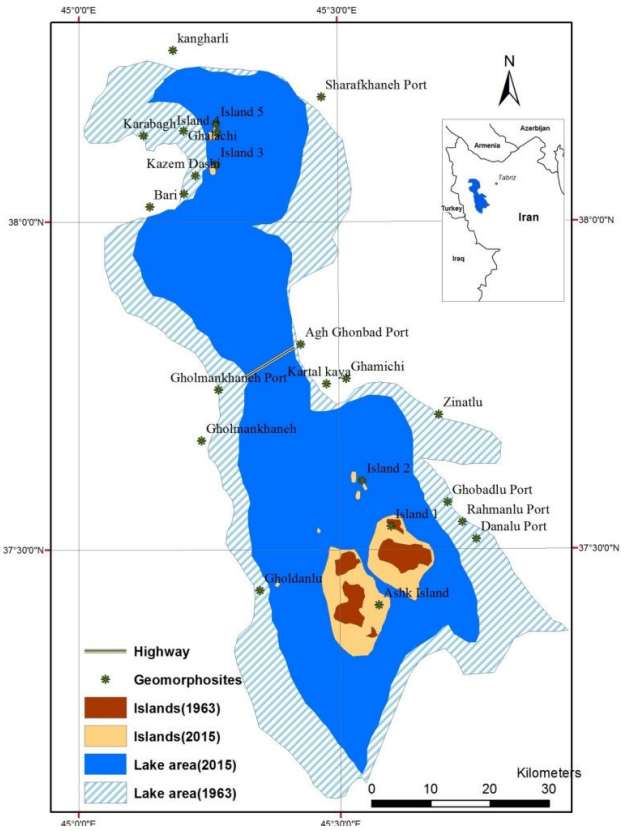

Fig. 1 The situation of Urmia Lake (1963 & 2015) and geomorphosites around it

Due to the nature of geomorphosites, the effect of the environmental change is inevitable. The consequences of Urmia lake regression on natural and cultural heritage have not been investigated in any detail. In this paper, we summarise the current trend affecting geomorphosites of Urmia Lake and the direct and indirect consequences on geomorphosite values and features.

Fig. 2 Therapeutic properties of the coastal sludges and tourists [1]

II. Literature Review

The effects of climate change on nature-based tourist areas [2] and in particular the effect of global warming on polar regions and increased tourist access to the polar regions[3], mountain glaciers, and the role of environmental and climate change in developing loess geomorphosites [4] has received much attention. Effects of climate change on shortening the ski season, storms in coastal areas, the risk of growth of corals in dive tourism destinations due to increased water temperatures and ocean acidification, and ultimately increasing the risk of fire in forest areas are other factors affecting the tourism industry [5]. However, climate change constitutes only a part of environmental changes and the changes occurred in the tourism destinations must be focus on other aspects of the environment and how they change.

Studies show that the lake at the end of the Pleistocene, have been much larger than today. Identification of 3 terraces at an altitude of 75, 160 and 270 meters to the current level by Kahnh [6], confirms this issue. These changes are as a result of a balanced human interaction with the natural landscape, under the influence of natural factors has run its normal course up to 50 years ago. But, studies showed that precipitation falling [7]-[12], changes in lake catchment water resources [13]-[15], land use change [16], reducing the volume of water entering the adjacent basins, tectonic activity [17], [18], and the Lake causeway road construction among the reasons cited for the lake drying.

All these changes, particularly changes in the area of the lake and coastal displacements, thus reducing the water level of the lake, have been driving vanishing or possibly creating of geomorphosites. Although there is not accurate statistics on the tourists who visited the region geomorphosites or visit but, obviously some important geomorphosites lost its geotouristic value, or at least their location has changed.

III. Methods & Materials

This research based on monitoring the changes of water level and extent of Urmia lake and evaluation of corresponding changes in the adjucent geomorphosites location and their capabilities using satellite images and field work is done. This paper analyses and discusses features and evolution in several representative coastal and island geomorphosites. For this purpose, a total of 23 geomorphosites were studied in two data series (1963 and 2015) and the respective data were compared and analysed.

IV. Research and Results

What is the Problem?

The drying of the lake, a closed basin and because of its environmental significance is now an important challenge facing the authorities and planners of environmental issues and intellectual concerns of the people living around it. The lake, with an area of approximately 5,500 km^2 and a catchment area of 51,876 km^2, and to which various reasons over time, especially in the last fifty years have seen a sharp decline (Fig. 3) and have decreased by about 93 % in two recent decades. These variations are not only driving significant changes in the morphology and ecology of the present lake landscape, but at the same time are shaping newly formed morphologies, which vanished some valuable geomorphosites or develop into smaller geomorphosites with significant value from a scientific and cultural point of view (Fig. 1).

As a result of this rapid environmental evolution, many geomorphosites located at caosts and islands could experience value reduction and/or could disappear in the next few decades. These changes will have significant impact on geomorphosites, further accelerating their rates of value reduction. The most visible impact of this trend will be seen in the aesthetic values of geomorphosites.

The geodiversity of coastal areas could be influenced in different and apparently opposite ways by lake recession: in a first stage, gives rise to the development of several minor morphologies. These smaller morphologies, although characterised by a short lifespan, contribute to increasing the geodiversity of the site at a local scale. On a longer time-scale, on the other hand, the effect of lake recession is a general decrease of geodiversity due to the complete disappearance of geomorphosites. During the first stage of lake recession, it is also impressive to consider that such vanishing geomorphosites see their scientific value increase, as they are the clearest and unambiguous witnesses of environmental change (Fig. 4).

Natural systems will not be the only victims of lake recession: the economies of surrounding areas will also be affected. In fact, the tourism industry in the Urmia Lake is already concerned by the consequences of environmental change and the ongoing reduction in water. In the case of summer tourism and in the warmer summer conditions, the expected impacts of environmental change and of lake retreat are more complex and clear.

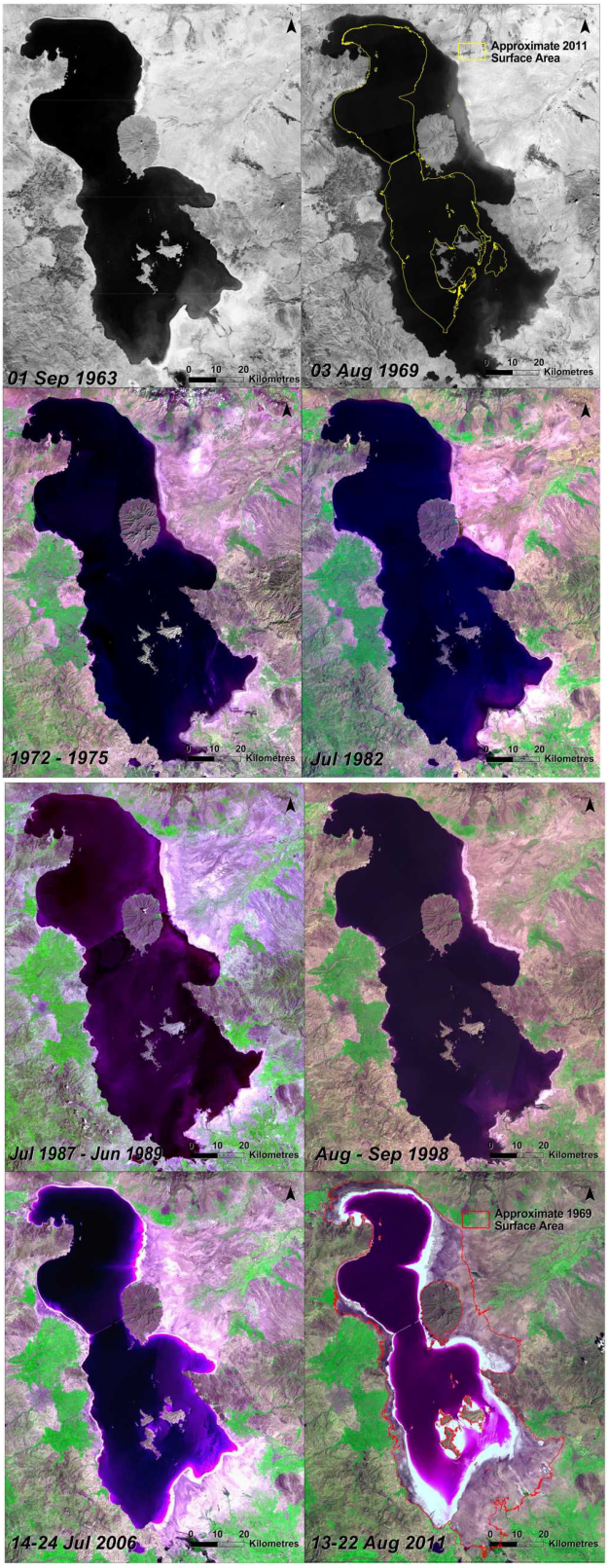

Fig. 3 Satellite Images of Lake and water loss in the period from 1963 to 2014 (UNEP- GEAS, 2012)

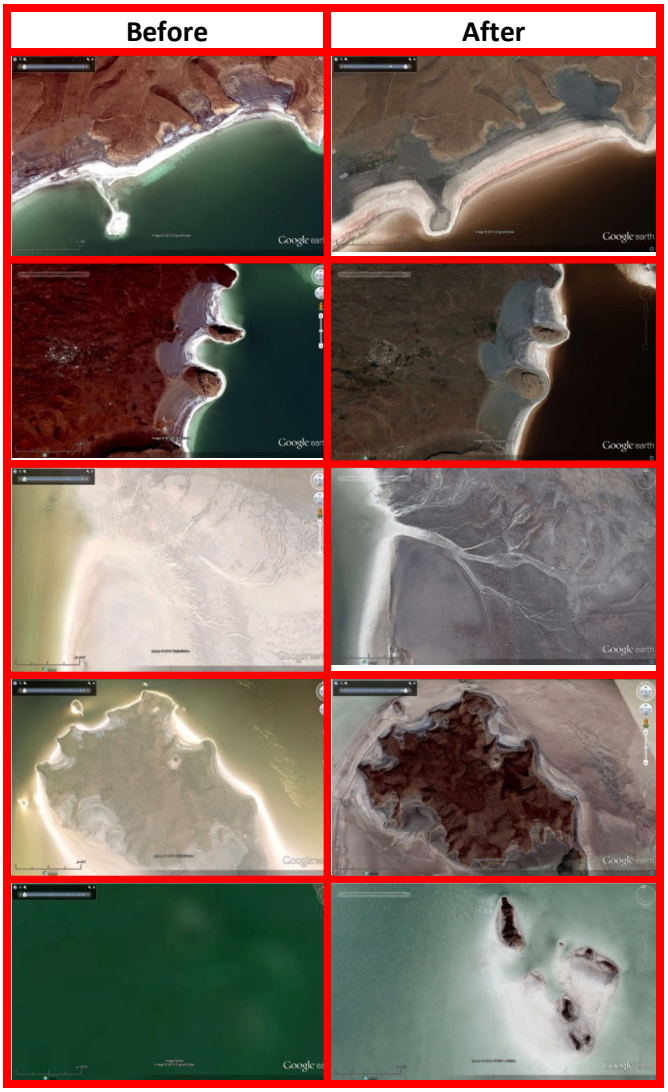

Fig. 4 The conditions of some of geomorphosites around Urmia lake before and after of environmental changes in two recent decades

It was found to have decreased in lake area by about 93 % in two recent decades. These variations are not only driving significant changes in the morphology and ecology of the present lake landscape, but at the same time are shaping newly formed morphologies, which vanished some valuable geomorphosites or develop into smaller geomorphosites with significant value from a scientific and cultural point of view (Fig. 1).

V. Discussion and Conclusions

The retreat of lake waters and the disappearance of the geomorphosites linked to its presence are occurring together with the genesis of new, smaller geomorphosites, which in turn trigger a new complex landscape system. Areas where in the recent past the main shaping and driving factors were environmental changes are now subject to the action of saltation, rill and gully erosion, eolian processes. The

scientific value of the newly formed morphologies together with their scenic and aesthetic values, suggest they should be considered as independent geomorphosites. This is particularly true considering the changes affecting the sandy beaches, where the present retreat of the lake waters is generating an saltwater-free, playa flat areas which promotes erosion processes, salt crustification and building of fresh morphologies.

The total loss in geomorphosites area in a half century amounted to a loss of more than 90% of the valuable geomorphosites. Moreover, the comparison between the mean yearly value of coastal area lost over the entire period and the yearly average calculated for the shorter period (1998-2014) clearly indicates a pattern of acceleration. This acceleration in the rate of reduction in lake area was seen in most of the southern half of the lake. In the region as well, the general water-level falling is not only causing the loss of a significant water resource, which is followed by major impact on regional ecosystems, but is also driving the most marked recent (last century) changes in the geotouristic landscapes. In fact, the disappearance of geomorphosites means the loss of tourism phenomenon.

The Urmia lake caosts is therefore becoming an "open air environmental museum of geomorphosite changes" where people can see the effect of environmental and climate change on a hydrological system and on caost landscapes, even in short time frames. Furthermore, when the caostlines of lake have regressed, a major visible impact will occur in the aesthetic value of the caosts. The dynamic sandy and sludgy caosts will turn in to lifeless salt crusts without their medical and aesthetic values. And in addition to these changes impacting on tourism and culture, the lack of water on suitable geomorphosites will also have consequences on the swimming experience. Field observations show unfortunate prospects based on the possibility that salt crusts will rapidly colonise the areas of the lake had regressed. This is an ongoing process on the upper regressed sectors (Fig. 4) but such processes requires longer time frames for completion and it is unlikely that the abandoned beaches will rapidly become a salty landscape with an crusted pattern surrounding some pretty remains of caostal sand, dried sludges, lacustrine terraces.

In reality, It is feared that the developments of the next decades will include the complete disappearance of lake. This already discernable trend may be accompanied by the development of extreme and long-lasting disequilibria in the abiotic as well as the biotic parts of ecosystems and habitats, not only in geomorphosites areas but elsewhere around Urmia Lake. In this context attention must be paid to the question of conservation. The action needed to safeguard geomorphosites includes:

1) Preventive action; monitoring, reporting and mitigation of environmental change effects at a range of levels (local, regional, national and even global).
2) Corrective action; adaptation to the reality of environmental change through global and regional strategies and local management plans.
3) Sharing knowledge; including best practices, research, communication, public and political supports education and training, capacity building, networking, etc.

Accordingly, it should be noted that we are not just part of the landscape of the Urmia Lake, the lake is also part of our landscape.

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