

Research Article

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Thermodynamics Reason for Dying of Urmia Lake, This is not Just an Aral Syndrome!

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Abstract

This research demonstrates some physical factors that have been responsible for the drying up and shrinking of the Urmia Lake. The goal of this paper is to revive the Urmia Lake. The shrinking of the lake has been recognized as crucial by many researchers because of its impact on nature. Constructing a highway, which is one of the physical issues being highlighted, divides the lake into two parts and this is primarily why the lake is drying out.

Keywords: Urmia lake; Iran; Thermodynamics; Evaporation; Urmia bridge

Introduction

Urmia Lake is located in a closed basin between both the West and Eastern Azerbaijan provinces in the north-west of Iran (37°4'-38°17' N and 45°-46°E). The shape of the lake can be seen as a semi-triangle with a maximum length of 135 km and the surface area is between 5000 and 6000 km² [1]. The lake in its current form can be seen in Figure 1. Urmia Lake is one of the most saline lakes, as well as the second largest, in the world and the largest lake on the Iranian Plateau. It is considered as a UNESCO biosphere and a Ramsar wetland because the lake has a unique eco-system [2]. Surface flow, direct rainfall, and groundwater create the majority of the sources for the lake. In the Urmia lake basin, there are twenty-one permanents and thirty-nine episodic rivers. Among the thirteen main rivers, Zarrinerood is the largest river with total annual discharge value of about 2×10^9 m³. Annual inflow into the lake is $4.9\times10^9~\text{m}^3$ of which $6.9\times10^9~\text{m}^3$ comes from rivers, 0.5 $\times 10^9$ m³ from flood water and 1.5×10^9 m³ from precipitation. Before 2000 the average and maximum depth of the lake were 6m and 16m respectively [3,4]. During the Twentieth Century there were some variations in the water level and this is the fault of the variations in temperature and drought. However, in the Twenty-first Century the amount of water rapidly decreased; some recent research suggested the lake may dry up entirely in 2020 [5]. On the other hand in the another research the authors claimed that this is an Aral Syndrome and they have highlighted the demise of Aral Lake which disappeared because of the diversion of water for agriculture from the main rivers which were the main sources of the Aral Lake [6]. This research, initially, deals with the most important factors that caused this disaster. Secondly, it discusses one of the impacts caused, which has created this issue. Finally, the paper will offer a solution for the problem.

Why is the Urmia Lake Dead?

Much research has been carried out looking for the reasons behind the death of the Urmia Lake. This could focus on the irrigation of the lake's basin and the storage of the water behind dams [6,7]. On the one hand, some researchers also see climate change and long periods of droughts as well as irrigation as the main reasons for the drying out of the Urmia Lake [3]. On the other hand, this shrinkage was also discussed as possibly being because of the construction of a bridge on the lake, which connects the two main cities of Tabriz and Urmia. This bridge divides the lake into two parts and has affected the regional ecosystem [8,9]. It is clear that the evaporation of a liquid system strongly depends on temperature [10], and the variation in the temperature is



Figure 1: Urmia Lake in the current form derived from Google map.

obtained by the reputable approximate relationship for the state of a liquid.

$$\Delta T = \frac{Q}{mc} \tag{1}$$

where ΔT is the variation in temperature, Q is is the total heat transfer to the liquid, m is mass and c the specific capacity of heat [11]. The equation 1 shows when a mass of a thermodynamic system is equally divided for a constant transferring heat and one should expect a double increasing in the temperature. A combined equation to calculate evaporation was introduced by Penman [12].

$$\delta E = \frac{\ddot{A}(R_n - Q_t) + \gamma E_a}{\ddot{A} + \gamma}$$
(2)

where λE is the latent heat of evaporation in MJm-2t-1, λ is a psychrometric constant in kPa0C-1, Δ is the slope of saturation

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Figure 2: Changes in area of Lake Urmia from October 1972 to August 2014, derived from LandSat imagery [6].



vapor pressure curve at temperature Ta in kPa0c-1, (Rn-Qt) is the net radiation minus the change in energy storage in MJm-2t-1, and Ea is a bulk aerodynamics expression in MJm-2t-1containing an empirical wind function

$$E_{a} = 6.43(a_{w} + b_{w}u_{z})(e_{z}^{0} - e_{z})$$

Where a_w and b_w are empirical wind function coefficients, u_z is wind speed at the z-height in m/s, \mathbf{e}_z^0 is the saturation vapor pressure and e_z is the actual vapor pressure at height z.

In the equation 2 E strongly and straightly trusts to the temperature and the temperature and the evaporation are correlated.

Figure 2 shows the variation in the area of Urmia Lake from October 1972 to August 2014. After 2000, a catastrophic decrease took

place in the rea of the lake, especially in the southern part where the vanishing process is completed but in the north there are still some signs of life. Figure 3 graphically shows this variation in both area and volume of the lake by years. It can be seen that the disaster has continued since 2000, when the construction of the famous bridge on the lake started. The lower depth and greater surface area of the south part saw the inflow decreasing because irrigation was beginning to completely dry the lake [13,14].

Conclusion

The paper has explained why Urmia Lake has dried up. Most of the research seems to have forgotten that the lake has been two different lakes since 2008. The irrigation and the construction of dams in the basin's lakes are responsible for decreasing the amount of water in the lake [14], but catastrophic decreasing began in 2001 when the bridge construction came to an end. This construction has been responsible for dramatically increasing the evaporation of the water in the lake. The best solution to reviving the lake is to demolish the bridge and to find an alternative way to connect the two cities. Although, this costs more money, the bridge demolition would protect the lake.

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