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A Conceptual Analysis of Retrogression of Uromie Lake and Progression of Plant Species

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Abstract

The importance of Uromie Lake National park and Biosphere Reserve associated with is known worldwide; and thus, maintaining its optimized well-being and values are on the priority list of preserving, rehabilitation and ecologic management programs. Plants, as primary producers of the greater Uromie Lake ecosystem, despite their greater diversity have covered much lesser areas primarily because of climate change and disturbing human activities. Natural phenomena have caused for the Uromie Lake to retrogress and dry out in many areas, leaving bare lands behind, providing the opportunity for farmers to grasp more land for farming practices and in some areas, natural populations of halophyte plants pioneer. We do not know, how much of the plant success is because of natural processes, such as plant symbiosis, and thus, acquires further investigation. In this paper, results of a preliminary survey on soil and frequent plant species communities are presented, probable natural causes contributing to retrogression of Uromie Lake and potentials of using plant pollen and fungal spores records for determining past lake behavior are discussed.

Keywords: *Uromie Lake, Lake retrogression, Climate change, Plant succession, Halophytes*

1. Introduction

It is commonly known where global warming causes change in climate regime, changes in ecosystem attributes and biodiversity is not only expected but in many instances it is unavoidable. Climate changes and discourse has taken place many times over in the history of earth, and even in time spans of couple of hundred years plant communities and even ecosystems have been often disturbed and replaced with other plant and biota species. It is expected with increasing effects of global warming such disturbance cause species replacement, community succession and extinction of species and diminishing of ecosystems in extreme instances of temperature shifts (Peters, 1992).

In reviewing the literature on the effects of global warming on the biosphere, it is quite common to find publications about changes in species dispersion and patterns of succession, both altitudinal and latitudinal, but fewer articles cover diminishing of ecosystems such as wetlands and inland lakes, a case in point, Uromie Lake in northwestern Iran which is diminishing faster than ever before.

Historical studies on the Uromie Lake are scarce,

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however, it is possible to find records of temperature changes for the past half a century and deduct from that the recent climate patterns in the region. Further, studies on the pollen records (Webb, 1992) of deeper sediment layers of the lake and or possibly deeper glaciers in Sahand and Sabalan peaks might reveal the climatic and ecologic history of the past 10,000-30,000 years.

According to Webb (1992), over the past million years, three noticeable events of glacial and interglacial oscillation in climate pattern has taken place, with glacial periods coinciding roughly with periodicity of earth's eccentricity pattern, i.e. 100,000 years. During the past 150,000 years, the last interglacial period with temperatures warmer (2±1 °C) than present took place between 130,000 to 120,000 years ago, followed by a full-glacial period occurring 23,000 to 13,000 ago; the present interglacial period began about 10,000 years ago (Webb, 1992). In the context of earth's natural fluctuations of temperature because of grand variations in global climate, aspects of retrogression of Uromieh Lake ecosystem and progression of plant communities needs to be examined closely with paleoecological aspirations.

2. Materials and Methods

Uromia Lake is located within 37° 5′ to 38° 46′ N latitude and 45° 6′ to 45° 54′ E longitude. It used to occupy 225,800 h including its salt marshes. Soil samples were collected from 11 stations along the western shores of the lake and plant communities surveyed in randomly selected plots. In each station, 3 plots of 10x10 m 50 m apart were sampled for soil using a 10 cm diam. stainless steel pipe at 30 cm depth and ecological data of plant species were recorded on survey sheets and plant specimens collected and numbered. Few specimens were pressed for later identification and other specimens were transferred to the lab for biochemical analysis.

Table 1. Geographical coordinates of Sampling Stations along the Uromia Lake

Station no.	N latitude	E longitude
1	37 44 22.82	45 15 20.83
2	37 37 28.85	45 15 23.64
3	37 30 25.57	45 15 25.76
4	37 20 49.16	45 17 34.16
5	37 16 38.76	45 18 44 .96
6	37 11 20.01	45 22 35.50
7	37 08 05.71	45 26 31.86
8	37 06 22.29	45 29 12.64
9	37 53 42.16	45 02 43.98
10	38 00 00.36	45 05 05.46
11	38 03 17.2	45 11 45.67

2.1. Soil Analysis

pH and EC of soil samples were determined from saturated soil solution. XRF elemental analysis of soil samples was carried out at Faculty of Sciences X-Ray laboratories using the standard procedure in which samples are first, burnt into ash in an 1100 °C oven, and then pressed into a tablet ready for XRF analysis (Table 2).

3. Results

Soil pH of the stations was alkaline and ranged between7.8 to 8.7 with an average of 8.2. Electric conductivity (Ec) of saturated soil ranged between 0.75 to 1.31 ds/m with an average of 1.12 ds/m. Distribution of elements in sediments of Uromie Lake indicated presence of oxides of 14 elements (Table 2). Except for Ti and Zr, all elements occurred in all stations. Among elements, Na, K, P, Fe and Al were present in greater quantities followed by Ca and Mg (Table 2). Ti was detected in one station and Zr in 5 stations (Table 2).

Survey of plant communities indicated the greatest abundance of plant species were Chenopodiaceae and Poaceae with frequent genera of Salicornia, Suaeda and Salsola and associated species of genera, such as Tamarix, Alhaji, Cynodon, Cyperus and Fragmites (Table 3).

Table 2. Soil pH, EC and element contents (gram atomic weight/kg) of Uromie Lake

St No	pH	EC ds/m	Cl	P	S	I	Na	K	Ca	Mg	Si	Fe	Al	Sr	Sn	Zr	Ti
1	7.8	0.87	0.38	91.7	84.0	1.26	15.5	51.1	0.96	14.8	1.1	15.9	4.96	0.03	0.24	0.0	0.0
2	8.7	1.31	0.98	127.6	116.9		21.3	42.5	1.27	18.4	0.9	122.8	4.4	0.22	0.08	0.02	0.57
3	7.8	0.75	0.36	92.7	84.9		15.8	46.	1.1	12.8	1.0	179.5	5.0	0.25	0.09	0.02	
4	8.2	1.02	0.26	32.2	26.0		14.6	76.4	0.59	13.4	1.4	16.8	6.4	0.28	0.08	0.0	
5	8.3	1.05	2.22	133.1	111.9		31.7	45.3	0.43	26.1	1.1	129.62	6.0	0.33	0.20	0.03	
6	7.9	0.76	0.31	57.8	52.91		16.9	6.7	14.3	15.5	1.4	19.2	6.9	0.2	0.1	0.02	0.43
7	8.2	0.88	0.86	62.0	56.8		31.1	48.4	0.79	24.3	1.0	170.7	6.1	0.26	0.08	0.03	0.30
8	8.1	0.89	0.22	62.9	57.6		15.7	111.1	0.36	21.8	2.3	50.3	13.9	0.1	0.12	0.02	
9	8.1	0.94	0.48	360.8	330.6		78.2	13.0	10.8	14.1	1.0	9.0	3.5	0.08	0.0	0.0	0.58
10	8.4	1.12	0.57	18.4	16.8		20.9	39.7	0.4	26.7	1.2	48.2	8.2	0.07	0.18	0.04	
11	8.2	0.95	2.17	635	58.2		29.0	45.5	0.5	25.5	1.0	81.4	4.6	0.20	0.09	0.03	0.75
Average	8.15	0.96	0.8	152.2	90.6	1.26	26.43	47.79	2.86	19.40	1.22	76.67	6.36	0.18	011	0.02	0.44

*All values are average of 3 subsamples from each station based on atomic weight of each element from percent Oxide form of each element.

Table 3. Ecological characteristics of frequenting plant species in Uromia Lake coastal plant communities

St. No	*Salicornia* sp.					*Saueda europea*					*Salsola* sp.					*Juncus* sp.					Other species present
	A	D	H	R	C	A	D	H	R	C	A	D	H	R	C	A	D	H	R	C	
1	249	15.6	37.7	17.9	60	175	10.9	64	13.5	40											
2	247	15.4	27.1	18.1	45	215	13.1	91.1	17.9	20											Spergularia Sp.
3						11	10.7	60	505	15	227	19.33	26.1	19.9	85						
4	262	14.3	29.4	18.5	69	67	4.2	36.4	22.1	25	23	1.5	25	27	6						
5																9	1.1	76	66	35	Alhagi Sp., Spergularia Sp.
6	218	13.7	27.6	17.6	63	93	5.8	33.7	17.8	27						1	8	90	80	6	Cynodon Sp.,
7	153	14	17.9	11.8	21	67	5.6	29.3	17.2	26						1.5	0.2	90	80	9	Cyperus Spp., Fragmites Sp.
8	163	12.5	30	19.4	72											6	0.4	78	63	26	Cynodon Sp.,
9	22	0.9	32.2	24	9																Tamarix sp.
10	207	12.9	16.5	13	55	74	4.9	21.4	15.2	27											Cyperus Spp.
11	3	0.29	27	15	16	2	7	0.4	20	2	2	0.12	25	40	5						Reamuria Sp.
Average	169.33	27.27	11.07	17.26	45.56	88.00	7.78	42.04	78.59	22.75	84	19.00	6.98	25.73	28.97			83.5	72.25	19.00	

A= Presence and Abundance; D=Density^{-1}; H=Height in cm; R=Diameter in cm; C=% area coverage

4. Discussion

A review of literature on the diversity and distribution of plant communities in greater Uromie Lake ecological realm indicates establishing of plant communities along the gradient of water quality and salinity. For example, Khara and Zare-maivan (2005) and Khara (2004) have indicated about 230 species of plants around and on islands of the lake ecosystem. A general overlook of plant populations indicated that with increasing distance from lake shore distribution of halophytes decreased and glycophytes increased. Majority of species are listed among Irano-Touranian elements with species introduced from Euro-Siberian realm. The distribution of species is correlated with soil salinity, particularly on the surface, which affects soil texture and accessibility for root growth negatively. Furthermore, the salinity inserts a sort of physiological drought stress, causing plants to be shrubby and woody in texture (Table 2). This observation changes with increasing distance from the lake area and plant community composition differs accordingly, for example, at about 50-75 km from Lake's margin. Furthermore, percentage of plant coverage area differed among stations and this was dependent on the density of plant cover as well as plant height (Table 3). Usually under natural circumstances, a light distribution profile is formed in the ecosystem. However, in the study area such profile did not form in plant communities primarily because of shorter plants and smaller canopy (Table 3). Such ecosystem characteristics enhance irradiation on the ground and heats soil. Soil is heated faster and greater when metals, such as Fe and Al and salt are abundant despite some reflection of light occurring because of salt crystals.

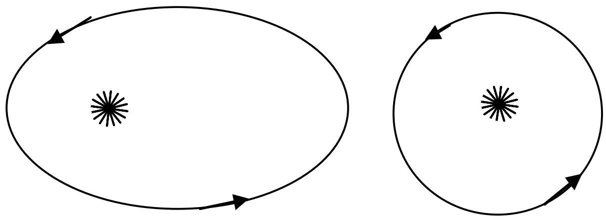
Geological survey and sedimentological study of the greater Uromie Lake, particularly towards southeast and eastern plains, would reveal paleoecolgy of the region at least for the past 5-10,000 years, coinciding with the recent interglacial period and orbital movements of the earth. In a further observation, glacial and interglacial references at least for two periods as far 36ON. latitude as around Tehran, Iran about 13,000 and 18,000 years ago. It is quite evident that territories of this part, including Uromie Lake, of the northern hemisphere have experienced both glacial episodes of the Permian era and uprising of the earth's crust as a result of volcanic activities of Damavand and Sahand and Sabalan Peaks, respectively and plate tectonics of the Iran's Plate. Remnats and signs of such glacier activities are shown in Figures 1 and 2 around 35.3o N. latitude in Karaj, Iran. In this context, it is postulated that Uromie Lake retrogression started some 10,000 years ago, but more rapidly in the past 5,000 years as angle of tilt moved towards 23.5°. This postulation merits further comprehensive investigation, both sedimentologically and ecologically.

Fig. 1: Glacial erosion bed in Khozankola valley in Dizin watershed area ,Iran photo actual size

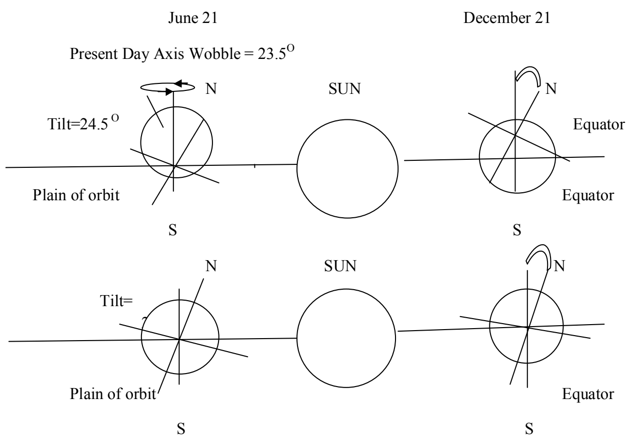
Fig. 2: Glacial Erosion lines on different layers indicating different time spans in upper altitude of Khozankola valley , photo actual size

Imbre and Imbre (1979) and Mc Dowell, et al. (1991) have stated that obliquity, eccentricity and precession of the equinoxes cause variations in climate in different periodicities. For example, earth's orbit around sun is eccentric and it changes between almost elliptical to almost circular every 100,000 years (Fig. 3A) or the earth's axis is oblique and is tilted between 21.5° to 24.5° (with an average of 23° approximately in every 21000 years) against the plain of the orbit in equator every 41,000 years. Although, these two long-term orbital rhythms do not alter the overall radiation input into the earth's atmosphere, the affect the distribution of energy in time and space in each hemisphere of the earth and hence, influence the scope and severity of seasonal temperature fluctuations, particularly in northern hemisphere where greater land mass exist. Severity or moderation in seasonality in the earth's hemispheres is influenced by the precession of equinoxes in which, the precession of earth within its elliptical orbit changes the time of year when the earth is near or far from the sun with a periodicity of 21,000 years. At present, the earth's angle of tilt is about 23.5° (Fig. 3B), which is moderate compared to 24.5, and as such the climate is moderate, but tending to get warmer depending on the overlap and simultaneous coincidence of tilt and precession which can counteract or reinforce each other. Furthermore, at present, the earth is closer to sun on January 4th (perihelion) and the farthest on July 4th (aphelion) but 11,000 years ago, perihelion and aphelion were in June and December, respectively (a reversal of present condition) (Fig. 3C).

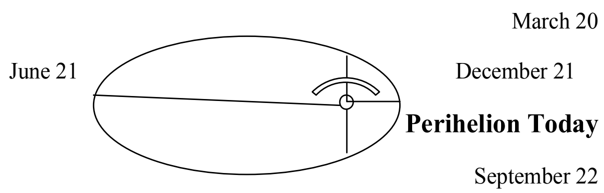
A. Eccentricity of the orbit changing every 100,000 years between almost elliptical to almost circular

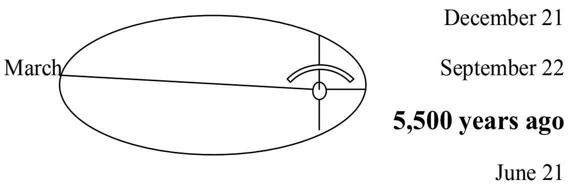


B. Obliquity of the Earth's Axis tilting between 24.5O and 21.5 O with an average of 23 O every 41,000 years (hitting average approximately every 21,500 years)



C. Precession of the Equinoxes with periodicity of approximately every 21,000 years





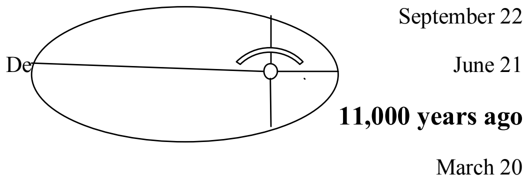


Fig. 3: Periodic orbital factors affecting climate change on earth (Adapted from Peters and Lovejoy, 1992)

Similarly, present equinoxes are March 20th and September 22nd in the northern hemisphere with winter and summer solstices in December 21 and June 21, respectively. However, 11,000 years ago, the reverse of this condition prevailed. In this way, northern and southern hemispheres react inversely to orbital patterns and experience relatively different conditions depending whether they are closer or farther from sun and the load of radiation they receive from sun.

Khara and Zare-maivan (2005) indicated extensive distribution of many glycophytes and halophytes species as well as prevalence of arbuscular mycorrhizal fungal (AMF) spores in the soil and marginal sediments of the Uromie National Park ecosystem. Further, studies on the pollen records (Webb, 1992) of deeper sediment layers of the lake and of AMF spores records and appropriate sediment dating would reveal natural history, paleoclimate and past behavior of the Uromiae Lake.

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