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An Ecological study of some characteristics of water column in Derbendikhan Reservoir

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Abstract

Vertical profile from (surface to 21 meters) of Derbendikhan reservoir were focused for 4 sites (**Zimkan, Tanjero, Arawan and Qashtee**) and 7 days(1st to 7th March 2010).Daily water samples were analyzed in every meter depth for parameters of (Air andWater Temperatures, pH, EC, DO, Turbidity, PO^{-3}_4, NO^-_2, NO^-_3, and Chlorophyll a) Results showed that there were a significant differences for different parameters among sites under study.

From the direct measurement in the field during the sampling periods at each site, air temperature was ranged between (17.8 - 19.0 Cº) for sites 2 and 3 as a minimum and maximum respectively and there was a significant differences between sites 2 and 3 as compare with other sites this may be due to the location, elevation and altitude. While the water temperature was ranged from (13.6 -15.5 Cº) at sites 4 and 2 respectively ,in fact this site is more open with motorboats movement in addition to the discharge of water from the dam. Statistical analysis shows that surface water temperature was significantly differ from the depths($p< 0.5$) for sites 1, 2, and 3 this may be due to many environmental factors such as elevation, current velocity, water depth, bottom materials exposure to direct sun light and degree of shading or vegetation cover, evapotranspiration and wind speed.

pH was on alkaline sides of the neutrality (8.2-8.3) for studied sites and the significant differences ($p< 0.5$) was between sites 1, 2 with 3, 4. while for the differences in depth, EC of the studied sites and different depths revealed that there was no significant differences in the water column, because EC is indirectly depend on the climate, temperature, soil erosion, geological formation and directly on ion content. some parameters were decreased with increasing depth such as

DO were the mean concentration was about 17 mg l^{-1} in the surface for most of sites, but this value was dropped to about less than 10 mg l^{-1}, mean concentration of DO in site 1 was decreased from 3 mgl^{-1} down to the reservoir, because it contain sewage water come from Sulaimani city.
Generally, results of Turbidity in site 2 was ranged from (5.67 – 12.05) NTU in both sites 3 and 4. Mean PO^{-3}_4 concentration of the studied sites were ranged from (7.11-14.79)µg at-P l^{-1} in sites 3 and 1 in respective. NO_2 was ranged from (31.78 -93.24) µg at-N $^{l-}$ at sites 1and 2 with the significant differences among studied sites($p< 0.5$), generally, the higher concentration was occurred in site 2., NO_3 was ranged from (82.06-185.04µg at-Nl^{l-}) for sites 4 and 2, recorded values for chlorophyll a were (11.12µg at -ch-a l $^{l-}$) in site 1 and (78.52µg at -ch-a. l $^{l-}$) in site 2, and both sites of 1, 2 are significantly differ from other sites.

Turbidity, PO^{-3}_4, NO^-_2, NO^-_3, and chlorophyll a with different depths revealed that there were no significant differences of the water column.

Key words: Derbendikhan reservoir, water column, physicaland chemical properties

1- Introduction:

Basic water quality parameters should be monitored to provide a record of environmental conditions at the time of sampling and to provide information used in assessing the condition of benthic assemblage, and understanding ecosystem processes. Water quality parameters should be measured at the same time of biological sampling (APHA,2005). Domestic waste water contains substantial quantities of metals. The prevalence of heavy metals in domestic formulations, such as cosmetic or cleansing agents, are frequently overlooked. On the other hand, agricultural discharge contains residual of pesticides and fertilizers, which contains metals (Sofi, 2008; Rasheed 2008). Increased use of lakes for, fishing, irrigation and hydroelectric power generation has emphasized the need of intensive water quality studies and management. (Odum, 1971). The changes in abundance and composition experienced by phytoplankton communities in lakes and reservoirs occur in response to variations in the physical (light climate or energy) and the chemical (nutrient availability or resources) constraints for algal growth (Hoyer *et al.*, 2009)

Reservoirs are increasingly used for recreational purposes. In this respect, the pollution levels of these lakes may pose a risk to human health. During recreational activities, human exposure may occur via three different pathways: ingestion, inhalation, and dermal contact. Human exposure through dermal contact includes direct contact of the skin with contaminated sediments, with riverbank soils, and with water, exposure through ingestion occurs through contaminated sediment, surface water during swimming, and via consumption of fish (Bockting *et al*., 1996). Air temperature is the most important factor affecting on the distribution and abundance of organisms in nature (Kemmer, 1988). In thermally stratified lakes Hydrogen ion concentration plays an important role in many of biological process and even on the water quality assessment variables, (Wahby *etal.* , 1978).

The goal for this study is to evaluate some parameters in water column of the reservoir in order to get some information about the daily changes occurred from the surface toward the depth.

2- Literature review

The studies concerning Kurdistan lakes in Northern Iraq were few, Dokan reservoir was studied by Al-Hamed (1976), Shaban, (1980), also produced a comprehensive study on this lake. Chemical and Bacteriological study on some commercially fish in Dokan Lake a research of two parts was studied by Al-Aswad *et al*. (1980). Toma (2000) was studied the same lake. While Derbendikhan reservoir was first studied by Zdanowski *etal.* (2001), then Rasheed (2008) carried out her PhD study on the same reservoir .Quantitative reconstruction of lake conductivity in the Quaternary of the Near East (Israel) using ostracods was done by Mischke *etal.* (2009). Determination of the origin of the waters of Köyce iz Lake, Turkey was studied by Bayaria *etal.* (1999) .Linking Watershed and Reservoir Models other study was carried out by (White *etal.* (2004). Spatial and Seasonal Variations in Chlorophyll-Nutrient Relationships in The Shallow Hypertrophic Lake Manyas, Turkey (Kemal 2006).

3- Description of the area

Derbendikhan reservoir is located on the south east of Sulaimani 35° 6' 35" N, 45° 41' 20" E, and it is the second largest reservoir in the Iraqi Kurdistan region at an altitude of about 485 m above sea level. This reservoir was founded when the dam was constructed in 1956-1961 by Harza Company (Anon, 2006). The area of this water reservoir is roughly about 114.30 km^2 (Al-Sahaf, 1976; Lehner and Doll, 2004) with the maximum depth of 75.0 m, while the Mean depth is (14.8-24.9) m. The estimated volume of the Derbendikhan reservoir ranges from 1.3-1.4 km^3. Both maximum length and maximum width are 45km and 20 km respectively (Anon, 2006). The catchment area is about 17, 850 km^2 (Lehner and Doll, 2004). Design inflow is 18, 700 m^3/s rated discharge is 3 × 113 m^3/s (Anon, 2006). The annual water exchange in the reservoirs is rather low, hence it is clearly stratified, and regards thermal and oxygen conditions. Consequently Derbendikhan can be classified as limnetic water body; as warm and monomictic with only one circulation period in winter and a water temperature that never falls below 4 Cº, (Szczerbowski *etal*. ,2001).The main water reservoir of Derbendikhan dam is located on the Diyala Sirwan river approximately 65 km south-east of Sulaimani. The main structure is a 128 m high dam with a central clay core and rock fill shoulders. The crest length of the dam is 445 m. The climate of the area is Irano - Turanion type, characterized by three seasons: A cold winter, mild growing period of spring and hot- dry summer (Hutchinson, 1966 and Guest, 1966). Mean annual precipitation of(635–700) mm; occur in winter and early spring. The wet seasons extends from October to April, while the hotest months are July and August. Air temperature varies widely from winter to summer. The studied sites were shown in fig.(1) with coordinates in table (1).

Table (1): Shows coordinates of Sites

Sites	Coordinates (North (N) and East(E)
Site (1): Tangi Saed Muhammed	"40.60'7 ° 35N - 45°50'30.87"E
Site (2): Tanjero	"30.56'10°35N - 45°48'5.90"E
Site (3): Arawan	"7.54'9 °35N - 45°47'43.80"E
Site (4): Qashtee	"41.51'7 °35N - 45°43'35.62"E

Fig. (1): Map shows the studied sites, (Google earth, 2010)

4--Materials and Methods:

In the present study within Derbendikhan reservoir, four sites were selected for determining certain physic-chemical properties for the water column. During the period of one week from(1st to7th) in March 2010, daily sampling was carried out using polyethylene bottles which are washed with distilled water then rinsed at least twice with the sample according to(APHA, 2005).

Water samples from different vertical-profiles were collected from surface to the depth of 21 meters using a 4 liter Van Dorn sampler (Hydro-Bios Apparatus ebau Gmbh, 23 KIEL Holten AU.W. Germany). Air and water temperature were measured in the field using simple mercury thermometer with scale marked from 0 Cº to 100 Cº graduated to 0.1 Cº.Water pH of the samples was recorded by using a pH meter model TPS90FL-T field lab analyzer after the calibration was conducted by using standard pH buffers of 4, 7, and 9. (Brown, 1976).Electrical conductivity and TDS were determined using the multi meter model TPS90FL-T Field Lab Analyzer for recording in (µS cm-1), after temperature correction of samples, Turbidity was recorded using turbidity meter model TPS90FL-T Field Lab Analyzer, the results were expressed as nephelometric turbidity unit, (Golterman, 1975).

Dissolved Oxygen was determined in the field by using the oxygen meter model TPS90FL-T. Field Lab Analyzer, nutrients (PO^{-3}_4, NO^-_2 and NO^-_3) with chlorophyll a were determined according to(APHA 2005).The results were statistically analyzed according to the statistical program (SPSS), Version 15. Collected data were treated with two ways analysis of Variance (ANOVA) .(Duncan) to detect the variation of different variables at sites and sampling period. The mean, Standard Deviation, and the significant differences at the probability1% and5 % of each data were calculated. (Al-Rawi and Abdul Al-Aziz,1985).

5-Result and discussion:

Generally mean of air temperature as shown in table (2) from the direct measurement in the field during the sampling periods at each site, was ranged from about (17.8 to 19.0) Cº for sites 2 and 3 as a minimum and maximum respectively and there was a significant differences between sites 2 and 3 with other sites this may be due to the location, elevation and altitude. While the surface water temperature was ranged from (13.6 -15.5) Cº at sites 4 and 2 respectively. Table (3) shows that site 4 was significantly differing from others ($p < 0.5$) when the mean was 15.55Cº, in fact this site is more open with motorboats movement in addition to the discharge of water from the dam. Statistical analysis shows that surface water temperature was significantly differ from the depths ($p < 0.5$), for sites 1, 2, and 3 this may be due to many environmental factors such as elevation, current velocity, water depth, bottom materials exposure to direct sun light and degree of shading or vegetation cover, and wind speed (Hutchinson, 1957;Bartram and Balance, 1996), while site 4, shows that 4 m depth was significantly differ with all other depths ($p < 0.5$).

pH was on alkaline sides of the neutrality (8.2-8.3) for studied sites(Al-Jaboury *et al*., 1988) and the significant differences ($p < 0.5$) was between sites 1, 2 with 3, 4 (table 4), pH of the sites show that depths are not significantly differ ($p < 0.5$) except of site 2 when at 12m was significantly differ, this may be due to the buffering capacity of the water because of the geological formation, soil and mineral properties of the mountainous areas (Al-Saadi, *et al.*, 1986), alkaline pH value was due to the accumulation of the calcareous eroted soils and consumption of CO_2 through photosynthesis (Al-Lami, *e tal*., 2002).

Electrical Conductivity is the measure of the ability of water to conduct an electrical current and it's highly dependent on the amount of dissolved salts in the water (Goldman andHorne, 1983). Turbidity is measured by quantifying the degree of light traveling through a water column which is scattered by the organic particles and suspended organic included algae, thus the scattered light increased with greater suspended load (Champion and Starks, 2001). Oxygen is regarded as an important parameter in limnological studies, (Cole, 1983) and is one of the most important limiting factors enter the aquatic system through the air-water interface and by the photosynthesis activities of algae and other aquatic plants (Elmaci *et al*., 2007).

Minimum and maximum EC values were from (406.7-420.8 µs cm^{-1}) for sites (2, 3) and1 respectively and there was a significant differences ($p< 0.5$) between sites 2, 3 with each of 1 and 4(table 5), generally the high value of site 1 may be return to the high dissolved ion concentrations. EC of the studied sites and different depths revealed that there was no significant differences in the water column, because EC is indirectly depend on the climate, temperature, soil erosion, geological formation and directly on ion content (Prosser *et al*., 2003).

During the studied period the DO concentration was ranged from 11.3mg l^{-1} in site 4 and 12.8 mg l^{-1} in site 3 as the minimum and maximum mean values, actually site 3 is the middle of the reservoir with the widest and deeper feature so the surface area and the wind movements was the more two factors for increasing the DO concentration.(Shaw *et al.*, 2007) statistical analysis shows significant differences between sites 4, 1 with 2, 3($p< 0.5$) (table 6) as well as there was a significant differences between surface water and the depth of 21 m, and the concentrations were decreased in the deep layers of the water these results were coincided the fact that DO concentration is affecting by salinity, altitude and temperature, as well as the main source of DO in water is by contact to the direct air (Odum 1971).Site 2 shows that significant differences were between depths and surface water, really mean concentration of DO was decreased from 3 m down to the reservoir, because this site is contain sewage water come from Sulaimani city.

Turbidity in water sample was ranged from (5.67 – 12.05) NTU in both sites 3 and 4 and show that these values are over the range, and the same results was concluded by Rasheed (2008). According to WHO(1996) the acceptable level of turbidity in drinking water should be less than 5NTU the significant differences ($p< 0.5$) was for each of sites 2, 3 with 1 and 4 (table 7) .

Nutrient inputs to lakes, estuaries, and oceans from streams draining disturbed watersheds are often accompanied by high turbidity, which results in light limitation of algal production, particularly at high river flows, and in most estuaries Many rivers and estuaries with high concentrations of N and P do not develop high algal biomass because deep mixing in a turbid water column prevents adequate exposure to light for photosynthesis (Cole 1983). These turbid aquatic systems eventually deliver their plant nutrients to lake or coastal waters where there is sufficient light available in the water column, and the plant nutrients are consumed until one or more are depleted from surface waters. Thomas *et al*., (2001). Generally, PO_4 concentration in the studied sites was from (7.11-14.79) µg at-P l^{-1} in sites 3 and 1in respective, this may be due to the effluents came from Iran as well as the erosion of the soil and rock types, and site 3 was significantly differ from other sites($p< 0.5$) (table 8).On the other hand, NO_2 concentration was ranged from(31.78 -93.24) µg at-N l^{-} of sites 1and 2 with the significant differences among studied sites($p< 0.5$) (table, 9) generally, the higher concentration was occurred in site 2, because of the enrichment of organic compounds as well as fertilizers and other pollutants from sewage water of Tanjero wild enters to this reservoir through this site (Kamees, 1979).

Nitrite is an indicator of pollution in water when present in concentration more than 1 mg l^{-1} USEPA(2006), on the other hand, NO_3 concentration was ranged from (82.06-185.04)µg at-N $^{l-}$ for sites 4 and 2, Nitrate level is affected by irrigation, precipitation rate and in filtration rate, also depending on the site, fertilized soil and manure from farm livestock, furthermore, the major problem is shallow aquifer in rural area, oxygen can diffuse in to system aquifer confining condition, with present a suitable temperature may all NH_3 converted by microbial activity to NO_3 (Jun *et al*. 2005) .On the other hand, motorboat exhaust contributed about 1% up to 5% of the total nitrogen loading to the lake. (Asplund, 2000).The significant differences for site 2 with others($p< 0.5$) are shown in (table 10), recorded values for chlorophyll a were 11.12µg at -ch-a l $^{l-}$ in site 1 and 78.52µg at -ch-a. l $^{l-}$ in site 2 in real, these values are coincided with Rasheed (2008) and both sites of 1, 2 are significantly differ from other sites(table 11). Turbidity, PO_4, NO_2, NO_3, and chlorophyll a in different depths revealed that there were no significant differences of the water column.

6-Conclusions and Suggestion

1-Tanjero(site 2), is a main source of organic pollution, it's a main sewage duct of Sulaimani. It is significantly differ from other sites for most of the studied parameters.

2-There is no significant differences among different depths under study for most studied parameters, so more studies must be carried out for depths more than 21 m, as well as including more other parameters e.g. biotic and a biotic factors.

3- Monitoring this reservoir either seasonally or even monthly because of the importance of this reservoir in many purposes such as irrigation, fisheries, as well as the power supply in addition to the fact that this reservoir is a source of drinking water in the area, and treatment of the sewage before its discharge into the reservoir, by building the waste water treatment plant.

Table (2) Statistical analysis of air temperature(C^o)for the studied sites.

Sites	N	Subset for alpha = .05		
		1	2	3
2.00	176	17.8773		
1.00	176		18.380	
4.00	176		18.494	
3.00	176			19.05
Sig		1.000	.637	1.00

able(3):Statistical analysis for Water temperature (C ^{o}) for different site

Sites	N	Subset for alpha = .05	
		2	3
1.00	176	13.6307	
2.00	176	13.6881	
3.00	176	13.6881	
4.00	176		15.5551
Sig		.928	1.000

Table(4):Statistical analysis for pH of different sites

Sites	N	Subset for alpha = .05	
		1	2
4.00	176	8.2655	
3.00	176	8.2838	
2.00	176		8.3663
1.00	176		8.3874
Sig		.231	.168

Table(5):Statistical analysis for EC(µS cm^{-1})

Sites	N	Subset for alpha = .05	
		1	2
2.00	176	406.7500	
3.00	176	406.7500	
4.00	176		420.5114
1.00	176		420.8125
Sig		1.000	.902

Table(6) The statistical analysis of DO concentration(mgl^{-1})

Sites	N	set for alpha = .05	
		1	2
4.000	176	11.3239	
1.000	176	11.6810	
2.000	176		12.5288
3.000	176		12.838
Sig		.370	.437

Table(7):Statistical analysis for Turbidity (NTU) for the studied sites

Sites	N	Subset for alpha = .05		
		1	2	3
3.00	176	5.6780		
2.00	176	7.0171		
1.00	176			
4.00	176		12.0556	12.0556
Sig		.273	1.000	1.000

Table(8):Statistical analysis for PO_4conc.(μg at-P l^{-1})

Sites	N	Subset for alpha = .05	
		1	2
4.000	176	7.1189	
1.000	176		12.3557
2.000	176		14.4516
3.000	176		14.7988
Sig		1.000	.188

Table(9):Statistical analysis for NO_2 conc.(μg-at-Nl^{-1})

Sites	N	Subset for alpha = .05			
		1	2	3	4
1.00	176	31.7823			
4.00	176		44.4123		
3.00	176			53.1949	
2.00	176				93.2421
Sig		1.000	1.000	1.000	1.000

Table(10):Statistical analysis for NO_3 conc. (µg-at-Nl^{-1})

Sites	N	Subset for alpha = .05		
		1	2	3
4.00	176	82.0612		
3.00	176	92.9725		
1.00	176		161.0036	
2.00	176			185.0477
Sig		.259	1.000	1.000

Table(11):Statistical analysis for chlorophyll (µg-at-chl.-a l^{-1})

Sites	N	Subset for alpha = .05		
		1	2	3
1.00	176	11.1235		
4.00	176	21.8435	21.8435	
3.00	176		27.4174	
2.00	176			78.5284
Sig		.058	.323	1.000

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الخلاصة

تم دراسة عمود الماء لغاية من السطح ولعمق 21 متر ولمدة سبعة ايام في مستودع دربنديخان المائي.وقد تم التركيز على اربع محطات هي (زمكان ، تانجرو ، اروان واخيرا منطقة قاشتي).

تم اخذ العينات وتحليلها بنفس اليوم لكل متر عمق من محطات الدراسه، وتم قياس كل من العوامل التاليه (درجة حرارة الهواء والماء، التوصيليه الكهربائيه للماء ، الاس الهايدروجيني ، تراكيز الاوكسجين المذاب ، العكورة ، الفوسفات ، النتريت ، النترات ، وصبغة الكلوروفيل أ).

اظهرت النتائج بوجود فروقات معنويه واضحه للعوامل البيئيه المختلفه خلال فترة الدراسه.

من النتائج المباشره في الحقل لدرجة حرارة الهواء تراوحت بين (17.8 C° - 19.0) للمحطات 2 and 3 لاقل واعلى درجة حراريه على التوالي . وهذه المحطتين قد اضهرت اختلافا واضحا ايضا مع المحطات الاخرى ويعود ذلك لاختلاف الموقع وارتفاعها عن مستوى سطح البحر. اما درجات حرارة المياه فقد تراوحت في المحطات 4 and 2 بين (13.6 C° -15.5) على التوالي. ويجدر الاشاره الى ان هذه المحطتين تظهر نشاط واضح لحركة الزوارق وكذلك تتاثر بكميات كبيره من المياه المصروفه من السد.

اظهر التحليل الاحصائي بوجود اختلاف واضح بين درجات حرارة مياه السطح ومياه الاعماق ، حيث كانت($P<0.5$) للمحطات 1,2 3and وهذا قد يعود الى عدة عوامل بيئيه مثل ارتفاعها عن مستوى سطح البحر ، سرعة التيارات ، عمق المياه ، سرعة الرياح ، ومقدار التبخر الحاصل في المياه).

كانت المياه وللمحطات جميعا الصفه القاعديه على طول فترة الدراسه حيث تراوحت الاس الهيدروجيني بين (8.2-8.3) وكانت الفروقات المعنويه ($P<0.5$) . اما قيم الاس الهيدروجيني لمياه الاعماق وكذلك الحال بالنسبه لقيم التوصيليه الكهربائيه فلم يسجل اي فروقات معنويه بين الاعماق ، حيث التوصيليه تعتمد بشكل غير مباشر على المناخ في تلك المنطقه ، درجة الحراره ، تأكل التربه والتكوين الجيولوجي.اما العوامل المباشره فتعتمد التوصيليه على المحتوى الايوني بشكل اساسي.

كما لوحظ ان بعض العوامل تقل قيمها كلما اتجهنا الى اسفل عمود المياه في الاعماق ومثال على ذلك تراكيز الاوكسجين المذاب حيث تراوحت قيمه بين 17mg.l-1. في السطح لمعظم المحطات ، بينما اظهرت قيما قليله وصلت الى اقل من $10mg.l^{-1}$ في مياه الاعماق . اظهرت معدلات قيم الاوكسجين المذاب في المحطه الاولى قيما منخفظه تحت عمق 3 متر والى اسف الخزان وذلك بسبب احتواء هذه المياه على مياه الصرف الصحي القادمه من مدينة السليمانيه.

اظهرت نتائج العكوره في المحطه الثانيه تغايرا ملحوظا حيث تراوح بين (12.05-5.67 NTU) وفي كلتا المحطتين4and3. ان معدلات تراكيز الفوسفات للمحطات المدروسه كانت تتراوح بين (7.11-14.79 ug at-p l^{-1}) .للمحطات 1and3 على التوالي . وكانت تراكيز النتريت قد تراوحت بين (l^{-1} 31.78 – 93.24 ug at- N) للمحطتين 1 and 2 وبفارق معنوي واضح للمحطات المدروسه ($P<0.5$) .بشكل عام اعلى التراكيز كانت في المحطه 2 .وكانت تراكيز النترات NO_3 قد (82.06-185.04 ug at Nl^{-1}) للمحطات 4 and 2 .واظهرت قيم الكلوروفيل أ قيما تراوحت بين (ug-at ch-a l^{-} 11.2^{1}) في المحطه الاولى واما المحطه الثانيه فقد كانت القيم (78.52ug at- ch-al^{-1}.) اما كلا المحطتين 1 and 2 فقد اظهرا بشكل واضح اختلافهما عن بقية المحطات .

ان قيم العكوره ،الفوسفات ، النتريت ، النترات وكلوروفيل أ لم تظهر اي فروقات معنويه مع العمق في جميع محطات الدراسة.