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WATER QUALITY PARAMETERS IN TERMINAL PART OF GORGANROUD RIVER (IRAN) DURING 2009-2010

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The present study was designed to demonstrate the seasonal variations in physical-chemical parameters in a part of River Gorganroud water for a period of twelve months from April 2009 to March 2010. Water samples were collected on monthly basis and analyzed for estimation of dissolved oxygen, pH, temperature, BOD_5, COD and electrical conductivity. These parameters were compared to water quality standards to indicate probable pollution in the river Gorganroud. The overall water quality of the study site remained within the safe limits throughout the study period. An attempt has been made to explain the effect of seasonal changes on physical-chemical characteristics in a part of river Gorganroud water.

Seasonal variations – Physical-chemical characteristics – River Gorganroud

2009թ. ապրիլ ամսից մինչև 2010թ.-ի մարտ ամիսը իրականացվել են Գորգանրուդ գետի գետաբերանի ջրի ֆիզիկա-քիմիական ցուցանիշների ուսումնասիրություններ: Ամսեկան կտրվածքով վերցվել են ջրի փորձանմուշներ և հաշվարկվել են լուծ-ված թթվածինը, pH-ը, ջերմաստիճանը, $ԹԿՊ_5$, ԹՔՊ, ջրի մակերևույթի էլեկտրահաղորդականությունը: Գորգանրուդ գետի գետաբերանի աղտոտվածությունը բացահայտելու նպատակով ֆիզիկա-քիմիական ցուցանիշները համադրվել են ջրի որակի նորմերի հետ: Ընդհանուր առմամբ գետի ուսումնասիրված հատվածում հիդրոքիմիական ցուցանիշները չեն գերազանցել թույլատրելի սահմանները: Փորձ է արված բացատրել սեզոնային փոփոխությունների ազդեցությունը Գորգանրուդ գետի ջրի ֆիզիկա-քիմիական ցուցանիշների բնույթի վրա:

Սեզոնային փոփոխություններ - ֆիզիկաքիմիական ցուցանիշներ - Գորգանրուդ գետ

В период с с апреля 2009г. до марта 2010г проводились исследования химических параметров воды р. Горганруд. Ежемесячно проводился отбор проб воды и определение растворенного кислорода, pH, температуры, $БПК_5$, ХПК, электропроводности. В целях выявления вероятного загрязнения р. Горганруд полученные физико-химические показатели были сопоставлены со стандартами качества воды. В целом в исследованной части реки гидрохимические показатели были в пределах допустимого. Сделана попытка объяснить влияние сезонных изменений на физико-химические показатели воды в исследованной части р. Горганруд.

Сезонные изменения – физико-химические показатели – р. Горганруд

The major proportion of all water quality degradation worldwide is due to anthropogenic causes [4]. The degree of pollution depends on the material, the physical nature, chemical nature of the material discharged, water depth and hydrographic conditions [1]. Polluted water can reduce productivity and biodiversity and could contribute to stock decline or lack of fish in some areas [2]. Pollution has negative impact on the quality of fish that reaches the consumer. Water pollution brings external cost to society in general [2].

DO and BOD is used to state the pollution status of aquatic system. Nevertheless, the concentration of DO in water always is a reliable factor to indicate the pollution state of aquatic system [6]. Redox potential (Eh) and Oxidation Reduction Index (rH2) are among the important indicators of pollution state of river.

Demand for oxygen in the system is quantified by BOD_5. Oxygen in eutrophic waters can fluctuate dramatically with diurnal changes in photosynthesis and respiration rates. Often, high oxygen demand results in low levels of dissolved oxygen in nutrient-enriched waters.

When biodegradable organic matter is released into a body of water, microorganisms, especially bacteria, feed on the organic matter, breaking it down into simpler organic and inorganic substances [5]. The total amount of oxygen required to oxidize organic matter suspended in the water column is called the biochemical oxygen demand (BOD).

BOD may come from natural sources like leaf litter fall or from anthropogenic point or nonpoint sources like wastewater treatment plant discharges or agricultural runoff. Detritus (non-living particulate organic matter), whatever its origin, is an important source of BOD. BOD may also be also influenced by incoming water from tributaries. In streams, biochemical oxygen demanding substances can either be suspended in the water column, settle to the bottom, or be re-suspended from the sediment.

COD is the amount of oxygen required for the chemical oxidation of organic or inorganic compounds in water and is usually an important sink of DO in rivers that receive industrial effluents such as iron sulfite and aldehyde, which are readily oxidized [3]. In the presence of DO, oxidation takes place rapidly, so the oxygen demand is observed close to the pollutant source and can be quite significant. COD is generally not an important parameter in rivers or streams that do not receive industrial effluents. Since COD measurements are easier to conduct and often more repeatable than BOD measurements, some regulatory agencies allow measurement of COD as a surrogate for BOD provided that a linear relationship between the two can be developed for the stream in question.

Materials and methods. The present study was carried out for a period of twelve months (April 2009 to March 2010) in the terminal part of river Gorganroud water.

Since Gorganrod is the largest rivers in North-East Caspian Sea, we studied only on ~50 km of it by choosing 5 sampling stations (Figure 1, Table 1). These stations were chosen because lands along stations 1-2 have been using for agriculture and stations 2-5 are near river mouth that are strategic points of young fish release for stock enhancement purposes. The area of investigation was shown in figure 1. Gorganrod River can receive drainage of all flood, waste waters and runoff derived from precipitation of its huge basin; and we investigated the area after Woshmgir dam.

Samples were analyzed to determine temperature, pH, dissolved oxygen (DO), electro conductivity (EC), BOD and COD, using standard methods [7].

Results and Discussion. **Temperature.** Results showed that temperature values were significantly affected by the sessions, not the stations (Table 2). Figure 2 shows temperature fluctuations typically followed the years, where the lowest temperature was related to winter and highest related to summer.

Fig.1. Position of the Gorganrod river and sampling stations.

Table 1. Location of the sampling stations

Station	Distance from estuary	Location
1	49679.16	Agh Ghalla
2	10547.46	Khajenafas
3	6852.22	Chargholi
4	3302.72	Lookout unit
5	0	Estuary

Table 2. Analysis of variance for temperature values in different stations and sessions

Source	DF	SS	MS	F	P
Session	3	8.461	2.86	11.3158	0.003
Error	8	1.994	0.249		
Station	4	0.060	0.015	0.9295	
Session*Station	12	0.28	0.023	1.4550	0.1929
Error	32	0.512	0.016		
Total	59	11.306			

Split-plot design, n=3.

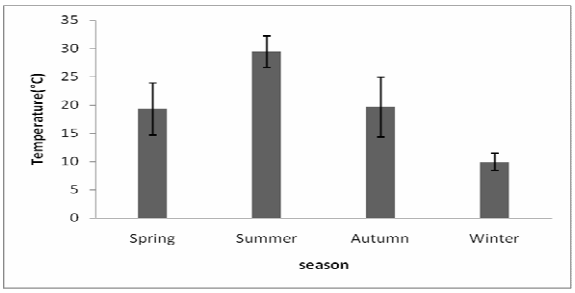

Fig.2. Seasonal changes in temperature values

Dissolved oxygen. Data indicated that DO levels were significantly affected by the seasons, station as well as their interaction (Table 3, Figure 3). DO level is believed to have negative correlation with temperature. Although temperature of spring was approximately two-fold higher than winter, DO values of these two seasons were similar. Reason of this is related to higher turbulence in spring due to more flood currents compared winter. The other reason of this might be due to daily movement local and guard of sea's boats along this part of the river.

Since this part of the river has low dept (not more than 2 m), single movement of a boat might cause a wide turbulence that leads to more dissolved oxygen levels and reach near saturation levels. DO levels decreased from station 1 to 3 and then increased after station 3 and in station 5, it reached the levels similar station 1. It is because the station 1 and maybe 2 are affected by local waste waters station 4 and 5 are affected by estuarine currents and turbulences which in turn lead to increase in DO levels. Another reason might be related to slop of the river. The slop of the river decreases from station 3 to 5 and in turn, the rate of the river decreases in these stations that consequently leads to less turbulence compared station 1 and 2. However, station 5, and in less magnitude station 4, are affected by estuarine current which increases the turbulence of these to stations compared station 3.

Table 3. Analysis of variance for dissolved oxygen values in different stations and sessions.

Source	DF	SS	MS	F	P
Session	3	124.3	1.041	15.4323	0.0011
Error	8	0.54	0.067		
Station	4	0.12	0.03	3.0440	0.0311
Session*Station	12	0.498	0.042	4.2240	0.0005
Error	32	0.314	0.01		
Total	59	4.96			

Split-plot design, n=3.

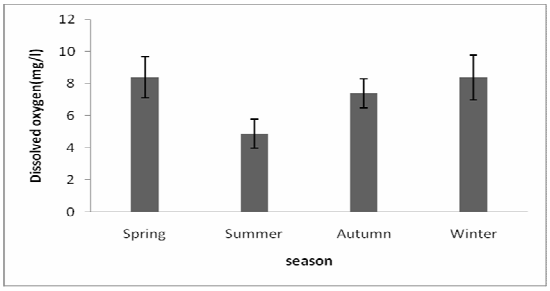

Fig.3. Seaasonal changes of dissolved oxygen values

BOD The BOD values were not affected by sessions, stations as well as their combination (Table 4). Since, BOD level is believed to be related to planktonic assemblages, it is not surprising that the BOD levels were similar in different sessions and stations, because Gorganroud River has very limited planktonic assemblages due to mainly high turbidity and speed of the river.

COD While station and interaction between station and session had no effect on COD levels, session significantly affected COD levels (Table 5). Figure 4 shows COD levels of spring, summer and autumn were similar and significantly higher than the values of winter . The reason might be due to limited microbial communications in winter due to low temperature compared the other sessions. On the other hand, similarity of the values between stations suggests that none of the stations organic materials.

pH: The pH values did not significantly change in relation to stations and sessions as well as their interaction (Table 6). Since, Gorganroud River is not exposed to different type of soils from stations 1 to 5,it was predictable that pH be stable between stations. Also, this result might suggest that the waste water and runoffs that are introduced to the river are approximately neutralized in the case of pH, or the tampon power of the river is high enough to neutralize the acidic or basic waste drainages.

The changes in pH in relation to sessions are related to photosynthesis intensity, if the effect of waste drainages be neglected. Thus, since there is no phytoplankton assemblages in Gorganroud River (due to high turbulence and turbidity), it is not surprising that pH values was similar and stable during different sessions.

Table 4. Analysis of variance for BOD values in different stations and sessions.

Source	DF	SS	MS	F	P
Session	3	7.972	2.657	2.4907	0.1344
Error	8	8.535	1.067		
Station	4	1.38	0.345	0.7912	
Session*Station	12	8.271	0.689	1.5810	0.1473
Error	32	13.950	0.436		
Total	59	40.107			

Split-plot design, n=3.

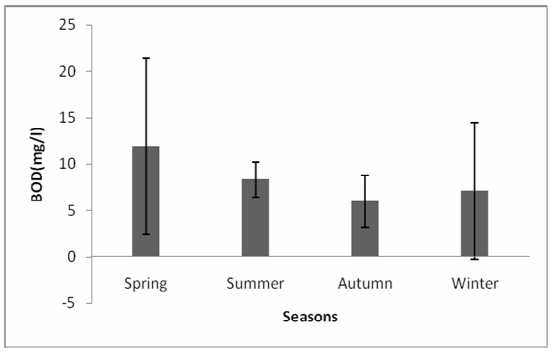

Fig.4. Seasonal changes of BOD values

Table 5. Analysis of variance for COD values in different stations and sessions

Source	DF	SS	MS	F	P
Session	3	15.596	5.199	6.7985	0.0136
Error	8	6.118	0.765		
Station	4	0.346	0.087	0.2362	
Session*Station	12	4.031	0.753	2.0520	0.0520
Error	32	11.737	0.367		
Total	59	42.828			

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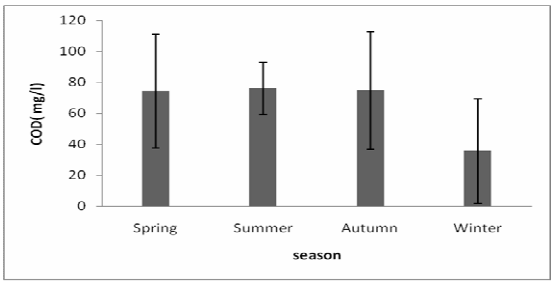

Fig. 5. Seasonal changes of COD values

Table 6. Analysis of variance for pH values in different stations and sessions

Source	DF	SS	MS	F	P
Session	3	0.025	0.008	1.4713	0.2938
Error	8	0.045	0.006		
Station	4	0.004	0.001	1.9770	0.1218
Session*Station	12	0.011	0.001	1.7435	0.1033
Error	32	0.017	0.001		
Total	59	0.102			

Split-plot design, n=3.

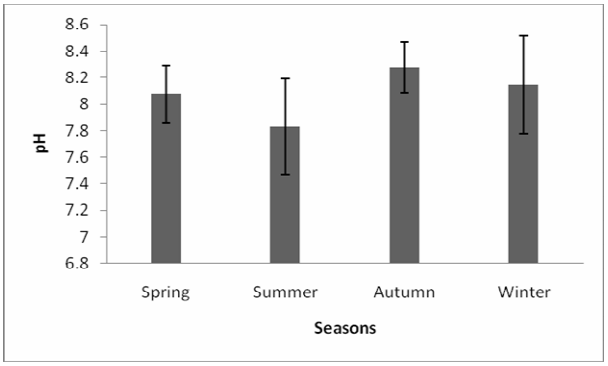

Fig. 6. Seasonal changes of pH values

Electro conductivity. EC values were significantly affected by the stations, not the sessions and nor their interaction (Table 7). The values of the stations 1-4 were similar and significantly lower than the station 5 (Table 16). The reason is due to invert currents from sea water to the river and increase in salinity levels. Higher EC values of the station 5 can be more important in spring and summer, when the sturgeon fingerlings were released to river mouth (station 4) and then migrate toward Caspian Sea for stock enhancement purposes. The other importance of high EC values of the station 5 might be related to aquatic plants assemblage that might be limited in the case of growth, despite of suitability of the other factors like light, temperature and nutrients.

Regarding to the above-mentioned, particular considerations are needed when fish fingerlings are released to the river mouth; the place that seems to be not favorable for this purpose.

Table 7. Analysis of variance for electro conductivity values in different stations and sessions

Source	DF	SS	MS	F	P
Session	3	3.667	1.226	0.5142	
Error	8	19.066	2.383		
Station	4	10.991	2.748	8.7563	0.0001
Session*Station	12	2.079	0.173	0.5521	
Error	32	10.041	0.314		
Total	59	45.853			

Split-plot design, n=3.

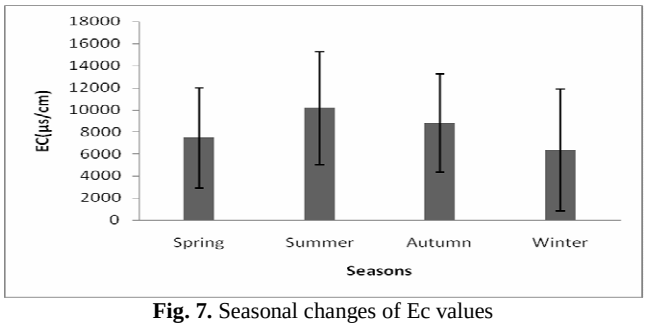

Fig. 7. Seasonal changes of Ec values

Gorganrod River is used for different aims such as local economic, irrigation seawards farm, fish emigration, brood stock for valuable fish species, and place for abandon a valuable fish finger species and natural environment for spawning. Time of releasing sturgeon fingerling fishes would be from end of April to middle of July, and there is not any inlet current water in the river. Of course, inlet waters were limited at this period and wastes were introduced to the river, however, examined parameters didn't show critical point and no serious problems seems to be existed in the aspect of the water quality.

REFERENCES

1. *Cairns, W.J.,* North Sea oil and the environment: Developing oil and gas resources, environmental impacts and responses. (Edited). London: Elsevier Applied Science, 1992.
2. *Clark, J.R.,* 1996. Coastal zone management handbook. London: Lewis Publishers. Burrows P., The economic theory of pollution control. Oxford: Martin Robertson, 1979.
3. *Cox, B.A.* A review of dissolved oxygen modeling techniques for lowland rivers. Science of the Total Environ. 314-316, 303-334, 2003a.
4. *Faniran, J.A., Adeleke, B.B., Oderinde, R.A.* Forcados Terminal Integrated Projects: Baseline Ecological Studies. Commissioned by Shell Petroleum Development Company of Nigeria, 1994.
5. *Masters, G. M.* Introduction to Environmental Engineering and Science. 2nd ed. Upper Saddle River, N.J.: Prentice Hall, 1998.
6. *Voznaya, N.F.* Chemistry of Water and Microbiology, Mir Publishers, Moscow Quality of Domestic Water Supplies, Assessment Guide 1, 2nd ed., Department of Water Affairs & Forestry, Department of Health and Water Research Commission, 1983.
7. *Wetzell,R.G.and Likens, G.E.* Limnological analyses. springer verlag, 1991.

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