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RESEARCH ARTICLE

Correlation among Physico-Chemical and Microbial Parameters of Water Quality Characteristics of upstream, Degala Basin and downstream water body, Erbil- Kurdistan Region of Iraq

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Abstract

The present study was carried out on the correlation of physical, chemical and microbial parameters of water quality among upstream, basin and downstream of Degala Basin over six months period (March to August 2015) in order to bridge the information on its limnology and microbial characteristic differences to assess its physico-chemical and microbial changes. Dissolved Oxygen, pH, EC, TDS, Na, K, Cl^-, total hardness, Ca and Mg hardness, NO_3, total alkalinity, SO_4 with bacteriological parameters were analyzed.

The results revealed that the conditions of this dam in different sampling sites were fluctuated in physico-chemical parameters among both sites with high significant relationship for both (EC, TDS, chloride, Na, K, Ca hardness, total alkalinity, nitrate and DO) with low significant relation for both (pH, total hardness, Mg hardness and Sulfate) at ($p \leq 0.05$ level). All water samples from all sampling sites showed contamination with bacterial cells that's due to open area and draining many waste disposals through stream branches that drain their water to upstream river and draining municipal waste water of Degala town through basin and downstream water bodies directly.

Introduction:-

Water plays a key role in different vital activities and is inevitable for all living organisms as it has a great social and economical value ultimately affecting human life. Water is extensively used for irrigation, industrial development, hydro electrical generations, fisheries, human life survival and for domesticated animals. Hence physico- chemical analysis is of prime importance to assess the quality of water for its best usage and also to know the pollution load on receiving water bodies. (Kesre., et al 2011).

Dams, built to change natural flow regimes, are one of the most significant human interventions in the hydrological cycle and they can result in post-impoundment phenomena that are specific to reservoirs and not natural lakes. The size of the dam, its location in the river system, its geographical location with respect to altitude and latitude, the detention time of the water and the source(s) of the water all influence the water quality (Bhatnagar, et al. 2013).

Water pollution is an acute problem in all the major rivers and dams and water is known to contain a large numbers of chemical elements, the interactions of both the physical and chemical properties of water play a significant role in composition, distribution and abundance of aquatic organisms (Mustapha and Omotosho, 2005).

The Degala Basin is about 35 km to the northeast of Erbil city (Fig.1). The main stream that drained to it is composed of two branches which are intermittent. The watershed has a kidney shape. At the outlet there are several

springs which are the sources of the base flow during dry seasons. The inhabitants at the upstream are engaged in raising animals and dry farming. Irrigation farming is practiced to a very low extent. The whole area has an undulating topography. The vegetative cover includes oak trees and some accompanying species such as hawthorn, wild cherry and wild pistachio. The soil of the watershed has a fine textured soil with patches of unconsolidated materials belonging to Kolosh formation. The main objects of this investigation were to assess physico-chemical and bacteriological parameter among upper stream, Degala basin and lower stream with correlation among them at each station.

Description of the study area:-

The Degala basin constitutes of a small water reservoir located in the centre of Degala sub- district which is located about 50km east of Erbil City. It is located within the Degala valley which drains its water from springs located few kilometers to the north. Moreover rain and snow melting water will be another important source for accumulating water. Little amounts of forests and crops were present within the area of which streams drains its water in basin.
The dam is earthy dam with an elevation of about 30m above ground surface with latitude 36.171586 and longitude 44.38215. While the capacity of the lake will be about 1.06 million cubic meters.
Data analysis: Descriptive Statistics (mean, graphs) and inferential statistics (Univarate analysis) were used through Statigraph application.

Results and Discussion:-

pH

The pH ranged between minimum 8.1 to maximum 8.89 that was recorded during March in downstream to August at Dam basin, with averages of (8.39, 8.45 and 8.33) and ±SD (0.102, 0.264 and 0.206) were recorded from upstream, basin and downstream respectively. The statistical relation among both sampling stations during study period revealed that there were small variation in pH among sampling sites at ($P \leq 0.05$). Water pH is an important variable in water quality assessment as it influences many biological and chemical processes within a water body and all processes associated with water supply and treatment. The pH variation among upstream, Basin and Downstream samples might been due to the exposure of dam water to atmosphere, biological activities and temperature changes because of increasing of dams water surface area that cause excessive evaporation and deep of water basin with temperature variations (APHA 1995). Dial variations in pH can be caused by the photosynthesis and respiration cycles of algae in lake water. The pH of most natural waters is between 6.0 and 8.5, although lower values can occur in dilute waters high in organic content, and higher values in eutrophic waters. The desirable pH range for fish is between 6.5- 9. At higher temperatures fish are more sensitive to pH changes. The mean pH value of Degala dam was 8.46 that were suitable for fish production and its variation among sites described in Figure1.

Electrical conductivity and Total Dissolved Solids (EC and TDS)

In present observation the EC varies from 717 to 995 µs/cm during August at upstream samples to April at basin surface water, and TDS varies from 394 to 597 mg/l at the same time and location due to close relation between EC and TDS according to standard methods (2005). The results showed averages of (741.6, 917 and 818.5) and ±SD (36.5, 46.54 and 38.7) were recorded from upstream, basin and downstream respectively for EC variables and averages of (408, 504 and 450) and ±SD (20.2, 25.58 and 21.22) were recorded from upstream, basin and downstream for TDS variables respectively. The statistical relation among both sampling stations during study period for EC and TDS revealed that there were significant correlations with high fluctuation among sampling sites at ($P \leq 0.05$).

Water conductivity and dissolved solids values that measured for basin were higher than for the other streams that attributable to excessive evaporation of water from the dam because of increasing surface area and changing its dissolved minerals, which might have consequently increased the concentration of dissolved salts through accumulation of them as reflected in the TDS values (Irenosen O. G., et al., 2012).

Dissolved Oxygen (DO):-

DO an important limnological parameter indicating level of water quality and organic pollution in the water body. The value of DO is remarkably significant in determining the water quality criteria of an aquatic system. In the system where the rates respiration and organic decomposition are high, the DO values usually remain lower than those of the system, where the rate of photosynthesis is high (Yeole, S.M. and G.P. Patil, 2005). The maximum value of DO is recorded as 9 mg/l in April at downstream and minimum recorded as 4.3 in Degala Basin at August. The averages of (7.53, 5.17 and 7.9) and ± SD (1.17, 0.81 and 1.03) were recorded from upstream, basin water body

and downstream respectively. Statistical analyses revealed significant correlation among both studied sites during studied period at (P≤0.05). The maximum DO value is recorded in downstream because of low water temperature and higher influences with atmosphere due to its location and heavy running of water and lower temperature at this station and also in runny season in contrast to other sites of sampling (Kalwale A. M. and Savale P. A., 2013)

Chloride:-

Chlorides are found in practically all natural waters. This is the most common inorganic anion present in water. Man and animals excrete high quantities of chlorides therefore it indicates sewage contamination. Variation observed is usually associated with the hydrology of the basin (Sangpal R. R., et al., 2011). In the present study the value ranges from 17 to 41 mg/l from upstream in August to March at basin water, with averages of (20.83, 36 and 32.3) and ±SD (3.3, 3.7 and 4.47) were recorded from upstream, basin and downstream respectively. The statistical relation among both sampling stations during study period for Chloride revealed that there were significant correlations among sampling sites at (P≤0.05) during studied period. The relatively higher values during rainy season can be attributed to the increase in erosion of soil contain chlorides in upstream and accumulation in basin and increasing evaporation and increasing its concentration in water body make it more concentrated than other areas.

Total hardness:-

The value of hardness fluctuates from 418 mg$CaCO_3$/l to 570 mg$CaCO_3$/l. Higher values were observed in semi rainy season in April while minimum values were recorded in July with average for upstream, basin and downstream (443.8, 499.7 and 487) with ±SD (22.6, 61.3 and 47) respectively. The results shown that there was significant correlation at (P≤0.05) among sampling sites during investigation.

In most of the fresh water T.H, is imparted mainly by the calcium and magnesium ions, which apart from Sulphate, Chloride and Nitrates are found in combination with carbonates and bicarbonates of river resulting to greater erosion of river coastal level (Chatterjee and Raziuddin, 2002). Although hard water has no known effect on health but it is unsuitable for domestic use (Ashish Kumar and Yogendra Bahadur, 2009).

Calcium (Ca) and Magnesium (Mg):-

Calcium is an important micronutrient in an aquatic environment and this environment is affected by adsorption of calcium ion on the metallic oxides. In addition to this it has effect of microorganisms, which play an important role in calcium exchange between sediments and overlaying water. While Magnesium: Magnesium is essential for chlorophyll and acts as a limiting factor for the growth of phytoplankton. Therefore depletion of magnesium reduces the phytoplankton population. Magnesium is required as an essential nutrient for aquatic plants (Annalakshmi, G. and Amsath, A., 2012).

Calcium and Magnesium are essential for all the organisms. They are required as micronutrient for algae and important nutrient for the metabolism of plants (Dubey M., et al., 2013).

Recorded values for Ca and Mg ranging from Minimum concentrations (285 mg $CaCO_3$/l) in July in upstream water and (98 mg $CaCO_3$/l) in July in basin water to maximum of (399 mg $CaCO_3$/l) during April in basin water and (179 mg $CaCO_3$/l) during May in downstream river respectively. Averages of Ca and Mg concentrations were (307, 353.7 and 333.7) and (136.8, 146 and 153) with ±SD (17.27, 32.9 and 33.7) and (13.97, 29.96 and 21.94) were recorded at upstream, basin and downstream respectively. In all sampling sites and dates the level of Ca concentration were higher that Mg concentration and the results shown that there were significant correlation among sampling sited during studied period at (P≤0.05) for both Ca and Mg hardness.

Nitrates:-

Nitrates are very important nutrient factor in aquatic ecosystems, generally, water bodies polluted by organic matter exhibit higher values of nitrates (Shanthi*et al.*, 2002). The values of nitrate ranged from minimum of 20 to maximum of 34 mg/l. from basin in May to downstream river in March with averages of (26.83, 24.5 and 29.16) with ±SD (2.85, 2.66 and 3.54) were recorded from upstream, basin and downstream respectively. The statistical relation shown that there were significant correlation at (P≤0.05) among basin water body with both upstream and downstream rivers. The results of the Nitrate present revealed that the higher values recorded during rainy season. This may be attributed to the oxidation of ammonia by nitrifying bacteria, and the presence of nitrate concentration in indicated level due to presence of many villages and crop farms on upstream river that most of them use fertilizers

and it erosion to nearby water during rainy or windy days. The lower values recorded during semi rainy month April may be related to the denitrifying bacteria in basin water body (Seike *et al*., 1990) and mixing of waste water bodies with downstream river due to close contact between Degala sub-district and downstream basin and drain Degala Sewer system through downstream.

In aquaculture, nitrate is considered a less serious environmental problem, it can be found in relatively high concentrations where it is relatively nontoxic to aquatic organisms, but stimulates the growth of plankton and water weeds that provide food for fish. This may increase the fish population, but when concentrations become excessive, and other essential nutrient factors are present, eutrophication and associated algal blooms can become a problem.

Sulfate:-

Sulphate in water mostly arise from anthropogenic additions in the form of sulphate fertilizers in the catchment area (Pawar, S.K. and Pulle, J.S., 2005) and from domestic and industrial wastes. The sulphate contents of all the sample sites in the present study were much below the permissible limit (400 mg/l, WHO 1984) with the values ranging from Minimum concentrations (204 mg/l) were recorded in downstream river during August to higher concentration (284 mg/1) during March in basin water body. With averages of (224.16, 251.8 and 231.6) and ±SD (15.34, 27.39 and 18.4) were recorded from upstream, basin and downstream respectively. According to Statistical relations among both studied sites during investigation there were significant relation at (($P \leq 0.05$). Sulphate exist in nearly all natural water, the concentrations varying according to the nature of the terrain through which they flow. No health based guideline is proposed for sulphate, but its presence in drinking water can cause noticeable taste, and very high levels might cause a laxative effect especially with the presence of magnesium and sodium. (Irenosen O. G., et al., 2012). Lower concentration of sulphate during the summer may be due to more intense decomposition of organic matter by anaerobic bacteria at the higher ambient temperature and also due to dilution of basin water (Khound N. J., et al 2012).

Total Alkalinity:-

Alkalinity of surface water is primarily caused by the function of carbonate and bicarbonate contains ions. The total alkalinity values were ranged between (262 to 204 mg/l), the highest value was recorded in upstream during August and the lowest value was recorded in downstream river during March with averages of (239.67, 162.6 and 222.16) and ± SD (19.77, 8.5 and 14.7) from upstream, basin water body and downstream respectively with significant correlation among both studied sites during studied period at ($P \leq 0.05$). The value of total alkalinity provides idea of natural salts present in water (Gawas *et al.,* 2006). Natural waters with high alkalinity are generally rich in phytoplankton, especially the blue greens. It is an important factor for productivity of an aquatic ecosystem. Total alkalinity of water is caused by presence of cations and mineral salts in it (Das B. K., et al., 2014). As shown in present investigation the total alkalinity of basin water body lower than other sites that may be due to adding waste water to dam basin and increasing organic matter activities in it.

Sodium:-

The value of Sodium was ranged between (28 to 97 mg/l). The lowest value was recorded in upstream during March and the highest value was recorded in basin water during May with averages of (35.3, 92.5 and 79.3) and ± SD (4.36, 3.45 and 3.77) from upstream, basin and downstream water body respectively. The sodium concentration in basin water body were higher than other sampling sites but were within the permissible limit as per prescribed by WHO (Shraddha S., et al., 2012). Because of the high solubility of sodium minerals, sodium is ubiquitous in the water environment depending on regional and local hydrological and geological composition, the time of year, and salt utilization patterns. The statistical analysis revealed that there were significant correlation among both studied sites during studied period at ($P \leq 0.05$).

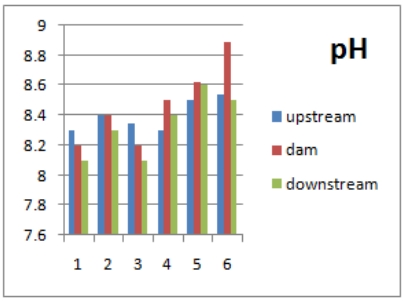
Potassium

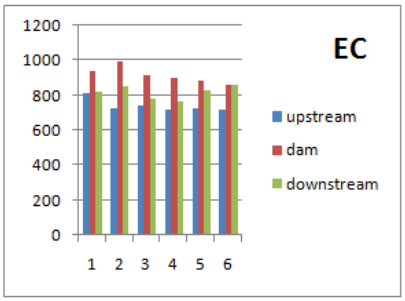
The detectable value of potassium was ranged between (2.2 to 7.8 mg/l). The lowest value was recorded in upstream during April and the highest value was recorded in basin water body during August with the averages of (2.66, 7.23 and 6) and ± SD (0.28, 0.35 and 0.82) were recorded from upstream, basin and downstream water body respectively, also there were significant correlation among both studied sites during investigation period at ($P \leq 0.05$).

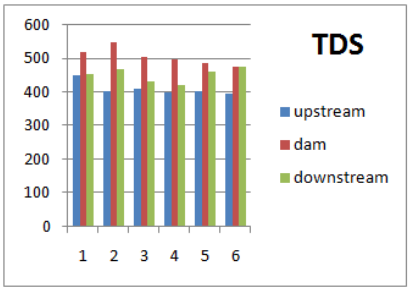
Potassium is common in many rocks. Potassium plays a critical role in many vital cell functions, such as metabolism, growth, and repair and volume regulation. Higher concentration of potassium may cause kidney disease, hypertension (yelmame v.b., 2015).

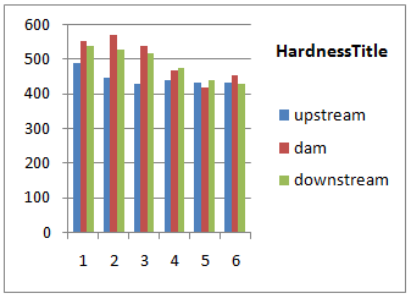
Microbiology:-

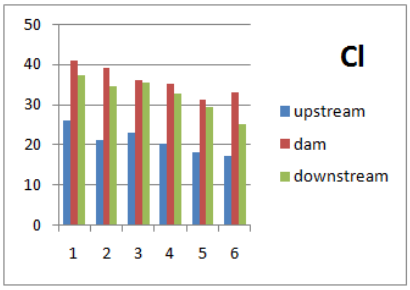
Surface water especially dam and streams water is more easily contaminated by animal and human wastes, and chemicals from runoff. Surface water may also be at risk of algal blooms due to the potential for contamination, surface water is not recommended as a source of drinking water unless filtered and disinfected. As showed in this investigation all water samples from all sampling sites showed contamination with bacterial cells that's due to activities in the water catchment area and the associated run-off to water resources. Disease causing microorganisms can enter surface water from human waste, animal waste, and intensive farming practices around studied area. Surface water may also contain agricultural chemicals such as pesticides that used from villages around water resources and drain it through runoff to upstream river and draining municipal waste water of Degala town through basin and downstream water bodies.

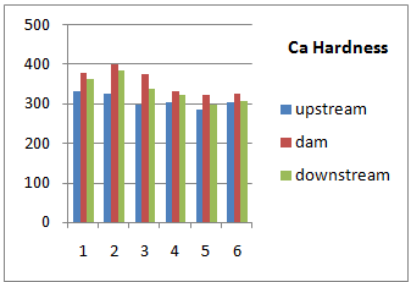


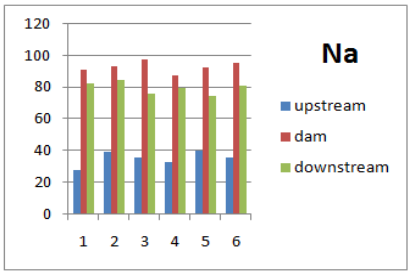


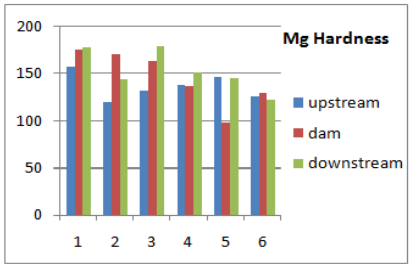


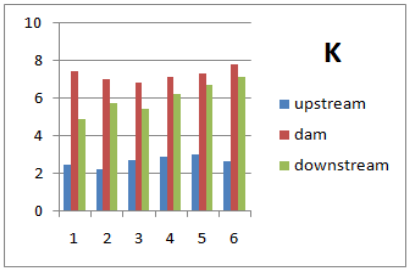


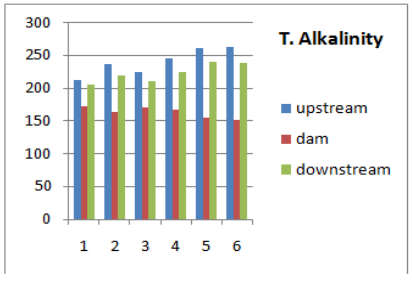


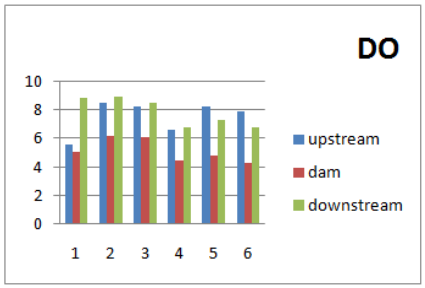


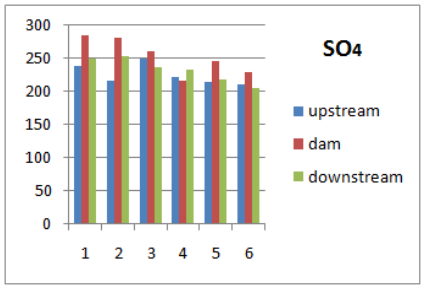












Conclusion:-

a. Comparing present values of selected parameters with the permissible limits prescribed by WHO, it can be concluded that the water samples in present investigation within WHO permissible limits.
b. The statistical analysis of results revealed that there were high fluctuated in physico-chemical parameters among both sites with high significant relationship for both (EC, TDS, chloride, Na, K, Ca hardness, total alkalinity, nitrate and DO) and low significant relation for both (pH, total hardness, Mg hardness and Sulfate) at ($p \leq 0.05$ level) for all studied sites parameters.
c. All water samples from all sampling sites showed contamination with bacterial cells that's due to open area and draining many waste disposals through stream branches that drain their water to upstream river and draining municipal waste water of Degala town through basin and downstream water bodies.
d. There is small change in the pH value during the observation period among upstream, basin and downstream sites.

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