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Statistical analysis for physico-chemical characteristics in the shoreline region of Gaza City

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Abstract Gaza Strip facing a series wastewater management problems: large-scale discharge of untreated or partially treated wastewater, leaking of collected wastewater from sewer systems and cesspits, water treatment plants that do not function or function only poorly and uncontrolled reuse of partially treated wastewater. This is causing many health and environmental problems. In this study, spatial variations of seawater quality in shore line region of Gaza City were evaluated using the modern statistical techniques, such as Analysis of Variance (ANOVA) Test, Central Tendency and Dispersion Measurements. Seawater data collected from five sampling stations located in the coastal region during the period from Jan to Jul of 2009 by four samples in each station within every month, these samples were tested for five parameters (Temperature, pH, Turbidity, Salinity and Dissolved Oxygen). Statistical analysis of the results of samples showed obvious variations in concentration of pollution between stations. Dissolved oxygen parameter used as an indicator for the presence of organic contamination, DO in S2 (5.4 ,mg/l) and S4 (5.5 mg/l) were lower than in S1, S3 and S5 (9.8, 8.6 and 10.04 mg/l, respectively, and it consists of the quantity of untreated wastewater discharges in these locations. it evinced that there are a regions setting along the coastal zone of Gaza Strip were completely deteriorated and polluted by row toxic untreated wastewater which discharged directly to the Mediterranean Sea causing several diseases between Gazians, destroying the fishing and recreational area, this requires urgently to work on a common and urgent efforts to assist in solving or decreasing the effects of this problem.

Keywords: Shoreline; Wastewater; Statistical analysis; Contamination

Introduction

Gaza Strip lies in the southwestern part of the Palestinian coastal plain. Its total area is 378 km^2 (UNEP, 2009) its length is approximately 45 km. Bounded by the Negev desert to the Southeast and the Sinai desert to the Southwest. Gaza is characterized by its desert nature. The average daily mean temperature ranges from 25 °C in the summer to 13 °C in the winter. Average daily maximum temperatures range from 29 °C to 17 °C and minimum temperatures from 21 °C to 9 °C in the summer and in the winter respectively. The average annual rainfall varies from 450 mm/year in the north to 200 mm/year in the south (PHG, 2002). Regarding evaporation, maximum values of 140 mm/month have been quoted for the summer, while

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relatively low pan-evaporation values of around 70 mm/month were measured during the months of December and January. The daily relative humidity fluctuates between 65% in the daytime and 85% at night in the summer and between 60% and 80% respectively in the winter (PHG, 2002).

In the Gaza Strip, wastewater treatment has been neglected to a certain extent, with most attention focused on measures to solve water quantity and supply problems. The lack of operational and efficient wastewater treatment plants makes wastewater the main source of pollution of the coastal zone of Gaza Strip. Most of the wastewater is discharged untreated or partially treated along the shoreline, the Palestinians resulting in pollution of most of the shoreline (ARIJ, 2001). In addition to the treatment plants effluents, there are more than 20 individual sewage drains, ending either on the beach or a short distance away in the surf zone. The 45 kilometers of shoreline is already under intense pressure, with substantial environmental degradation of terrestrial and marine resources (MOPIC, 1996). High percentage of the wastewater that is generated in Gaza City is currently discharged without treatment into the sea (50,000 m3 per day) in addition to the Wadi Gaza's wetland effluent channel for the raw sewage from refugee camps adjacent to the watercourse, estimated at 6,000- 8,000 m3 per day (Anon, 2002). Only about 40% of the sewage generated in the Gaza Strip is properly treated. The percentage of population served by sewerage systems is 60% (PWA, 2001). The insufficient number of sewage treatment plants in operation, combined with poor operating conditions of available treatment plants, and the present disposal practices are likely to have an adverse effect on the quality of seawater. The population of Gaza Strip continues to grow rapidly, thus increasing the amounts of poorly treated or untreated sewage wastewater being discharged into the coastal water.

The aim of this study is to evaluate the Physico-chemical Characteristics in the Shoreline Region of Gaza City due to organic contamination discharge and its impacts on Human Health and marine Environment.

Methodology

Samples Locations:

Five stations along the Gaza Strip shoreline were selected. Station 1 is located in the northern part of Gaza Strip and station 5 is located in south of Wadi Gaza. Both stations 1 and 5 are situated in free wastewater discharge. It is determined to consider the position in where no obvious sources of pollution. Station 2 is located between Beach Camp and El-Sheikh Redwan region, and station 4 is located in the middle part of Gaza strip shoreline. Stations 2 and 4 lie at the outfall of major raw sewage discharge but station 3 is located north of Wadi Gaza at the outfall of partially treated sewage.

Sampling was carried out four times monthly for 7 months (January, February, March, April, May, June and July 2003). At each sampling event four samples were obtained at fixed stations for field measurements. Temperature, pH, dissolved oxygen, salinity and turbidity were measured in situ.

Sample Collection:

Seawater samples were collected form five srations for seven months and four times in each station of shoreline of Gaza Strip. Then, collected samples were kept in suitable separated polyethylene plastic bottles cleaned many time with distilled water and finely soaked tightly. All seawater samples were stored and deliver in the same day to laboratory to conduct the requested chemical analysis process.

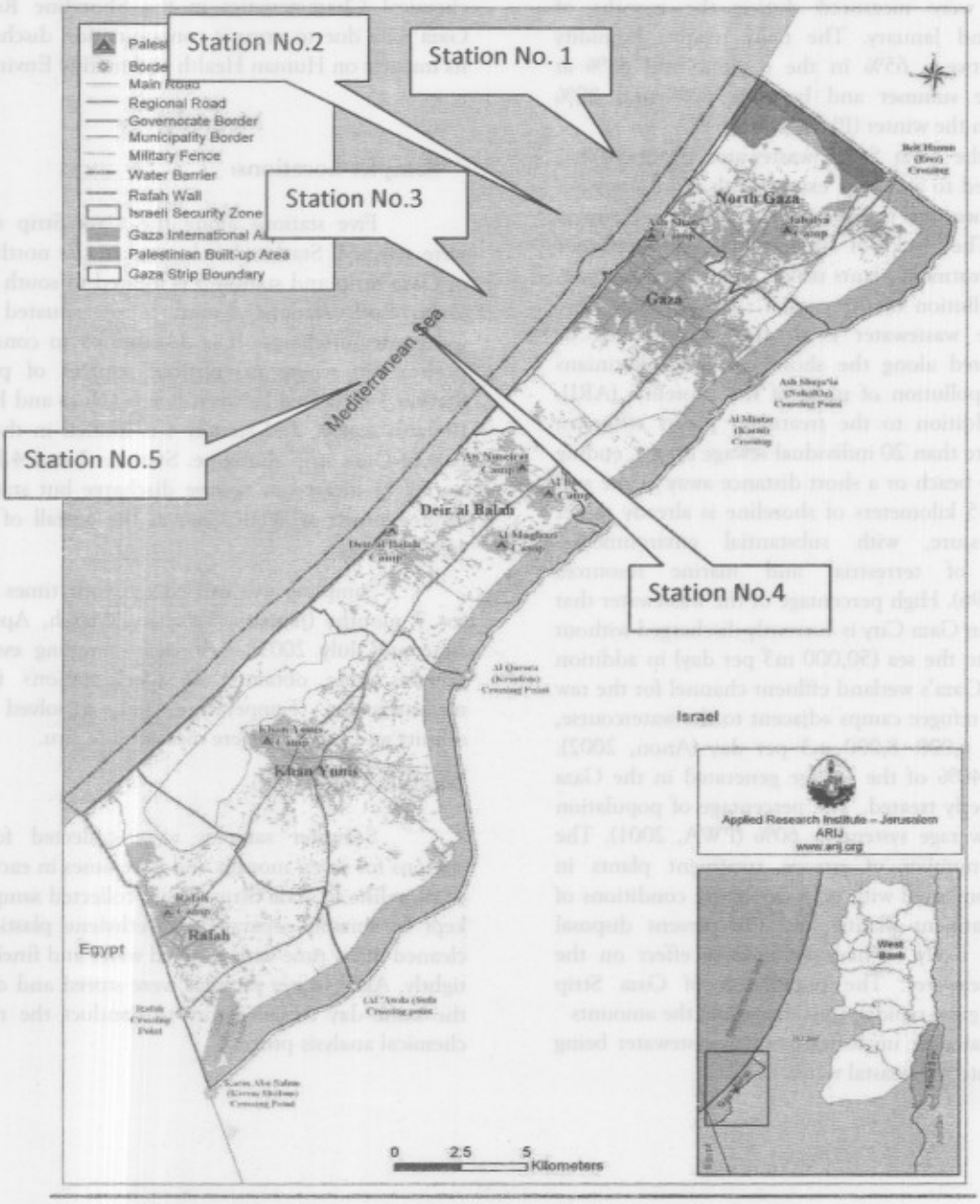

Figure 1.1: Map of Gaza Strip shows shoreline region with locations of the five sampling stations

Analytical Methods:

The selected physico-chemical parameters consist of Dissolved Oxygen (DO), Temperature, pH, Salinity, and Turbidity.

The temperature, pH and DO concentration of the seawater were measured on-site by a thermometer, pH and DO meter (using HACH sensION 156 portable), respectively. The salinity and the turbidity were analyzed laboratory.

Statistical Analysis:

A one way ANOVA (Analysis of Variance) was used to examine differences between stations (spatial variations).Differences between the means of concentrations of each physico-chemical parameters and some times the direct compare of means method is used.

All statistical application was done using the Statistical Package for Social Sciences (SPSS) and some times Microsoft Office-Excel.

Results and Discussion

The study in our hands has handled of some of physico-chemical parameters such as Temperature, pH, Salinity, Turbidity and Dissolved Oxygen in five different sites located on the shoreline region of Gaza Strip.

The results we have mentioned it recently show without doubt the differences between the physical properties of the different locations due to the variation of the environmental situations in each site.

The averages of all physico-chemical analysis at each station are presented in table 2. The data revealed spatial variations in seawater quality along the shoreline region within the sampling stations locations. A quick overview of some central tendency and dispersion measures for the means of all parameters (Table 3). The observed variations of physico-chemical parameters among different stations were statistically analyzed using one way ANOVA and the overall mean of each parameter at different stations were specially compared using Post Hoc Test –LSD were shown in (Table 4).The result indicate significant special variations occurred between stations. The physico-chemical parameters, among different stations were statistically analyzed.

The concentration of DO followed an obvious decreasing pattern (as shown in Figure 1,2).,with significantly higher values ($P<0.05$) recorded in S2,S3,S4 and a maximum level of Dissolved Oxygen in S1,S5 (Table 2, 4).

However, although water temperature and pH profiles showed some variations, statistical comparisons revealed non-significant difference between stations ($P<0.05$) and both parameters within the different stations were similar to each other to a certain extent as shown in (Table 2,4)

Turbidity, on the other hand, varied greatly at each station. Results indicate that turbidity was significantly higher ($P<0.05$) in S2,S4 . Turbidity was greatly low in S1,S5 and it was in the meddle within S3.(Figure 3)

Salinity, is an inverted image of the turbidity, it is very clear that salinity varied mostly between different stations, output of data analysis indicate that salinity was significantly ($P<0.05$) higher in stations 1 and 5, it was apparently lower in S2, S4, and medium in S3.(Figure 4)

Table 2: Means of all variables for all stations in all months.

Site	T	pH	Turbidity	Salinity	DO
S.1	22.493	8.271	.816	35.443	9.757
S.2	22.671	8.268	7.400	17.682	5.379
S.3	22.829	8.311	4.632	26.382	8.604
S.4	22.711	8.375	7.211	17.368	5.543
S.5	22.433	8.263	1.080	35.007	10.041

As it shown in figure 1,2, the DO concentration in both S1,S2 is the highest level due to the absence of sewage discharge (the region were sewage free) there are plenty of oxygen in the region naturally. This is the final indicator of the presence of variation between the different locations.

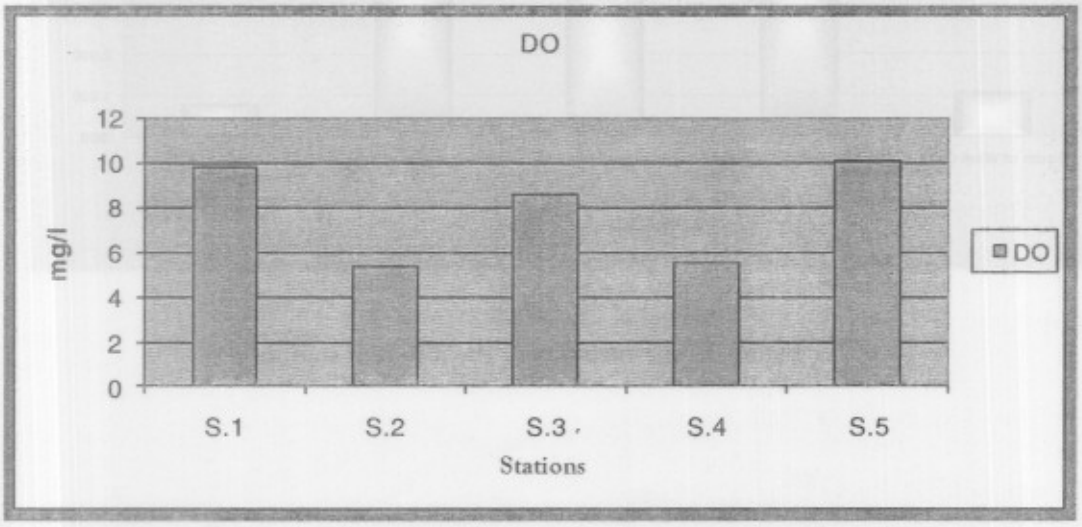

Figure 1: The concentration of DO in the different stations

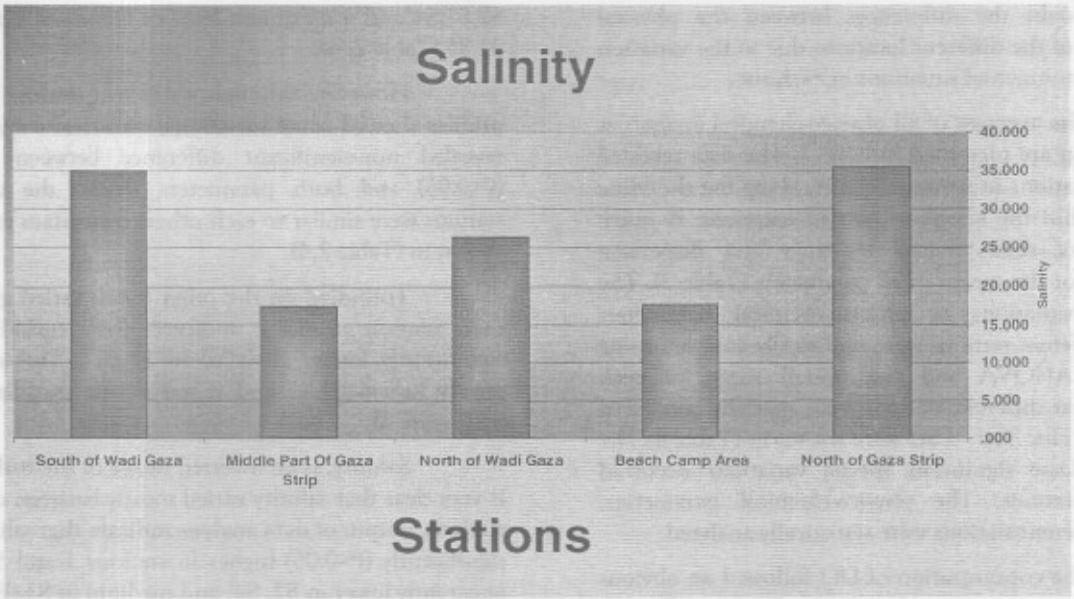

Figure 2: Salinity in the different stations

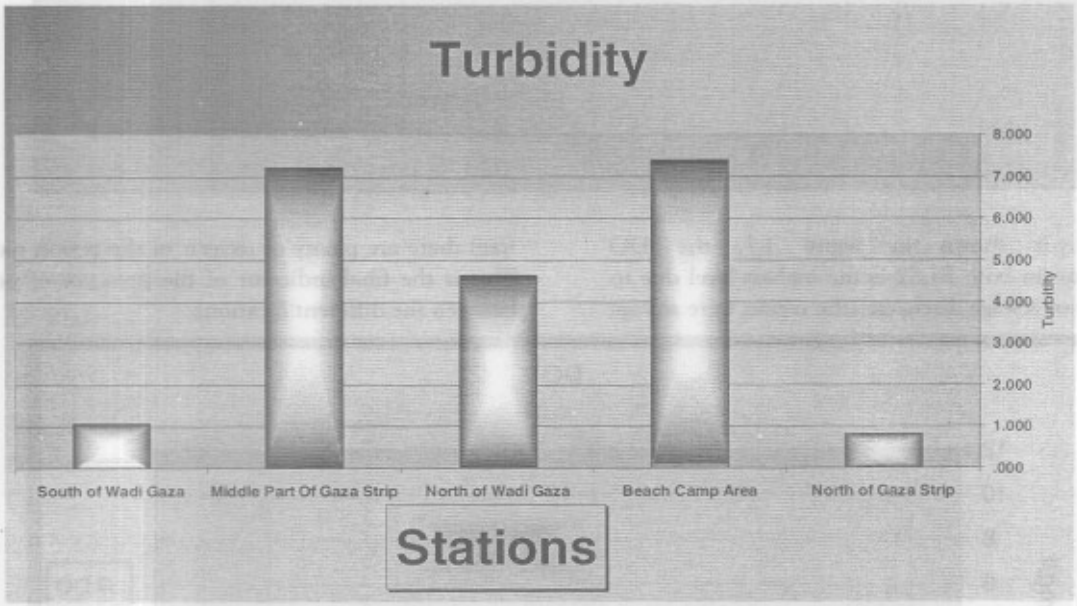

Figure 3: The turbidity in the different stations

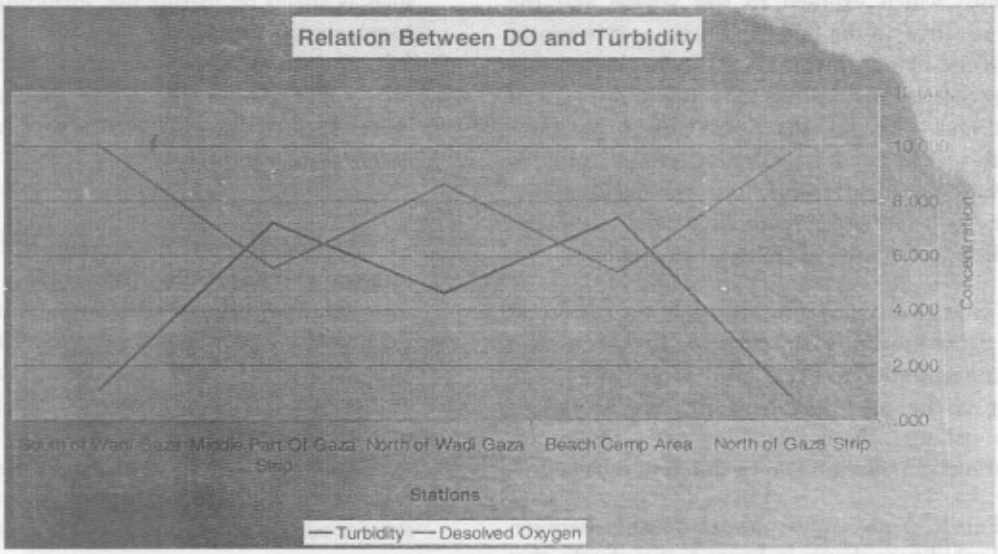

Figure 4: Relationship between DO and Turbidity

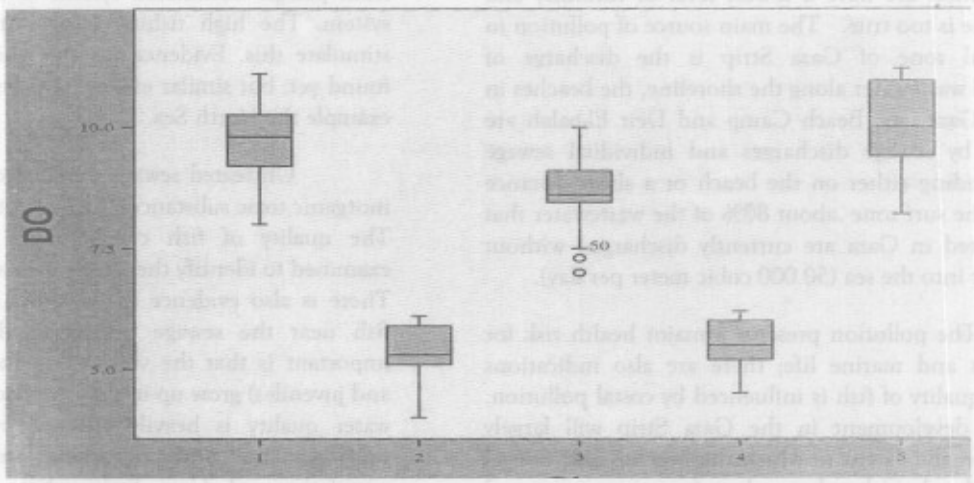

Figure 5: the Plot Box diagram of mean of DO in all locations

Seawater quality awareness in the world is constantly growing and stream cleaning projects were a common phenomenon during the last decade, however, great awareness of the importance coastal protection and deterioration of Gaza seawater quality have been recently developed among government departments, universities and research centers in Palestine. Many studies have shown that the changes of physico-chemical and biological seawater quality parameters are a result of sewage discharges and other factors such as storm water runoff, marine traffic and coastal land use conflicts.

As it appears in the table(4)which show us values of the significance of F-test (F column) which suppose that there is no variation between locations for all variables (Null hypothesis) and the P value (significance column) in the final column, it is obvious that the values in this column in regard to DO, Salinity and Turbidity were less too much than P=0.005 so the null hypothesis (no variance) is rejected and the alternative hypothesis (there is a variance) is completely true.

By another words, decreasing of the DO concentration as example of variation in S2,S4 (figure 1,2), were a good indication for presence of raw sewage (untreated wastewater) discharges in the region that because the exist of plenty accounts of Bacteria which need to absorb oxygen in the organic matter degradation and digestion process, organic matter is the main component of raw sewage which measured by the Biochemical Oxygen Demand (BOD).

In the region S3 which exposed to partially treated wastewater (Figure 1, 2) the results shown high concentration of DO , this is another indicator for the effect of wastewater on the seawater quality with presence of organic material and the bacteria which feed on it .

By the same way, the Turbidity well be high in the locations which exposed to row sewage and the reverse is also true in the other locations as it is appear like sun in the figure 3 , it is scientifically proved that raw sewage always rises the turbidity due to the exist of suspended molecules and other sediments , so locations S1,S2 were sewage free have a lowest level of turbidity and S2,S4 are the highest while S3 is the medium level of turbidity as it received a partially treated wastewater from inefficient Al-Shekh Iglean treatment plant.

That theory will directly apply on salinity as shown in figure 4, salinity concentration in S3 is neither equal its concentration in S1,S5 nor its concentration in S2,S4.that is the other emphasis on our hypothesis which is talking about an obvious variation in concentrations of pollution among different stations.

Finally, You can see the relationship between DO and Turbidity as shown in figure 5, it is clearly that locations which have a highest level of DO concentration are have a lowest level of turbidity and the reverse is too true. The main source of pollution in the costal zone of Gaza Strip is the discharge of untreated wastewater along the shoreline, the beaches in front of Gaza city, Beach Camp and Deir El-balah are polluted by sewage discharges and individual sewage drains, ending either on the beach or a short distance away in the surf zone .about 80% of the wastewater that is generated in Gaza are currently discharged without treatment into the sea (50.000 cubic meter per day).

The pollution presents a major health risk for swimmers and marine life; there are also indications that the quality of fish is influenced by costal pollution. Tourism development in the Gaza Strip will largely depend on the extent to which the beaches and coastal cliffs will be cleared and stay clean from wastewater and the extent to which the sewage effluent entering the surf zone of the costal waters will be reduced.

The discharge of untreated wastewater into the shallow waters of Gaza Strip is a serious problem for the marine ecological system. The input of raw sewage water into the sea can cause a number of detrimental effects, such as affects on marine life, including phytoplankton, zooplankton, crustaceans, macro-algae and (juvenile) fish, Oxygen deficiency of water, Eutrophication (the increase of the nutrients concentration) which may cause, Algal blooms that may be harmful and Excessive bacterial growth.

An increase in nutrient concentrations can therefore change the ecosystem. High nutrient concentration, high temperature and sunlight enhance the growth of phytoplankton species and may result in algal blooms that even maybe toxic. Excessive bacterial growth may also occur. The increased nutrient and the organic matter concentrations may favour certain species at the expense of others. Micro-benthic species for example that feed on dead organic material will have more food and their growth may be promoted.

As a result the species composition may shift from pelagic dominated system to benthic dominated system. The high fishing effort for pelagic fish may stimulate this. Evidence for this shifts have not been found yet, but similar effects have been recorded in for example the North Sea.

Untreated sewage outfalls contain organic and inorganic toxic substances, such as nitrates and chlorine. The quality of fish caught near the shore is not examined to identify the effects of sewage on fish health. There is also evidence of weakened or poorly looking fish near the sewage outlets at the beaches. More important is that the very young stages of fish (larvae and juveniles) grow up in the near shore zone, where the water quality is heavily affected by the raw sewage outfalls. This poses a severe threat to the fish populations of Gaza Strip where many wastewater outfalls discharged untreated sewage in to the sea. (Gaza Coastal and Marine Environmental Action Plan, Dec.2001).

Table 3: A quick overview of some central tendency and dispersion measures for the means of all parameters.

Statistics

		T	pH	Turbidity	Salinity	DO
N	Valid	5	5	5	5	5
	Missing	0	0	0	0	0
Mean		22.62738	8.29760	4.22762	26.37648	7.86458
Std. Error of Mean		.072499	.021128	1.426142	3.958785	1.010781
Median		22.67140	8.27140	4.63210	26.38210	8.60360
Std. Deviation		.162112	.047244	3.188949	8.852112	2.260176
Variance		.026	.002	10.169	78.360	5.108
Skewness		-.091	1.503	-.159	.000	-.375
Std. Error of Skewness		.913	.913	.913	.913	.913
Kurtosis		-1.779	1.685	-2.993	-2.991	-3.076
Std. Error of Kurtosis		2.000	2.000	2.000	2.000	2.000
Range		.395	.112	6.584	18.075	4.662
Minimum		22.433	8.263	.816	17.368	5.379
Maximum		22.829	8.375	7.400	35.443	10.041

Table 4: Summary of calculations of the combined (one way) ANOVA of the Physico-chemical characteristic of the shoreline region of Gaza Strip. (Within the five Stations)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
DO	Between Groups	567.388	4	141.847	285.831	.000
	Within Groups	66.499	134	.496		
	Total	633.887	138			
Salinity	Between Groups	8701.261	4	2175.315	526.492	.000
	Within Groups	553.650	134	4.132		
	Total	9254.911	138			
Turbidity	Between Groups	1128.987	4	282.247	279.559	.000
	Within Groups	135.288	134	1.010		
	Total	1264.275	138			
pH	Between Groups	.249	4	.062	2.511	.045
	Within Groups	3.320	134	.025		
	Total	3.569	138			
T	Between Groups	2.905	4	.726	.039	.997
	Within Groups	2482.360	134	18.525		
	Total	2485.265	138			

Conclusion

From the previous results and its discussions, it is clear that there is a variation of sea water quality through different locations due to exposure to raw sewage water or not , we found that the stations which received a massive amount annually of untreated wastewater were had a worst physico-chemical properties. And the stations which had been free of

sewage water were had the natural properties and the appropriate conditions were found there.

By this study we become now very sure about the effects of raw sewage on the seawater quality and after this study we will able to determine the site which is polluted or the other which is not polluted by untreated or partially treated wastewater, and by back to the subtitle which is called the Problem which has been illustrated previously you can defined what is the meaning of polluting the seawater by raw sewage and untreated wastewater. .

Recommendation

There are only a few insufficient and inefficient wastewater treatment facilities in Gaza Strip and due to the external and internal conflict with the occupation from side and between the Palestinian to gather from the other side or inadequate management most of them are not functioning properly. This is an alarming issue since the untreated wastewater is polluting the seashore and the coastal zone in addition to its polluting of the ground water aquifer.

- Wastewater issue should given high priority in the development of the region; current trends and threats from untreated wastewater undermine the livelihood development and jeopardize the quality of the sea and the coastal zone.

- Standards should be established and implemented for the various reuse of treated wastewater, such as irrigated agricultural and aquifer recharge.

- The institutional framework on wastewater management should be strengthened. The role of the National Authority in controlling the wastewater should be clarified. Similarly, the municipal authority should be given clear tasks and to implement sound wastewater practices.

- The construction of wastewater networks and wastewater treatment plants must be given the highest priority.

- The wastewater effluent discharged to the wadis and the Mediterranean Sea in Gaza must be of advanced international standards.

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الملخص العربي

التقييم الفيزيوكيميائي لنوعية مياه البحر
في منطقة الشاطئ لمدينة غزة

أحمد هشام حلس ، سالم سليم أبوعمرو
معهد المياه والبيئة / جامعة الأزهر – غزة ٢٠١٠

يواجه قطاع غزة مشاكل وتحديات حقيقية في موضوع إدارة المياه العادمة ، الكميات الكبيرة جدا من المياه العادمة الغير معالجة أو المعالجة جزئيا والتي يتم ضخها في البيئة في قطاع غزة استمرار ، التسرب من شبكات الصرف الصحي وأنظمة الجمع الموجودة والتي تعاني الكثير من المشاكل ، محطات المعاجلة التي لا تعمل أو تعمل بشكل غير سليم وغير كافي ، وغياب الآليات السليمة لإعادة استخدام المياه العادمة المعاجلة جزئيا، كل ذلك يتسبب في العديد من المشاكل الصحية والبيئية في قطاع غزة ، في هذه الدراسة، تم عمل تحليل إحصائي مكاني وزماني للمواصفات الفزيوكيميائية لتقييم جودة مياه البحر في منطقة الساحل الشاطئي لمدينة غزة بالتحديد وذلك باستخدام تقنيات إحصائية حديثة مثل تحليل التباين ، (ANOVA) دراسة النزعة المركزية وقياسات التشتت. تم جمع بيانات مياه البحر من خمس محطات لأخذ العينات تقع في منطقة الشاطئ خلال الفترة ما بين يناير/كانون ثاني وحتى يوليو/تموز من العام ٢٠٠٩ (أربع عينات من كل محطة في كل شهر) ، هذه العينات تم فحصها بواسطة خمس معايير جودة وهي (الحرارة pH ، درجة الحموضة ، العكارة، الملوحة و الأكسجين المذاب) ، لقد أظهرت التحاليل الإحصائية للنتائج التي تم الحصول عليها اختلافا واضحا في تركيز التلوث بين محطات اخذ العينات الخمس المختلفة، استخدم تركيز الأكسجين المذاب للدلالة على وجود التلوث بالمواد العضوية (من المياه العادمة الغير معالجة)، تركيز الأكسجين المذاب في المحطة ٢ (٥،٥ ملغرام/ لتر) وفي المحطة ٤ (٥،٥ ملغرام/ لتر) حيث اقل بكثير منه في المحطتين ١ و ٢ و ٥ (٩،٨ ، ٨،٦ و١٠،٤ ملغرام/ لتر على التوالي)، كلما قل تركيز الأكسجين المذاب كما هو في المحطتين ٢ و ٤ كان ذلك دليل على وجود تلوث بالمياه العادمة (المواد العضوية) والتي تحتاج إلى أكسجين بكمية اكبر لزوم عمل البكتيريا التي تتغذى على تلك الملوثات. يدل ذلك على وجود مناطق تقع في منطقة الساحل لقطاع غزة وتعاني من تدهور كبير بسبب التلوث بالمياه العادمة الغير معالجة والشديدة السمية والتي تضخ في مياه البحر الأبيض المتوسط بشكل مباشر لتحدث العديد من الأمراض بين المواطنين في قطاع غزة ولتدمر مناطق صيد الأسماك ومناطق الاصطياف والاستجمام على الساحل، لذلك فان هناك ضرورة ملحة لتكاتف كل الجهود وتركيزها في اتجاه حل مشكلة المياه العادمة في قطاع غزة أو التخفيف من شدة الآثار السلبية المترتبة على ذلك.

الكلمات المفتاحية:
الساحل، المياه العادمة، التحليل الإحصائية ، معايير، التلوث.