WATER QUALITY STUDY AT HIDD AL-HALAB

Purpose:

In accordance with a request by the Director of Tourism and Archaeology, a water quality study around Hid Al-Halab was undertaken to assess the levels of pollution and to judge whether the anticipated reclamation activity near it, for the development of tourism will have any environmental impact.

INTRODUCTION

The area at Hid Al-Halab is to be developed for recreation purposes. It is essential water quality in that area must be of a high standard for this use. In these areas pollution should not exceed certain criteria to avoid health hazards, unacceptable visual pollution, oxygen depletion and odor problems. In this area the main source of pollution is untreated sewage, which enters the sea through several sewer outfalls in Manama, Muharraq, and Juffair. A number of other outfalls discharge storm drainage water in this area (see Figure-1).

To assess the water quality, the following substances were considered:
1) Total suspended solids.
2) Total Coliform bacteria.
3) Nutrients (ammonia, nitrite, nitrate and phosphate)
4) Hydrocarbons
5) Physical parameters (Temperature, salinity, pH, turbidity)
6) Dissolved oxygen

Materials & Methods:

Sample collection:

The pollutant sampling stations are shown in Figure-2. Sea water samples were taken from a depth of 0.2 meters at all stations, following procedures outlined in MOOPAM (1983). Samples for total hydrocarbons were collected in specially cleaned amber colored bottles. For the determination of phosphate, samples were collected in 100 ml glass bottles. Samples for bacteriology were collected in sterilized glass bottles.

Water analysis:

Temperature, pH, D.O and salinity were measured in situ using a Hydrolab Surveyor-11. Turbidity was measured by use of a H.F. Instruments DRT Turbidimeter. For nutrient analysis an Aquatic automatic water analyzer was used.

1. Ammonia-N

The samples were treated in an alkaline citrate medium with sodium hypochlorite and phenol in the presence of sodium nitroprusside as a catalyst. The reaction is for ammonia nitrogen which includes NH4 ions and unionized NH3. The absorbance was measured at 640 nm using a Bauch & Lomb Spectronic 21 with 5 cm cells. Concentrations were calculated using a calibration factor derived from calibration curves.

2.Nitrate-N

Nitrate was reduced to nitrite by passing the sample through a column containing cadmium filings coated with metallic copper. The nitrite produced was determined by diazotizing with sulfanilamide and coupling with N-(1-Naphthyl)- ethylenediamine to form a highly colored azo dye which was measured with a spectrophotometer at 543 nm using 1 cm cells. Any nitrite initially present was corrected.

3. Nitrite-N

Nitrite was determined as in nitrate-N.

4. Phosphate-P

Seawater was reacted with a composite reagent containing ammonium molybdate and potassium antimonyl tartrate to form a heteropoly acid (phosphomolybdic acid) which was reduced to the intensely colored molybdenum blue by ascorbic acid. Absorbance was measured at 885 nm using 5 cm cells.

5. Total coliforms

Membrane filter technique was used for the determination of total heterotrophic bacteria.

6. Hydrocarbons

For hydrocarbon analysis a water sample (1000ml) was shaken repeatedly with n-hexane/dichloromethane mixture (7/3 v/v) in a separating funnel. The organic phase was separated and removed then made up to a certain volume. Hydrocarbon was measured using RF-540 Shimadsu Fluorescence Spectrophotometer.

Results & Discussion:

1.0 Water Quality:

Tables 1 and 2 summarize the water quality data sampled at Hid al-Halab.

Table-1

Sea water analysis results

Station No.	**Temperature** C	**pH**	**D.O** mg/l	**Salinity** ppt	**TSS** mg/l	**TC bacteria** NO/100ml	**Turbidity** NTU
1	25.3	7.9	7.9	44.9	6.8	200	3.1
2	26.3	7.9	5.8	43.8	6.8	68	1.6
3	26.5	7.9	5.9	43.9	9.6	12	2.7
4	26.1	7.9	5.8	43.9	6.6	12	2.0
5	26.6	7.9	5.7	43.5	5.6	30	1.9
Average	26.2	7.9	6.2	44.0	7.1	64	2.3

Table-2

Sea water analysis results continued

Station No	Ammonia-N ug/l	Nitrite-N ug/l	Nitrate-N ug/l	Phosphate-P ug/l	Hydrocarbons. ug/l
1	27.95	0.27	14.3	1.46	5.9
2	3.99	0.62	14.4	0.0	4.8
3	16.97	0.63	13.9	5.85	5.0
4	7.99	0.98	9.97	0.0	4.8
5	2.99	0.63	10.8	0.0	7.9

Average	11.98	0.63	12.67	1.46	5.68

Temperature:
Surface temperature varied from 25.3 - 26.6 C with an average of 26.2 C. Water temperature is an important characteristic of marine environments. The distribution of water temperature and salinity influences the physical mixing properties of water. The lowest and highest temperatures at which a fish may survive depend upon its previous acclimatization. Depending on tidal patterns, temperatures in the island area could exceed 40 degrees C during summer months.

pH.
The sea water pH shows a neutral value. pH influences sea water chemistry in several ways, notably the carbonic acid equilibrium, chemical form of metals and the characteristics of dissolved substances. In the study area sea water pH were quite normal.

Salinity:
Salinity of water varied from 43.5 - 44.9 % with an average value of 44. %. In general salinity value at this area is quite normal and typical of east coast values.

Turbidity:
Turbidity varied from 1.6 - 3.1 NTU. This is quite normal compared to the usual value of <1.0 in offshore areas.

Total suspended solids:
Total suspended solids varied from 5.6 - 9.6 mg/l. Compared to other offshore values this value is not high (1.0-5.0 mg/l usually). TSS includes both organic and inorganic materials. Suspended solids adversely affect fisheries by covering the bottom of the sea with a blanket of material that destroys the bottom dwelling plants and animals that provide shelter and food for fish and prawns.

Dissolved Oxygen:
D.O ranged from 5.7 -7.9 mg/l. Dissolved oxygen is a major factor of environmental water quality. Concentrations below 4.0 mg/l in marine or estuarine waters create stressful conditions for fish and other animal and are therefore unacceptable. D.O concentrations at Hid Al Halab are satisfactory.

Hydrocarbons:
Total hydrocarbon levels measured by fluorescence spectrophotometer varied from 4.8 - 7.9 ug/l. Comparison of the values with concentrations in other parts of the world suggests that the levels of petroleum hydrocarbons at these stations are not high. For example, based on Kuwait crude as reference oil, Faraco and Ros (1979) reported concentrations throughout the Western Mediterranean ranging from 1-123 ug/l with an average of 9.9 ug/l. Monitoring studies carried out in the North Atlantic off the coast of Canada show average levels of 4.9 ug/l (1.6-10.8 ug/l).

Ammonia-N:
Ammonia-nitrogen values ranged from 2.99 - 27.95 ug/l with an average of 11.98 ug/l. The highest value noticed was near the Muharraq outfall. The European inland Fisheries Advisory Commission (1973) stated that toxic levels of NH_3 for short term exposure usually lie between 0.6 and 2.0 mg/l. Unionized ammonia is more toxic. Concentration of unionized ammonia in marine waters should not exceed 0.4 mg/l.

Nitrate-N and Nitrite N:
Nitrate nitrogen varied from 9.97 - 14.4 ug/l with an average value of 12.67 ug/l. Although nitrates are essential for protein synthesis, high concentrations of nitrates in a body of water may stimulate algal bloom causing oxygen depletion. The levels reported in this survey are typical of values reported for eastern waters of Bahrain. Nitrite nitrogen levels were very low in all samples.

Phosphate -P:
Phosphate-P values ranged from 0- 5.85 ug/l which are very low. One result of pollutional enrichment of waters by ions NO_3, PO_4 and other plant nutrients is eutrophication. It has been reported that phosphorous is the main cause of such eutrophication, since even in the absence of combined inorganic nitrogen, nitrogen fixing algae will continue to flourish, provided that sufficient phosphate is available. The levels reported here are all very low.

Coliform bacteria:
This investigation shows total coliform bacteria ranging from 12-200 /100ml, with the maximum concentration occurring near the Muharraq Causeway Bridge. These values decline to 30 colonies per 100 ml or less in the vicinity of the proposed island. It is expected that the higher coliform counts in the vicinity of the causeway are due to fecal contamination from the many boats in the area and possible small-scale septic tank overflows.

Maximum fecal coliforms and B.O.D as simulated in a model by Delft Hydraulics are shown in Appendix A, and Figures 5.38, 5.21 and 5.20. This model was run to determine the effect of the Muharraq outfall on coliform concentrations in the Khawr al Qulay'ah. The maximum concentration expected in the island area is 750/100 ml from this source.

Water depth
The water depth in the development area is shallow and at low tide much of the area is exposed making it difficult for boats to gain access to the island. Development plans will have to take this into account and provide better boat access.

CONCLUSIONS

It is difficult to make any definitive conclusions from this limited survey, however, the general water quality in the area meets EEC standards for recreational bathing quality water.

There is a chance that the Muharraq outfall, which is connected to the sewerage network at present, could discharge up to 20000 cubic meters per day of raw sewage into the Khawr during a system failure. During these periods there is a possibility that high coliform bacteria concentrations will be prevalent at certain times depending on weather conditions, which can exceed EEC guidelines. Bad odors coming from the outfall area could also cause problems.

The water movement in the area is unknown, but it is assumed that the tidal exchange within the Khawr does not completely flush the water column over a 25-hour cycle. The flushing in the area of the island is expected to be somewhat less than other areas due to its shallow features and distance from either entrance to the Khawr. The limited flushing in the area could cause problems during and after the project is completed. Depending on the final project design and the number of people using the island water quality could deteriorate due to increased fecal contamination, littering with rubbish, and disturbances to the sea bottom.

The processes of developing the island could also seriously affect the water quality of the area. It has been shown in the past that reclamation projects generally detract from water quality by increasing turbidity and suspended sediment load and greater siltation of low energy areas. This would in turn decrease visibility in the water and create muddy bottom areas which would detract from swimming and other water sports. This is especially true when dredging operations are used for reclamation.

Birds as a roosting place during the low tides use the existing island in the development area. It is expected that the birds will not be able to use the island during times when people inhabit it.

RECOMMENDATIONS

1. Creation of the island should be done using methods to minimize the out slip of silt. Using low silt content fill material, water boxes, and proper slope protection may do this.

2. When the island is created the shallow depth of the water needs to be considered and steps must be taken to ensure easy access by boats. If dredging is necessary the dredge spoil should be used to create the island but steps must be taken to minimize siltation.

3. Development of the island's infrastructure should be accomplished in such a way that faecal contamination is prohibited.

4. Efforts should be made to eliminate the other sources of fecal contamination within the Khawr.

5. Rubbish containers must be provided and cleaned regularly.

6. Additional studies should be undertaken to evaluate the marine ecosystem and possible hydrographic modifications.

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