UTILIZATION OF GEOINFORMATICS TO ASSESS THE ENVIRONMENTAL EFFECTS OF POLLUTED DISCHARGE IN KUWAIT BAY

Submitted By

Ikram Mohammed Sharif Al Attar

B.Sc. of Engineering (Civil Engineering), Faculty of Engineering & Petroleum, Kuwait University, 1984
Master in (Civil Engineering), Faculty of Engineering & Petroleum, Kuwait University, 1993

A Thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
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Department of Environmental Engineering Sciences
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APPROVAL SHEET

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2019

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Abstract

Kuwait Bay is shallow and relatively well-sheltered, elliptically shaped embayment at the northwestern section of the Arabian Gulf. The bay covers an area of 735 km^2 and has 130 km coastline. It receives different flows such as treated and partially treated wastewater effluents, storm waters, and hyper-saline brine effluent along its shore. The bay is highly polluted due to 32 sewage outfalls located along the shore especially; the Jahra and the Syllabicate bay because they have 14 outfalls and are shelter bays.

This study has three phases, in the first phase the GIS technology is used in this study to analyze the water quality and determine the extent of pollution in Kuwait Bay using the collected data in 2014 during winter and summer months. The analysis included five water quality parameters namely ammonia, nitrate, phosphate, TOC and chlorophyll concentration. The IDW interpolation method proved to be helpful for better mapping of water quality. Seasonal variations in concentrations of all water quality parameters were observed in this study. Temperature plays an important role in such variations since the temperature of Kuwait bay reached an average value of 31.85ºC in July, while it reached an average of 14.22ºC in January. For both seasons, the bays' water is highly polluted according to KEPA standards, while summer months being more critical than winter months. The dissolved oxygen concentration in summer reached 4.0 mg/l while in winter is 6.8 mg/l. The used technique proved to be very illustrative in determining spatial distribution and mapping of water quality parameters.

The second phase was determining the environmental carrying capacity of the bay, as an indicative of the water body to accommodate pollutant without destroying its own function. Environmental capacity concept for

semi-closed coastal areas is defined as the capacity of water body to allow pollutant to get in it, without long term deterioration. It plays a great role in coastal water management especially on controlling pollution. The environmental carrying capacity problem is expressed as the maximized pollutant concentration of the sewage outfall when the pollutant concentration of a selected set of water quality control points does not exceed their respective standard values. Therefore, maximizing environmental capacity is an objective of any coastal water management and was calculated using linear programming model. The contribution of sewage outfalls to water quality points is calculated by using Delft3d Software, the two-dimension flow hydrodynamic model followed by a water quality model. The results showed that Kuwait Bay exceeds the environmental carrying capacity. Therefore, it is in deep need for applying rehabilitation plan. Such a plan is to reallocate the sewage outfalls in the optimum location, to mitigate the impacts of the sewage outfalls in the semi-enclosed bays of Sulaibikhat and Jahra respectively. Since Kuwait Bay is a unique ecosystem for many species of fish, shrimp, and crustacean, it is in deep need of a rehabilitation plan which will be the third phase of the research. Rehabilitation plans for Kuwait bay are a preventive measure for pollution source, one of the plans is to reallocate outfalls in favorable sites to mitigate their environmental impacts. In this paper, GIS technology was used to find site selection of reallocated sewage outfalls based on suitability evaluation method. This method used ecological factors such as bathymetry, Kuwait Bridge, land use, Desalination plants, Wastewater treatment plants and Kuwait current circulation in the bay as to prepare thematic maps for the analysis. The method used the Weighted Overlay Model of software ArcGIS 10.4 to assign the proper weights to the thematic maps and superimposed them as a tool to generate the suitability map of the concerned areas and to find the possible locations of sewage outfalls. This method proved to be simple and very illustrative.

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