Developing hydrological model for water quality in Iraq marshes zone using Landsat-TM

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Abstract. The Mesopotamia marshlands constitute the largest wetland ecosystem in the Middle East and Western Eurasia. These wetlands are located at the confluence of the Tigris and Euphrates Rivers in southern Iraq. However, there are series reductions in the wetland zones because of neighbor countries, i.e. Turkey, Syria built dams upstream of Tigris and Euphrates Rivers. In addition, the first Gulf war of the 1980s had damaged majority of the marches resources. In fact, the marshes had been reduced in size to less than 7% since 1973 and had deteriorated in water quality parameters. The study integrates Hydrological Model of RMA-2 with Geographic Information System, and remote sensing techniques to map the water quality in the marshlands south of Iraq. This study shows that RMA-2 shows the two dimensional water flow pattern and water quality quantities in the marshlands. It can be said that the integration between Hydrological Model of RMA-2, Geographic Information System, and remote sensing techniques can be used to monitor water quality in the marshlands south of Iraq.

1. Introduction

In the last century, there are several critical environmental problems have been raised up such as pollution, coastal and soil erosions [1-6]. Man-made is beyond all the environmental crises due to war, wrong behaviors and managements. It is not forgotten the three Gulf wars of 1980s, 1990, and 2003 which lead to several damages for environmental specially in the Arabian Gulf and specially in Iraq. For instance, during the 1991 Gulf War, roughly one million oil tones blackened the Arabian Gulf (Figure 1).

In Iraq, there are other problems have raised up in last decades such as water quality. American-Iraq war in 2003 has been affecting the water quality of rivers, streams, lakes and marshes in Iraq [7]. Further, inadequately treated sewage, poor land use practices, industrial waste waters discharges excessive use of fertilizers, and a lack of integrated watershed management are other factors impact water quality in Iraq [8]. The effects of these problems threaten ecosystems, endanger public health risks, and intensify erosion and sedimentation, leading to land and water resources degradation. Many of these negative effects arise from environmentally destructive development, a lack of information on the situation regarding water quality and poor public awareness and education on the protection of water resources [9].

However, clean water is essential to human survival as well as to aquatic life. Much surface water is used for irrigation, with lesser amounts for municipal, industrial, and recreational purposes: only 6% of all inland water is used for domestic consumption. An estimated 75% of the population of
developing nations lacks adequate sanitary facilities, and solid waste is commonly dumped into the nearest body of flowing water. Pathogens such as bacteria, viruses and parasites make these waste materials among the world's most dangerous environmental pollutants, waterborne diseases are estimated to cause about 25,000 deaths daily worldwide [10].

Remote sensing techniques play major roles for monitoring and mapping, water quality [11]. With advances using remote sensing for data acquisition and the integrating finite element numerical model with the spatial capabilities of GIS and the spatial and temporal capabilities of remote sensing applications could provide a powerful tool for management and assessment to surface water quality problems in the marshes zone of southern Iraq. This study is very important for monitoring and assessing the water quality in the wetland south of Iraq. The benefits of this study are restoration, rehabilitation of the wetlands as well as the environmental and water quality improving in the marshes in southern of Iraq. This research work mainly images of LANDSAT (TM) were selected to identify the spatial changes in the marsh zones and to support the catchment delineation marshes.

2. Study Area

The Mesopotamian Marshlands of Southeastern Iraq represents one of the largest wetland ecosystems in all of Asia and covered more than 15,000 km² and is formed by the confluence of the Tigris and Euphrates rivers. But in 2003 the marshes had been reduced in size to less than 7% of their 1973 levels (8,926 km² within Iraq)[12]. The major marshes in Iraq such as Al Huwazia marsh is located east of Tigris River by approximate area 3000 km² and the central marshes are located in a triangular area between the Tigris and the Euphrates by approximate area 2800 km² and Abu-Ziriq is located north of Nasiriya city on the western side of the former Central Marsh with area 2000 km² then Hammer marsh is south of the Euphrates River, extend from near Al Nasiriya in the west to Al Basrah on the Shat Al Arab in the east with area 4500 km², this study will focus on theses the marshes only (Figure 2).
3. Data Collection and Model

Data collection are required, such as a hydrological data (inflow and outflow) of all marshes and topographical data as the marsh boundaries, area, surface water elevation, depth water, geographical location of sources, pollution stations and geographical location for sampling stations as well as the satellite images such as Landsat-7 TM, ETM that resolution 30 m² and seven bands. The finite element model (FEM) is the dominant discretization technique in structural mechanics. The basic concept in the physical interpretation of the FEM is the subdivision of the mathematical model into disjoint (non-overlapping) components of simple geometry called finite elements or elements for short. The response of each element is expressed in terms of a finite number of degrees of freedom characterized as the value of an unknown function, or functions, as a set of nodal points.

The response of the mathematical model is then considered to be approximated by that of the discrete model obtained by connecting or assembling the collection of all elements. The disconnection-assembly concept occurs naturally when examining many artificial and natural systems. It can be applied to a fluid as the water to determine water depth and water flow analysis as well as for assessing and monitoring water quality when integrate with remote sensing techniques and Geographic information system applications.

4. Results and Discussion

In order to fulfill the overall aim and objectives of the study, the results and analyses will achieve based on the pre-processing and processing of the input datasets. The obtaining results as the water depth, velocity patterns as well as water quality parameter distribution, such as (TDS, TSS, Salinity) for four seasons (seasonally) in marshes of southern Iraq. Figures 3 and 4 show an exponential relationship between the march zones and elevations. The maximum elevation of 9 m coincides with an area of 2,500 km². Clearly the storage volume increase exponentially with elevation of 9 m. This can prove that there are exponentially relationships between area, storage volume and elevation of march zones. This study confirms the work done by Dunia Frontier Consultants [13].
Figure 5 shows the rainfall spatial variations in the maximum amount of 300 mm. Clearly the maximum range of rainfall amount matches with high concentration of water drainage zones which are closed to the Arabian Gulf. Further, the heavy dense concentration of march zones are existed along the drainage concentration in both river banks of Tigris and Euphrates rivers (Figures 2 and 5). In fact, march zones are required much amount of water to grow up and to keep on living.
In the last few years, however, water levels in Iraq’s rivers have rapidly decreased to less than a third of their normal capacity. Water levels may fall further in the coming years due to declining precipitation, gradual desertification, and upstream water use and damming. The long-term average annual precipitation in Iraq is equal to 216mm per year with high variability across time and governorate. In 2011, 507.4 mm of water fell in Suleimaniyah while only 65.3 mm fell in Basrah. Lakes, reservoirs, and minor rivers are also experiencing diminished levels of water. If present conditions remain unchanged, Iraq will experience a water shortage of over 33 million cubic meters a year by 2015 [14].

5. Conclusion

This study demonstrate method for water quality distribution in Iraq. The integration between LANDSAT satellite data and finite model was used to model volume of water quality variations. The study shows that the storage volume increase exponentially with elevation of 9 m. This can prove that there are exponentially relationships between area, storage volume and elevation of march zones. It can be said that the heavy dense of march zones are existed with area of high water storage which can be identified using LANDSAT-TM data.

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