Using spatial analysis techniques to Preparing maps for distribution of pollutant concentrations in Shatt al-Arab waters in November 2015.

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Abstract
Water has a great self-generating capacity that can neutralize the polluting interventions carried out by humans. However, if human activities continue this uncontrolled and unsustainable exploitation of this resource, this regenerating capacity shall fail and it will be jeopardized definitively. Shatt Al-Arab River in South of Iraq. It has an active role in providing water for irrigation, industry, domestic use and a commercial gateway to Iraq, in the last five years Shatt Al-Arab suffered from a rise in pollutants due to the severe decline in sewage networks, irregular networks and pesticide products, as well as the outputs of factories and companies that find their way to water sources and lead to a widespread collapse of water quality. In present work, by using Data observation with the integration between remote sensing and GIS techniques to prepare maps of the distribution of concentration materials in Shatt al-Arab River south of the province of Basra in January 2015 to determine the level of pollution in the river. These include pH, dissolved oxygen (DO2), phosphates (PO4), nitrates (NO3), calcium, magnesium, potassium, Total soluble solids (TDS), electrical conductivity (EC) as well as alkaline salts (ALK.) The quality of polluted water has been observed at the sites of the study due to the increase in wastewater flowing into the river, especially river branches and the illegal discharges of industrial waste and sewage. In addition to the severe shortage of water levels in the last five years.

Key word: Shatt Al-Ar Arab, pollution, Water Quality, remote sensing, GIS.

1. Introduction
Water is considered polluted if some substances or condition is present to such a degree that the water cannot be used for a specific purpose. Water pollution is the presence of excessive amounts of a hazard (pollutants) in water in such a way that it is no long suitable for drinking, bathing, cooking or other uses. Pollution is the introduction of a contamination into the environment. It is created by industrial and commercial waster, agricultural practices, everyday human activities and most notably, models of transportation. No matter where you go and what you do, there are remnants earths environmental and its inhabitants in many ways. [1]

1.1. Water Quality Assessment
Water quality study is the process of determining the chemical, physical and biological characteristics of water bodies and identifying the possible contamination sources that degrade the quality of water [2]. Degradation of the quality of water resources may result from waste discharges, pesticides, heavy metals, nutrients, microorganisms, and sediments. Different water quality standards have been developed to aid in checking the extent of water pollution, and consequently to maintain these quality standards.

1.2. Remote sensing and Geographic information system (GIS)
Remote sensing is the science of obtaining and interpreting information from a distance, using sensors that are not in physical contact with the object being observed. The science of remote sensing in its broadest sense includes aerial, satellite, and spacecraft observations of the surfaces and atmospheres of the planets in our solar system, though the Earth is obviously the most frequent target of study.[3]
GIS is a manual or automated system, which can store, retrieve, manipulate, and display environmental data in a spatial format. It has the capabilities to use different set of operation for working with spatially referenced geo-data. It uses several manual data elements like maps, aerial and ground photograph, statistical report etc. transportation planning, physical planning, land use planning or zoning, non-point source pollutants, monitoring hazardous waste sites etc.[4]

2. Interpolation Methods

Spatial interpolation is tool in GIS used to find the values of unknown points. It can be defined as a procedure of estimating the values of properties at un-sampled locations based on the set of observed values at known locations.

2.1. Inverse Distance Weighted (IDW)

This is one of the simplest and most readily available methods. It is based on an assumption that the value at an unsampled point can be approximated as a weighted average of values at points within a certain cut-off distance, or from a given number m of the closest points (typically 10 to 30) [5].

\[
z(s_\text{0}) = \sum_{i=1}^{N} \lambda_i z(s_i)
\]

Where:
- \( z(s_\text{0}) \) Represents a portended value at the unsampled site \( s_\text{0} \).
- \( N \) represents a measured sample point's number within the neighborhood determined for \( s_\text{0} \).
- \( \lambda_i \) represents associated distance-dependent weights with each sample point.
- \( z(s_i) \) Represents the observed value at site \( s_i \).

The obtained by weights are using:

\[
\lambda_i = \frac{d_{i0}^{-p}}{\sum_{i=1}^{N} d_{i0}^{-p}}
\]

\[
\sum_{i=1}^{N} \lambda_i = 1
\]

Where:
- \( d_{i0} \) is the prediction site \( s_\text{0} \) and the measured site location \( s_i \) distance.
- \( P \) represents the power parameter that determines the reduction rate of the weights as distance increases.

IDW is forced to be an exact interpolator to avoid the division by zero that occurs when \( d_{i0} = 0 \) at the sampled points

3. Study area Shatt Al-Arab

Shatt Al-Arab is a river of some 200 km (120 mi) in length, formed by the confluence of the Euphrates and the Tigris in the town of al-Qurnah in the Basra Governorate of southern Iraq. The southern end of the river constitutes the border between Iraq and Iran down to the mouth of the river as it discharges into the Persian Gulf. It varies in width from about 232 meters (761 ft.) at Basra to 800 meters (2,600 ft.) at its mouth. It is thought that the waterway formed relatively recently in geologic time, with the Tigris and Euphrates originally emptying into the Persian Gulf via a channel further to the west.[6]

4. Geography

The general climate of the Shatt Al-Arab region is subtropical, hot, and arid. At the northern end of the Persian Gulf is a vast floodplain formed by the Euphrates, Tigris, and Karun Rivers, featuring huge permanent lakes, marshes, and forest. The aquatic vegetation includes reeds, rushes, and papyrus, which support numerous species. The marshy land is home to water birds, some stopping here while migrating, and some spending the winter by feeding on lizards, snakes, frogs, and fish. Other animals found in these marshes are domestic water buffalo, two endemic rodent species, antelopes, gazelles, small animals such as the jerboa, and several other mammals.[7]
Figure 1. Scene of the Shatt Al- Arab

5. Material and Methods

Five monitoring stations were selected on the Shatt al-Arab. For the purpose of monitoring pollution in the study area to prepare pollution maps, as shown in Table (1).

Table 1 - Description of monitoring stations on Shatt al-Arab

| The province | Station Code | Location | Station coordinates |
|--------------|--------------|----------|---------------------|
| Al-Basra     | SH1          | Before the Karmat Ali River / water project (25) million and the unified Basra | 47° 45' 56" | 30° 39' 01" |
|              | SH2          | Almeql / near Khalid Bridge | 47° 46' 70" | 30° 34' 45" |
|              | SH2B         | Abo Al - Khasib - Al snaker / desalination plant water in Al snaker | 47° 56' 67" | 30° 27' 95" |
|              | SH3          | Al Saybah / near Seihan water project / Seihan border post and raw water pumps for Seihan water project | 48° 11’ 66" | 30° 19’ 60" |
|              | SH4          | FAO / Mooring Boats | 48° 29’ 04" | 29° 58’ 51" |

Data on the results of laboratory tests of the five monitoring stations in Shatt al-Arab water were used during the month of November on 2015 as shown in table (2), these tested includes pH, dissolved oxygen (DO2), phosphates (PO4), nitrates (NO3), calcium, magnesium, potassium, Total soluble solids (TDS), electrical conductivity (EC) as well as alkaline salts (ALK.).

Table 2 - Results of laboratory tests of the five monitoring stations in Shatt al-Arab water

| The province | Al-Basra | | | | |
|--------------|----------|----------|----------|----------|----------|
| Station Code | SH1      | SH2      | SH2B     | SH3      | SH4      |
| date for first monitoring | 03/11/2015 | 11/11/2015 | 04/11/2015 | 15/11/2015 | 15/11/2015 |
| date for second monitoring | 24/11/2015 | 25/11/2015 | 16/11/2015 | 28/11/2015 | 28/11/2015 |
| Results of tests | | | | | |
| PH | 7.95 | 7.95 | 7.7 | 7.6 | 7.5 |
| DO2 | 7.85 | 6.82 | 7.55 | 8.1 | 6.835 |
| PO4 | 0.3 | 0.335 | 0.255 | 0.345 | 0.295 |
| NO3 | 3.285 | 3.52 | 3.59 | 3.48 | 4.005 |
| Ca | 204 | 240 | 176 | 156 | 212 |
| Mg | 175.5 | 208.5 | 134.5 | 65 | 230 |
| TH | 1240 | 1470 | 1000 | 660 | 1490 |
By using the pollution data in Table (2) and using remote sensing and Geographic information system (GIS), we prepared pollutions maps for Shatt al-Arab water. These maps shown in figures (2-14).

**Figure 2.** PH Concentration map in the Shatt al - Arab

**Figure 3.** DO₂ Concentration map in the Shatt al - Arab
Figure 4. PO$_4$ Concentration map in the Shatt al-Arab

Figure 5. NO$_3$ Concentration map in the Shatt al-Arab

Figure 6. Ca Concentration map in the Shatt al-Arab
**Figure 7.** Mg Concentration map in the Shatt al – Arab

**Figure 8.** TH Concentration map in the Shatt al - Arab

**Figure 9.** K Concentration map in the Shatt al - Arab
Figure 10. Na Concentration map in the Shatt al - Arab

Figure 11. Cl Concentration map in the Shatt al - Arab

Figure 12. TDS Concentration map in the Shatt al - Arab
6. Conclusions

In this study, maps were prepared for the distribution of different pollutant concentrations in water of Shatt Al-Arab by using the integration of remote sensing techniques and geography information systems. Five stations were selected in the waters of the Shatt al-Arab south of the province of Basra in March 2015 to identify pollutants that affect the quality of the river water throughout its course. These include pH, dissolved oxygen (DO2), phosphates (PO4), nitrates (NO3), SO4, calcium, magnesium, potassium, Total soluble solids (TDS), electrical conductivity (EC) as well as alkaline salts (ALK.) The quality of polluted water has been observed at the sites of the study due to the increase in wastewater flowing into the river, especially river branches and the illegal discharges of industrial waste and sewage. In addition to the severe shortage of water levels in the last five years.
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