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Water quality index for Al-Gharraf River, southern Iraq

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ABSTRACT

The Water Quality Index has been developed mathematically to evaluate the water quality of Al-Gharraf River, the main branch of the Tigris River in the south of Iraq. Water samples were collected monthly from five sampling stations during 2015–2016, and 11 parameters were analyzed: biological oxygen demand, total dissolved solids, the concentration of hydrogen ions, dissolved oxygen, turbidity, phosphates, nitrates, chlorides, as well as turbidity, total hardness, electrical conductivity and alkalinity. The index classified the river water, without including turbidity as a parameter, as good for drinking at the first station, poor at stations 2, 3, 4 and very poor at station 5. When turbidity was included, the index classified the river water as unsuitable for drinking purposes in the entire river. The study highlights the importance of applying the water quality indices which indicate the total effect of the ecological factors on surface water quality and which give a simple interpretation of the monitoring data to help local people in improving water quality.

Introduction

Drinking water in Iraq comes from rivers, lakes, wells and springs. These sources are exposed to a variety of pollutants caused by the diffusion from nonpoint and point sources which are difficult to control, monitor, and evaluate, such as sewage, agricultural and industrial wastes (Ahuja, 2003). Water quality is determined by the chemical, physical and biological parameters of water. It is a measure of the state of the water with respect to the necessities of human needs or purposes (Abbasi and Abbasi, 2012). The water pollution of rivers requires great efforts, and water quality is an important issue in the field of water resources planning and management and requires data gathering, analysis, and interpretation (Yehia and Sabae, 2011).

The Water Quality Index (WQI) is a simple method utilized as a part of surveying the general water quality using a group of parameters which reduce the large amounts of information to a single number, usually dimensionless, in a simple reproducible manner (Abbasi and Abbasi, 2012).

It gives important data delineating the general water quality status which can be of extraordinary help in the choice of suitable water-treatment technique to address the issue of contamination. The primary WQI was suggested by Horton (1965) and subsequently other ideas were suggested as improvements to the original method. Numerous WQIs have been developed and approved around the world (Prasad and Kumari, 2008; Reza and Singh, 2010; Manoj et al., 2012; Dede, 2013), the differences between them being the statistical incorporation and translation of parameter values (Abbasi and Abbasi, 2012; Alobaidy et al., 2010; Lumb et al., 2011).

Al-Gharraf River is the primary source of water in the south of Iraq. It branches from the Tigris close to Al-Kut city and runs through the Wasit and Dhi-Qar regions. The water from it is utilized for essential uses such as; drinking, raising livestock, irrigation and fishing (Al-Gizzy, 2005). Wastewater and rural seepage water from these utilizations frequently come back to the waterway as inflows. Any threat, whether natural or anthropogenic, can conceivably greatly affect socio-economic aspects of the area (Ewaid, 2011).

The aim of this research is to develop a water quality index (WQI) for Al-Gharraf River based on physicochemical water quality parameters, to help the local people towards proper management of water resources and to build up gauge information which will help in future water administration and protection arrangements.

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Materials and methods

Description of the study area

Al-Gharraf is the principle branch of the Tigris River; it branches from the Tigris, south of Baghdad at Al-Kut Dam to the Euphrates basin passing Wasit and Dhi-Qar governorates and diminishes north of Nassyria City, in the south of Iraq. Its highest flow rate is 622 m^3/s, with a length of around 230 km and its drainage area is 435052×10^6 m^2. Fifty-two channels and 968 water system trench branching from it which irrigate an area of 700,000 hectares (Al-Sahaf, 1965; U.S. Department of Agriculture, 2009).

The watercourse land position, Table 1 provides the valley semi-arid atmosphere qualities, like high temperature in summer, low humidity, little mean yearly precipitation of around 150 mm, high rate of sun radiation and high rate of dissipation (Atiaa, 2015). Al-Gharraf experiences human and natural issues like; shortage of water, growth of plants such as water hyacinth (*Eichhornia crassipes*), contamination and the accumulation of mud (Ewaid, 2016).

Five sampling stations were chosen, Fig. 1. The initial station, at the start, had the same propertied of the Tigris, without any urban areas for 200 km. Near the second station, there were numerous horticultural fields on both banks and the water was affected by residential wastewater from Al-Hay town. The third station had salt zones on the left side and farming fields on the right. The urban wastewater from Qalaat Sekar and Rifai towns affect the waterway. The fourth station near the main Al-Bada'a sluice gate has four refinery stations on the right side before Shatrah town, which supply drinking water to Dhi-Qar and Basrah governorates. The fifth station had low water level and restricted width, located south of Shatra town and affected by its wastewater; see Fig. 1.

Table 1
The coordinates of the water sampling station.

No.	Points	Coordinates	
		N	E
1.	GR-1	32°30′00.32″	45°44′60.00″
2.	GR-2	32°11′16.10″	46° 0′26.32″
3.	GR-3	31°53′13.87″	46° 3′17.65″
4.	GR-4	31°34′32.48″	46° 7′26.55″
5.	GR-5	31°18′9.82″	46°14′17.06″

Field sampling and Analytical procedures

Water samples were collected monthly from December 2015 to January 2016 at each sampling station. Samples were preserved and analyzed according to American Public Health Association (APHA) standard methods (American Public Health Association (APHA), 2012). Biological oxygen demand (BOD), total dissolved solids (TDS), hydrogen ion concentration (pH), dissolved oxygen (DO), turbidity (Tur.), phosphates (PO_4), nitrates (NO_3), chlorides (Cl^-), total hardness (TH) electrical conductivity (EC) and alkalinity were measured by the methods in Table 2.

Calculation of the WQI

The Water Quality Index for the river was calculated from eleven parameters namely: BOD, TDS, pH, DO, turbidity, PO_4, NO_3, chlorides, TH, EC, and alkalinity for five sampling stations to assess the suitability of Al-Gharraf River water for drinking purposes. The WQI was calculated using the weighted arithmetic water quality index method which was proposed by Horton (1965), developed by Brown et al. (1970) and then by Cude (2001) in which water parameters are multiplied by a weighting factor and are then

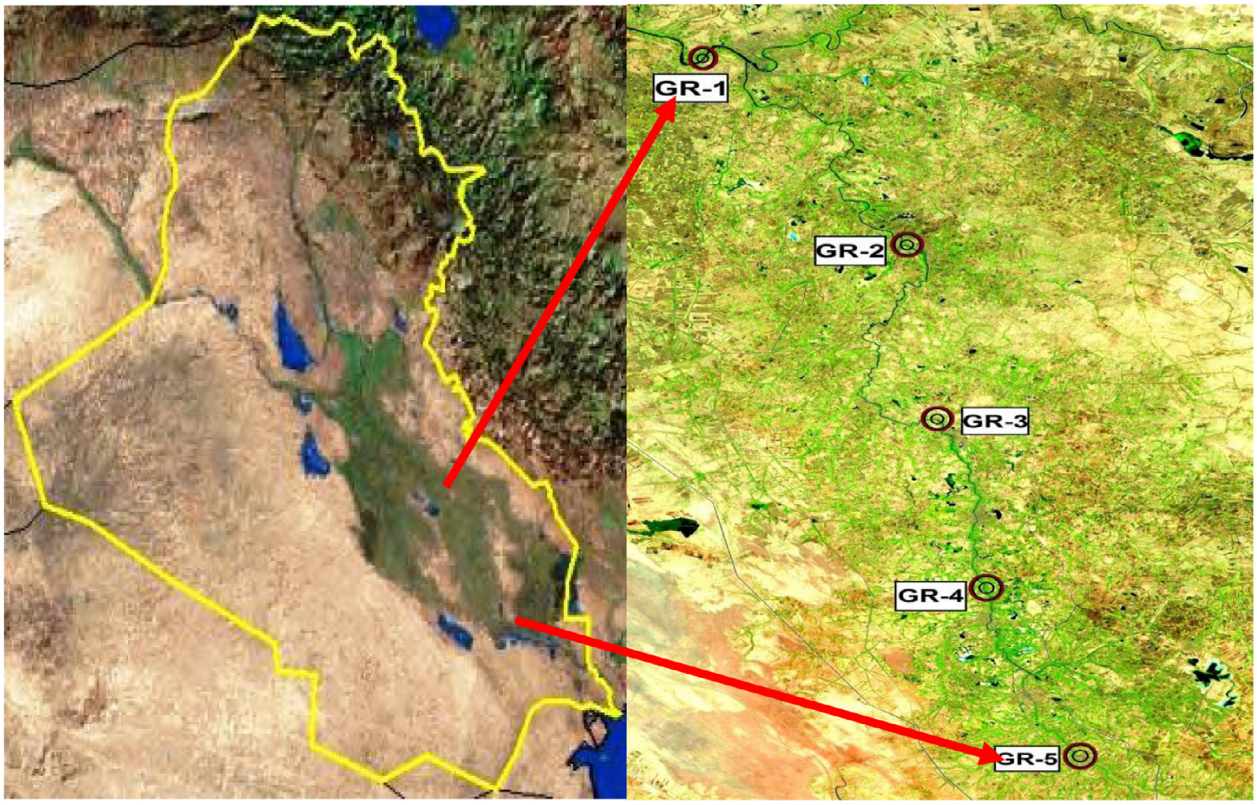

Fig. 1. The map and the sampling stations of the study area.