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Original Articles

Modification of expected conflicts between Drinking Water Quality Index and Irrigation Water Quality Index in water quality ranking of shared extraction wells using Multi Criteria Decision Making techniques

Sina Zahedi

Department of Renewable Energies and Environment, Faculty of New Sciences and Technologies, University of Tehran, Tehran, 31587-77871, Iran

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ABSTRACT

Groundwater resources play a crucial role in most arid/semi-arid regions such as Karaj plain, Iran. Excavation of wells and exploiting water resources of aquifers have long been known as ordinary solutions to supply water demands for drinking, agricultural and industrial purposes. In many agricultural areas such as the above-mentioned region, extraction wells have been utilized for both drinking and agricultural consumptions, while measures taken for water quality monitoring and protecting public health are seriously limited. On the other hand, most of the shared extraction wells in the region used for drinking purpose have been located near the agricultural lands and they are highly under the risk of getting polluted by Agricultural pesticides. The current paper firstly intends to demonstrate the results obtained from Drinking water Quality Index (DWQI) as well as Irrigation Water Quality Index (IWQI) and secondly determines probable conflicts that may be aroused in ranking of water wells using these two methods Subsequently, Multi Criteria Decision Making (MCDM) techniques such as Ordered Weighted Averaging (OWA), Compromise Programing (CP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) were employed to decrease effects of the conflicts. It was clarified that MCDMs, to some extent, alleviated contradictions in wells' ranks −determined by DWQI/IWQI- and authenticated this procedure as an appropriate method for water quality ranking in agricultural societies.

1. Introduction

Groundwater is one of the vital water resources on the earth planet which is extracted for fundamental uses such as drinking, agriculture and industry (Wu and Sun 2016; Li et al., 2016b; Chitsaz and Azarnivand, 2016). An imprudent increase in the demand of water resources causes depleting in natural aquifers due to rapid growth of population and accelerated haste of industrialization (Ramakrishnaiah et al., 2009; Krishan et al., 2016; Howard and Howard 2016; Li et al., 2015; Kumar et al., 2015; Kumar et al., 2016a; Kumar et al., 2016b; Kumar et al., 2017). In addition, over-exploitation and incautious use of groundwater influenced its quality and reduced access to groundwater resources. This negative trend expedited descends of groundwater level and deteriorated groundwater quality (Pophare et al., 2014). Poor drinking water quality, expensive water purification, threats to human health, and loss of water supply are the major hazards aroused from groundwater contamination. Accordingly, conduction of continuous inspections on chemical, physical and biological characteristics of groundwater resources should be known as an essential activity for a constant monitoring of water quality (Karkra et al., 2016a; Karkra et al., 2016b; Jang et al., 2013). In Iran, Groundwater is recognized as the most effective resource of water supply and plays a crucial role for satisfying drinking purposes, as well as agricultural, domestic and industrial demands (Sadat-Noori et al., 2013). As a result, several researchers have, so far, studied quality/quantity of underground water in different regions of Iran. For instance, Jamshidzadeh and Mirbagheri (2011) studied quantity and quality of Kashan basin, Iran. Their results demonstrated 0.5 m decline in average annual groundwater level for every year. They also reported that 53% of quality monitoring samples were appropriate for irrigation. Talaee (2015) investigated the quality of Ardabil plain in Iran. Their results illustrated that groundwater quality of the plain was situated in class "appropriate for agriculture" and concentration of chemical parameters was estimated to be under a predetermined warning level in a great area of the plain.

Several techniques of evaluation have been put into practice in order to present an accurate assessment of water quality (Zahedi et al., 2017). Among all, Water Quality index (WQI) is one of the recommended methods with a competence to facilitate analysis of water quality by relating a group of parameters to a common scale and combining them into a single number (Hosseini-Moghari et al., 2015).

E-mail address: Zahedi.Sina@ut.ac.ir.

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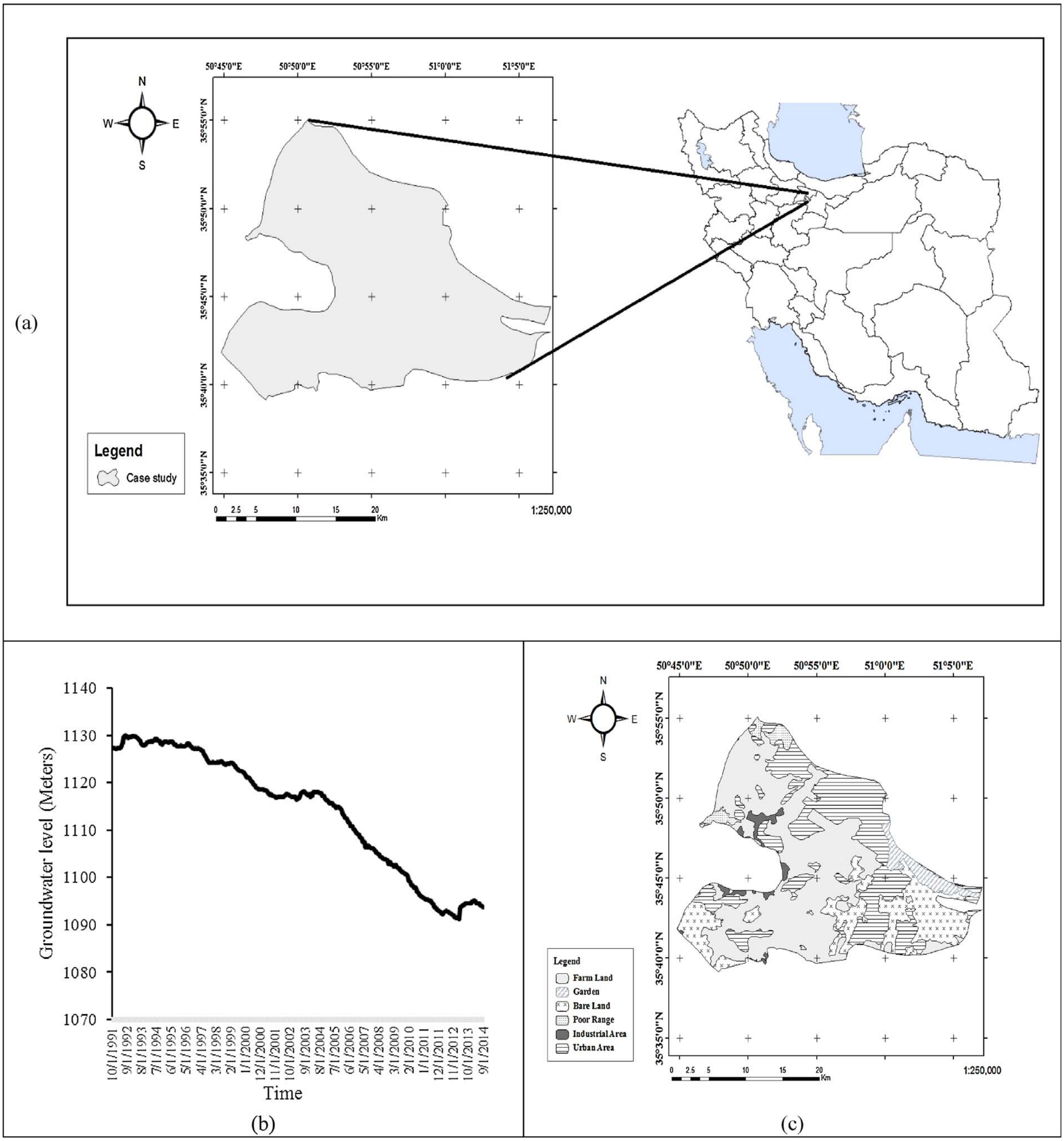

Fig. 1. Position of Karaj Plain (a), Average annual groundwater level of the study area during 1991–2014 (b), The land-use map of the studied area (c).

This method is specified for use in both surface and ground water quality assessment (Naubi et al., 2016, Bora and Goswami 2016). Nemati et al. (2014) studied groundwater quality of Saveh plain in Iran with a focus on the quality of water which is used for drinking purposes. According to their results, among an evaluated group of 12 drinking water wells, 2 wells were placed in class “excellent”, 5 wells in “good”, 4 wells in “poor” and one well was placed in very poor class of assessment. In another study, (Saeedi et al., 2010) illustrated a WQI map in which proper places for extraction of mineral water (in the study area of Qazvin province, Iran) are determined. Moreover, (Goher et al., 2014) developed Drinking Water Quality Index (DWQI), Irrigation water Quality Index (IWQI) and Aquatic Life Water Index in Ismailia Canal, Nile River, Egypt.

To the best of the authors' knowledge, few methods have, up to now, been practiced to evaluate irrigation water quality. Among the above methods, DWQI and IWQI have been utilized by (Goher et al., 2014; Bora and Goswami, 2016; Aher and Gaikwad, 2017). The assessment procedure in this method is similar to Drinking Water Quality Index (DWQI) released by WHO (2004). The only exceptional issue is that the standard value of each chemical parameter is extracted from the reports of FAO (1994). Meireles et al. (2010) have also innovated another assessment method known as IWQI. The calculation process in this method, however, differs from that of the previous one. After Meireles et al. (2010), some researchers utilized this method for evaluating IWQI in many regions (Brhane 2016; Chemura et al., 2014; Mohammad and Hassan, 2016).

In many parts of Iran, extraction wells are the major resources of water supply for agriculture and drinking purposes. Furthermore, priority examination of extraction wells can be conducted through estimations by Wilcox diagram which is specified for irrigation water assessment and uses only 2 parameters of calculation (Wilcox, 1955). However, the above assessment procedure – that entails defining DWQI