Research article

Suitability of Groundwater Use for Drinking and Irrigation Purpose, Case Study of Kien Svay District, Kandal Province, Cambodia

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Received 6 February 2018 Accepted 25 October 2018 (*Corresponding Author)

Abstract In Cambodia, some studies found that groundwater in some areas was contaminated by heavy metals and chemicals. Those contaminants can harm to human health if it is not properly treated. The research aims to analyze groundwater quality to find out the suitability of parameters for drinking and irrigation purpose, and to understand the condition of groundwater quantity used by local farmers. The study was conducted in Sre Ampil II Village, Chheu Teal Commune, Kien Svay District, Kandal Province in June 2017. Water samples from 6 tube wells with the depth ≥ 20 m and ≥ 50 m were collected to analyze its water quality. The sampling sites were done at the front-part, middle-part and rare-part of the village. Some parameters of drinking water: pH, TDS, EC, turbidity, hardness, As, Fe, Mn, Cl^-, F, NO_3^-, NO_2^-, SO_4^{2-}, *Escherichia coli* and total coliform were collected to analyze its concentration while the parameters such as pH, TDS, EC, hardness, salinity, As, Mn, Fe, SO_4^{2-}, Cl^-, NO_3^-, PO_4^{3-}, NH_4^-, Ca^{2+}, Mg^{2+}, and Na^+ were collected to analyze water quality for irrigation purpose. The results showed that only three of fifteen parameters exceeded desirable limit of FAO and the national standard of Cambodia as Mn concentration averagely was surpassed the standard limits (0.4 mg/L), especially in well 6 (2.64 mg Mn/L). For the concentration of harness, it was happened only in well 1 and 2 with its concentration of 306 mg/L and 360 mg/L, respectively, which was above the national standard (300 mg/L), yet it is below the standard recommended by FAO. *E. coli* and total coliform were also presented in all wells while its concentration were highly exceeded the guideline. The results of parameters in irrigation water from three tube wells showed that Mn (2.64 mg/L) and K^+ (5.19 mg/L) surpassed the guideline of FAO as it was only 0.2 mg/L and 2 mg/L, respectively, while other parameters were below the guideline. Considering this value as standard, the waters in the well 2 and 3 could problematic for long-term irrigation. Based on the groundwater testing, it could be concluded that water quality in the study is good for drinking and irrigating purpose as most of the parameters are below the guideline of Cambodia national standard and FAO.

Keywords groundwater quality, drinking water, irrigation purpose, Cambodia

INTRODUCTION

A fresh and reliable water supply is necessary for human, animal and plants to ensure a high quality of life and to push a strong economical and agricultural development. Intensive cultivating and

urban development has caused a great demand on groundwater resources. There have been various studies on assessment of suitable groundwater quality for drinking and irrigation purposes (Aksever et al., 2016; Ziani et al., 2016; Nag and Das, 2014; Kumar et al., 2014; Kaka et al., 2011). Groundwater locates in the deep layer and penetrates into small pore space between the rocks. Due to this natural flowing process, some mineral particulate components and hardness, Fe, Mn, As, NO3- and other particulate components are transferred by the water movement to various places depending on the groundwater flow direction.

The groundwater chemistry is an essential parameter for evaluating potential exploitable water of an aquifer (Gallardo and Tase, 2007). The main factors influencing hydrochemical groundwater quality are precipitation and dissolved minerals, ion-exchange and sorption and desorption in the groundwater flow (Apodaca et al., 2002). This situation is compounded by the complexity of the mineralogy saliferous, over exploitation of the aquifer and its low recharge, which limits the usable capacity of the aquifer this because of the considerable variation in the concentration of ions and the Total Dissolved Solids (TDS) (Belkhiri et al., 2012). At the same time, the environmental impacts of human activity like unused fertilizers, pesticides, sewage water and discharge of industrial effluents are considered as potential anthropogenic sources responsible for contamination of the groundwater (Venugopal et al., 2009). The presence of different chemical and physical constituents in excess of their permissible limits for various uses can create health hazards and environmental problems (Al-Zarah, 2007) and hence the water quality analysis is critical in ensuring that water consumed by the population meets the required quality standards (Amfo-Otu et al., 2014). In Cambodia, some studies found that groundwater in some areas was contaminated by heavy metals and chemicals. Those contaminants can harm to human health if it is not properly treated.

Having lived close to the Tonle Basac River, the main occupation of the people in Kien Svay District, Kandal Province, Cambodia is agriculture and related labor. Mostly they are growing vegetables with the application of heavy amount of chemical pesticide and fertilizers for increasing crop yields. This practice leads to increased potential contamination of agro- chemicals in environment and the water sources, especially surface water and groundwater, due to the leakage of agro-chemicals through precipitation and runoff.

OBJECTIVES

The research aims 1) To analyze groundwater quality to find out the suitability of parameters for drinking and irrigation purpose and 2) To understand the condition of groundwater quantity used by local farmers.

METHODOLOGY

The study was conducted in Phum II village located in Kean Svay District, Kandal Province where the water quality in the tube wells is not yet identified for both irrigation and drinking purposes. There are 214 families with the population of 862 people living in the village. The area of household is 20 ha while the paddy rice farming areas are 110 ha including dry and wet season cultivation. Villagers in this village can do the farming third time per year.

Sampling and analysis: Six tube wells were selected to analyze groundwater parameters with different depths of 20, 25, 30, 50, 55 and 60 m (for drinking purpose) and 50, 55 and 60 m (for irrigation purpose). The samples of water quality were chosen from the family whose tube wells were used in both irrigation and drinking purpose and the samples were collected by classifying the village into three sites: the front-part, middle-part and rare-part of the village. Some parameters such as pH, EC, TDS, hardness, turbidity and salinity were analyzed at the sites to avoid the error as their values are quickly changed with the times, while the other parameters such as As, Cl^-, F, Fe, Mn, NO_3^-, NO_2^-, PO_4^{3-}, Mg^{2-}, K^+, Ca^{2+}, *Escherichia coli* and total coliform etc. were brought to analyze in the laboratory at Resource Development International-Cambodia (RDI) by using

different method of water analysis based on each parameter. These samples were taken from drinking and irrigation water wells after 5 minutes of pumping, given sufficient time for the water temperature to stabilize and become representative of the temperature of the aquifer. Those analyzed parameters were compared with the drinking water standard guideline recommended by the FAO (2003) and World Health Organization (WHO, 2011) as well as the Cambodia Drinking Water Quality Standardby the Ministry of Industry and Handicraft (MIH, 2004).

Statistical analysis: Statistical analysis was conducted in this study. Microsoft Excel program was used to analyze describtive statistic and, standard deviation, while the statistical package was used to determine Two Sample T-test in order to compare the significant differences of water quality parameters with different depth of tube wells.

RESULTS AND DISCUSSION

Water Quality for Drinking Purpose:

The quality of groundwater depends both on the substances dissolved in the water and on certain properties and characteristics that these substances impart to the water (Heath 1982). The results of the analyzed water quality of the 6 tube wells with different depths of 20, 25, 30, 50, 55 and 60 m for drinking purpose mostly do not exceed two standard maximum allowable limit values. The results of statistical analysis of the chemical compositions of the groundwater samples are shown in Table 1. The table showed that most of the average values of those parameters are substantially below the limited standards, yet Mn concentration is exceeded the standard limit.

The values of pH indicated low alkalinity in the groundwater. The pH of groundwater in the study area is within the limits (6.5 to 8.8) of WHO guideline for drinking water quality. The electrical conductivity of the water samples was rated in the category permissible to suitable (EC = 484-801 μS/cm). The concentration of TDS ranged from 324 to 537 mg/L. The water with a TDS level less than about 600 mg/L is generally considered to be good (WHO, 2011). Also, the maximum permissible limit of TDS for drinking water is 800 mg/L as per the MIH (2004) drinking water standards. Thus, according to the WHO (2011), FAO (2003) and MIH (2004), the TDS values of all wells are suitable for drinking. The concentration of harness ranged from 198 to 360 mg/L and was exceeded above the national standard limits (300 mg/L) only in well 1 and 2 with their concentration of 306 mg/L and 360 mg/L, respectively. Ninety percent of analyzed samples were not exceeded the desirable national limit (200 mg/L) of chloride (Cl^-) according to WHO guideline for drinking water. Only ten percent of samples exceed the desirable limit (250 mg/L) of sulphate (SO_4^{2-}) of WHO guideline for drinking water. The NO_3^-, NO_2^- and F could not be detected by the machine. In Table 1, it is indicated that the concentration of Mn was very high above the standard limits. Arsenic presented in all wells and above the recommended standard of the WHO (2011) which the maximum permissible limit for As concentration in drinking water is 0.01 mg/L. The mean concentration values of Fe in the wells is 0.14 mg/L. According to the WHO (2011), maximum accessible values for Fe concentration in drinking water are 0.3 mg/L. Considering this as the standard value, the Fe contained in the water is still suitable for the drinking purpose, even though the well 5 reached to the peak of the limited standard (0.3 mg/L), following by well 6 (0.28 mg/L). *E. coli* and total coliform were also presented in all wells while its concentration were highly exceeded the guideline as the numbers of coliform were too numerous to count in the machine. However, the presence of these parameters do not cause serious illness to the human health as they could be eliminated by boiling water before drinking (RDI, 2016), or by using Biosand Filter-Zeolite, *E. coli* were completely removed during the first three trials after filtering total volumes of 1120 L, 1140 L and 1220 L (Mwabi et al., 2012). Moreover, the stables or pens which are located next to the wells should be removed to build at other place to avoid contamination.