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Hydrochemical characterization of various surface water and groundwater resources available in Matahara areas, Fantalle Woreda of Oromiya region

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ABSTRACT

Study region: The Matahara region is located in the East Showa zone of Oromiya regional state (Ethiopia). Matahra Sugar Estate and Lake Basaka (highly saline, alkaline and sodic lake) are situated within the flat plains of Matahara region. The area is vulnerable to the occurrences of various tectonic and volcanic activities due to its location in the upper most part of the Main Ethiopian Rift Valley region.
Study focus: In this study, the hydrochemical properties of different surface water and groundwater bodies available at Matahara region have been characterized for quality compositions. Water samples were collected from different water sources and analyzed for important major quality parameters following standard test procedures. Other chemical indices were derived from the measured quality parameters. The potential sources of minerals were suggested for each of the considered water sources based on their quality characteristics.
New hydrological insights for the region: Overall, the study result elucidates that the chemical composition of different water bodies are due to natural processes and/or anthropogenic activities within the region. The local anthropogenic processes could be discharges from factory, domestic sewage and farming activities. Some of the water types are found to have relatively higher concentration of dissolved constituents. Irrigation waters have almost equal chemical compositions, indicating their hydrochemical sources are almost the same. Most of the concentrations are relatively high in Lake Basaka, groundwater and hot springs. It is easy to imagine the potential damaging effects of such quality waters on crop production, soil properties and environment of the region.

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1. Introduction

Sustainable social and economic developments are largely dependent on water resources. However, securing water (quality and quantity) to satisfy the needs of humans and ecosystems is one of the primary issues challenging the 21st century (Amangabara and Ejenma, 2012). Compounding the problem is the fact that water quality is one of the most sensitive issues worldwide, potentially influenced by many natural and anthropogenic factors. These include (Freeze and Cherry, 1979): source of water, the degree of its evaporation, types of rock and mineral it has encountered (i.e. geology and mineralogy of the watershed), geological processes within the aquifer, velocity and direction of water movement and the time it has been in contact with reactive minerals. It is also affected by external pollution agencies such as effluents from agricultural return flow, industrial and domestic activities (Srinivasamoorthy et al., 2012).

The assessment of water quality has become an important part of water resource studies, planning and management. It is gaining significant importance due to intense urbanization, industrialization and agricultural activities that are increasing the risk of contamination of soil and water (Tiwari, 2011). Water quality monitoring is important for the protection of public health (*drinking or domestic use*), agriculture, industry, fishing, recreation, tourism and protection of aquatic ecosystems. The knowledge of the water quality status as well as the processes affecting water quality is vital for Integrated Water Resource Management (IWRM) activities within the catchment.

The development of large scale irrigation schemes within Middle Awash Basin of (Ethiopia) in the 1960s coupled with the construction of major highway and railway lines has brought a rapid industrialization and urbanization to the region. These developmental activities, coupled with the expansion of the highly saline and alkaline Lake Basaka (Dinka, 2010, 2012) have increased the risk of contamination of the soils and waters of the area. The area of Lake Basaka increased from about 3 km^2 in 1960 to about 48.5 km^2 in 2010 (Dinka, 2012). The expansion of the lake with such poor quality at a very fast rate in the past five decades is a serious developmental (social, economic and environmental) challenge for the region.

The various developmental activities in Matahara region were generating a variety of effluents and waste products, hence, adding pollutant loads to water resources and environment of the region for an extended period. For instance, Matahara Sugar Estate (MSE), one of the important large scale irrigation schemes in the region, is currently affected by various problems associated with environmental degradations (Dinka, 2010). Waterlogging and salinization are threatening the sustainable production and productivity of the sugar estate. Moreover, the sugar estate has been using various agro-chemicals for long period. The area is characterized by shallow groundwater, and therefore, groundwater recharge from irrigation and/or rainfall is relatively rapid. This condition facilitates the downward mobility (leaching) of agro-chemicals (herbicides, pesticides, inorganic fertilizers and organic compounds) into the shallow groundwater table and contaminating them quickly.

Due to the changing hydrological conditions and anthropogenic activities in the region in particular and Rift Valley region in general, the hydrochemistry of different water sources, especially groundwater, hot springs and Lake Basaka is expected to change over time. Knowledge and understanding the hydrochemical properties in such semi-arid climate will contribute to sustainable development and effective management of the available water resources. Hence, the characterization of the hydrochemistry of different water sources at the regional scale has paramount importance.

As far as our knowledge is concerned, no comprehensive hydrochemical characterization of the various surface water and groundwater (SW-GW) sources has been carried out in the study region. Most of the previous studies (Halcrow, 1978; Ayenew, 2004; Belay, 2009; Georner et al., 2009; Dinka, 2010, 2012; Dinka et al., 2014) were addressing aspects of the Lake Basaka expansion. In fact, most of the previous research findings are contradicting each other. A study report made by Halcrow (1978) and Ayenew (2004) have suggested that the nearby irrigation farms (Abadir and Nura-Erra) are discharging excess irrigation water into Lake Basaka and are responsible for its expansion. On the contrary, Georner et al. (2009) and Dinka (2010) reported that Abadir farm has little effect on hydrochemistry of Lake Basaka.

The present study, therefore, initiated with the objective to highlight the hydrochemical compositions of different SW-GW sources available in Matahara plain. Some of the important major water