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Hydrogeochemical investigation of groundwater in Jericho area in the Jordan Valley, West Bank, Palestine

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ABSTRACT

Water resources in the Middle East, particularly in Palestine, are extremely scarce and costly. The Jordan Valley is a fertile productive region, described as the food basket of Palestine. Groundwater originating from the Quaternary Aquifer System forms the main water resource in the Jordan Valley. However, the quality of this groundwater is threatened mainly by the high chloride concentration. The most representative area of the Jordan Valley is Jericho area, which was chosen to be the study area. The study area (65 km^2) is almost a flat area with a gentle decline towards the east. It is the lowest land on earth with ground levels reaching 400 meters below sea level (mbsl) near the Dead Sea shores. The Quaternary Aquifer System in the study area could be divided into an upper alluvial layer with thickness varying from 40 to 150 m and a lower low-permeable Lisan layer, which crops out in the eastern part of the study area with thickness over 200 m. Hydrogeochemical investigation reveals that the water is generally earth alkaline with higher content of earth alkalis and prevailing chloride. According to Stuyfzand (1986) and Piper's (1944) classification systems, water type in the Alluvial Aquifer varies from fresh hard $CaMgHCO_3$ or $MgCaHCO_3$ water in the west and northwest to brackish very-hard MgNaCl or NaMgCl in the middle. In the east, the water becomes brackish-salt extremely-hard MgNaCl or NaCl. Groundwater quality is deteriorating (increase in salinity) spatially towards the east and vertically with increasing depth (when nearing the Lisan Formation). As an indication of groundwater salinity, total dissolved solids show some variability with time over the last 21 years (1983–2004). In short-time scale, there are high seasonal and yearly fluctuations with regard to salinity, specifically in Cl^- and SO_4^{2-} contents. Spring water from the Upper Cenomanian Aquifer ($CaHCO_3$) represents the fresh end member, while Rift Valley Brines (RVB-CaNaCl) and Dead Sea Brines (DSB-MgNaCl) represent the saline end members. Existing water types are mixtures of the 3 end members. There is a consistency in results and analysis of geological, hydrogeological, hydrochemical and geophysical data. There are three probable sources of increase in groundwater salinity: mixing with saline end members (RVB/DSB); dissolution of minerals of the Lisan Formation (calcite, dolomite, gypsum and halite); and to some extent, agricultural effluent pollution.

1. Introduction

The Middle East and Palestine in particular suffer from severe scarcity of water due to natural and political conditions. The semi-arid to arid climate directly affects the rainfall amounts which represent the main source of groundwater recharge especially in the mountainous regions. Political restrictions imposed by Israeli occupation authority, including the full control over all ground and surface water resources, and the presence of Israeli colonies in the West Bank, also severely affect the amounts of water available for Palestinians.

There are two major water resources in the West Bank: groundwater, including wells and springs, and surface water and additionally some small portions of rainwater collected in cisterns. Groundwater is derived from different water aquifers contained within three groundwater basins: the North-Eastern, Eastern and Western Basins (Fig. 1). The estimated exploitable water quantity from the Jordan River system is about 1287 Mm^3/year (El-Musa, 1993, 1996). Now, Israel is using most of the river water and gives nothing to Palestinians.

The Jordan Valley is a fertile productive region, which constitutes 52% of the total irrigated land in the West Bank. It is described as the food basket of Palestine where citrus, bananas, date palms, vegetables and field crops are grown all over the year. Since precipitation rate in the Jordan Valley is low (150 mm/year), and potential pan evaporation is high (2200 mm/year), rain fed farming is not feasible in the region (JWS, 1994).

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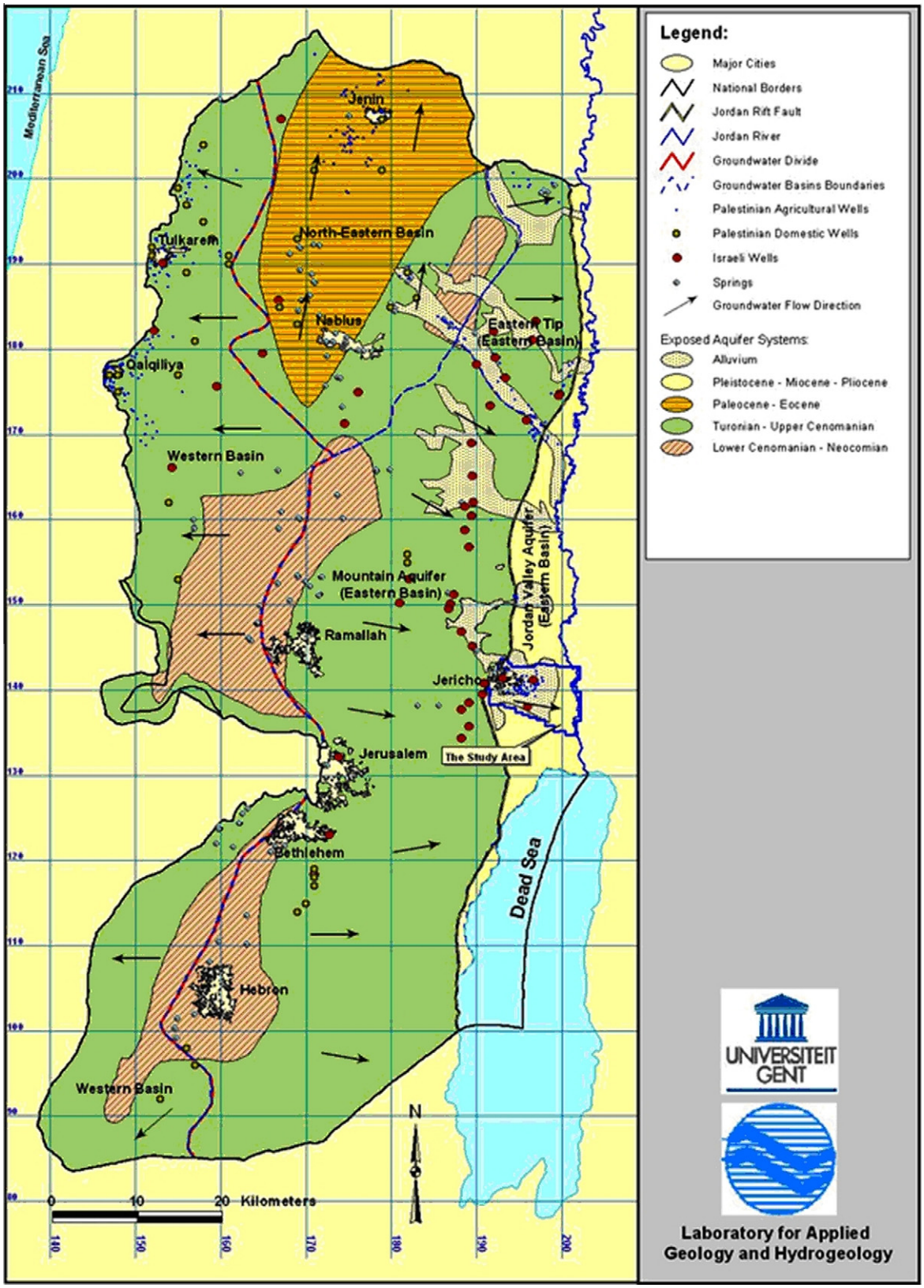

Fig. 1. Exposed aquifer systems; wells, springs and groundwater basins.

Reliance for additional exploitation is therefore totally on groundwater that originates from the Quaternary and Mountain Aquifers of the Eastern Basin through wells and springs. However, groundwater quality of the Quaternary Aquifer is threatened mainly due to high chloride concentration and, to some extent, to the elevated concentrations of sulfate and nitrate in some boreholes, which may restrict the use of groundwater, especially for agricultural purposes.