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Article

Seepage Velocity: Large Scale Mapping and the Evaluation of Two Different Aquifer Conditions (Silty Clayey and Sandy)

Qais Al-Madhlom [1,2], Nadhir Al-Ansari [1,*], Bashar Abid Hamza [2], Jan Laue [1] and Hussain Musa Hussain [3]

1 Department of Civil, Environmental and Natural Resources Engineering, Lulea University of Technology, 97187 Luleå, Sweden; qais.alsaady@gmail.com or qais.al-madhlom@ltu.se (Q.A.-M.); jan.laue@ltu.se (J.L.)
2 Faculty of Engineering/Al-Musayab, University of Babylon, Musayyib 51006, Iraq; basharabid74@gmail.com
3 Remote Sensing Center, University of Kufa, Kufa 540011, Iraq; hussainm.alshimmary@uokufa.edu.iq
* Correspondence: nadhir.alansari@ltu.se; Tel.: +46-7253-907-67

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Abstract: Seepage velocity is a very important criterion in infrastructure construction. The planning of numerous large infrastructure projects requires the mapping of seepage velocity at a large scale. To date, however, no reliable approach exists to determine seepage velocity at such a scale. This paper presents a tool within ArcMap/Geographic Information System (GIS) software that can be used to map the seepage velocity at a large scale. The resultant maps include both direction and magnitude mapping of the seepage velocity. To verify the GIS tool, this study considered two types of aquifer conditions in two regions in Iraq: silty clayey (Babylon province) and sandy (Dibdibba in Karbala province). The results indicate that, for Babylon province, the groundwater flows from the northwest to southeast with a seepage velocity no more than 0.19 m/d; for the Dibdibba region, the groundwater flows from the west to the east with a seepage velocity not exceeding 0.27 m/d. The effectiveness of the presented tool in depicting the seepage velocity was thus demonstrated. The accuracy of the resultant maps depends on the resolution of the four essential maps (groundwater elevation head, effective porosity, saturated thickness, and transmissivity) and locations of wells that are used to collect the data.

Keywords: darcy velocity large scale mapping; seepage velocity large scale mapping; average linear velocity large scale mapping; ArcMap/GIS software; groundwater tools; darcy velocity tool; thermal advection losses; heat transfer with porous media; mass transfer porous media; contaminants transfer within soil

1. Introduction

Groundwater represents a promising solution for one of the most significant problems facing humanity in recent decades. Amongst many significant complex problems, such as resource depletion, poverty, ecosystem service deterioration, pollution, biodiversity loss, and climate change and global warming [1–4], the shortage of water represents the greatest threat because it is directly related to human wellbeing [5,6]. According to the World Resources Institute (WRI), numerous countries have experienced serious problems regarding quality and quantity of water resources, and many more countries will face these problems in the future [7,8]. The Tigris and Euphrates river basin (spanning parts of Turkey, Syria, Iraq, and Iran) lost about 144 cubic kilometers of fresh water between 2003 and 2009. This loss is roughly equivalent to the volume of the Dead Sea [9]. The total loss of all water resources in the basin between 2003 and 2010 has been estimated to be a depth of about 200 mm [10], resulting in drought, and affecting the marshes of south Iraq [11–14].