以熱示蹤劑試驗與模式評估海岸帶含水層分層流動特性

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摘要

近年來海岸帶地下水補注(SGD)受到重視，儘管地下水補注量在海洋淡水補注總量中佔比不高，卻是非常重要的陸向海物質傳輸管道，其中沿海生態平衡，與陸源地下水所挾帶的營養鹽多寡息息相關。隨著沿海地區社會和經濟的發展，沿海生態環境惡化問題浮現，評估海岸帶含水層特性，以達到永續沿海生態環境為不可或缺的一環。本研究以中央大學 TaiCOAST 臨海工作站作為研究場址，結合現地熱示蹤劑試驗及數值模式模擬沿海含水層，旨為推估海岸帶含水層分層流動之特性。跨孔加熱試驗運用熱作為示蹤劑，搭配分散式溫度感測器(DTS)，將場址內各井垂直溫度分布同時進行高解析量測，透過不同觀測井所呈現之熱反應，推估該場址地下水流流向。數值模式採用 MODFLOW 及 MT3DMS 建立模型，以現地收集之水力傳導係數、地下水位、熱參數、水文地質參數作為初始條件及邊界條件，建立海岸帶含水層地下水流場。藉由模式所模擬出地下水流場與現地試驗結果相互比對，評估本研究場域地下水流動特性，提供海岸帶地下水補注參考依據，進而達到永續沿海生態環境之目的。

關鍵字：跨孔加熱試驗、海岸帶含水層 、數值模式、分散式光纖溫度感測器

Using thermal tracer tests and numerical models to evaluate the layered flow characteristic in a coastal aquifer system

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Abstract

Submarine Groundwater Discharge (SGD) has been emphasized in recent years. Although groundwater discharge does not account for a large proportion of total marine freshwater discharge, it is a very important land-to-sea material transport pipeline, where the balance of the coastal ecosystem is closely related to the amount of nutrient salts which is carried by groundwater. With the increased economic development in coastal areas, the problem of coastal ecological degradation has emerged, and therefore it is indispensable to evaluate the characteristics of coastal aquifers in order to achieve a sustainable coastal ecosystem. In this research, the use of in-situ thermal tracer tests and numerical models to estimate the characteristics of layered flow in coastal aquifer systems is applied at the TaiCOAST station of National Central University. The cross-hole heating tests use heat as a tracer and combine the distributed temperature sensor (DTS) to simultaneously conduct high-resolution measurements with the vertical temperature distribution in each observation well. This estimates the direction of groundwater flow in the research area through the thermal response presented by different observation wells. The numerical model uses MODFLOW and MT3DMS to establish the simulation of the coastal aquifer system, setting up the initial conditions and the boundary conditions by the measurement data in the field, such as hydraulic conductivities, groundwater levels, thermal parameters, and hydrogeological parameters. By comparing the simulation of groundwater flow field with the results of the in-site experiments, we assessed the groundwater flow characteristics of the study site and provided a reference for understanding the groundwater discharge in the coastal aquifer system, thus achieving the purpose of achieving a sustainable coastal ecosystem.

Keyword: Cross hole heating test, Numerical simulation analysis, Coastal aquifer system, Distributed temperature sensor.