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塔河下游间歇性输水河道附近地下水位动态响应

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Responses of groundwater levels to intermittent water transfer in the lower Tarim River

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摘要

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摘要 塔里木河(塔河)是中国最长的内陆河,沿塔克拉玛干沙漠控制着新疆大部分地区.塔河自大西子水库以下已经断流30多年,引发许多严重的生态环境问题.为缓解下游的生态压力,向下游进行了几次紧急生态输水,以检验输水对塔河下游地区环境问题的影响.本文依据塔河下游的水文地质特征和极端干旱的气候条件,建立了不存在源汇项条件下的一维非稳定流模型并引入了傅里叶变换求解方法.通过对河流水位的阶梯状概化,简化了非稳定流模型的边界条件.为了查明区内含水层的结构,考虑到高密度电法兼具电测深和电剖面的特点,在研究区实施了一条高密度电法剖面.电法剖面揭示,区内潜水含水层呈水平层状分布,平均厚度约为35 m.根据电法剖面的结果,经过实测资料验证,模型反演得到的潜水水位的最大平均绝对误差为0.3 m,远远小于区内潜水水位波动的幅度.相关性分析表明,模型计算值和实测值之间具有显著的相关性.因此,模型很好的刻画了塔河下游河道附近地下水对上游输水的响应,为评价塔河下游生态输水的环境效应提供了一个有力的理论工具.

关键词 塔河, 生态输水, 潜水含水层, 傅里叶变换, 高密度电法

Abstract: Tarim River is the longest in-land river in China, which controls most of the domain of Xinjiang province, along with the Taklimakan Desert. It has been about 30 years since the river depleted from Daxizi reservoir downstream, which results in lots of serious environmental problems. In the resent years, ecological water conveyances to the lower reaches were performed and tested its effects on solving these problems. Based on the characteristics of hydrogeology and the conditions of climate, a one-dimensional transient groundwater flow model without source and sink is established, and a new method, Fourier transformation, is introduced to solve the equation. In the process, the river table is simplified as steps and the boundary condition of the model is also rendered into a simple form. A section of high density resistivity is conducted to explore the condition of aquifer in the study area for its combining properties of resistivity sounding and electrical profiling. The result of geophysics unveils that the table water aquifer is horizontal and bedded with a thickness of about 35 m. Based on the result, a field data fitting from the simplified model shows that the calculated groundwater table has a very small mean absolute error with a maximum of 0.3 m which is far less than the fluctuation of observed groundwater table. And the correlation analysis unveils a significant correlation between computed and observed values. So the one-dimensional model is good to indicate the changes of groundwater levels in the vicinity of watercourse, and it can be used for evaluating the effects of ecological water conveyance in the lower reaches of the Tarim River.

Keywords Tarim River, Ecological water conveyance, One-dimensional transient flow model, Fourier transformation, High density resistivity method

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