Abstract

Hydrological modelling and Environmental Assessment of Agricultural Water Resource Dynamics in the Baakse Beek Basin, Netherlands

Sadhasivam Sathish[1], Marco Petitta[1], Giacomo Medici[1], Ahmed Abdelrady[2], Tom Sleutels[2], Joachim C Rozemeijer[3]

1 Earth Sciences Department, Sapienza University of Rome, Italy

2 Wetsus European Centre of Excellence for Sustainable Water Technology, Water Campus Leeuwarden, Netherlands

3 Deltares, Delft, The Netherlands

Agriculture stands as a cornerstone of the Dutch economy, heavily reliant on water resources from surface water channels and shallow groundwater wells. This study explores the intricate interplay between agricultural practices, water resource utilization, and environmental dynamics, focusing on the Baakse Beek basin, emblematic of Dutch environmental challenges. Despite the apparent abundance of water, intensive agricultural activities have led to a complex nexus of surface water-groundwater interactions, exacerbating contamination issues. The compounded effects of prolonged water usage and extreme climatic events, such as the 2018 drought, further strain water quality and quantity in the region. The Baakse Beek basin, occupying 60% of its land for agricultural purposes, serves as a microcosm of these challenges. Long-term pumping from well fields, coupled with recent drought conditions, has resulted in groundwater depletion and escalating contaminant levels, notably nitrate concentrations. To address these concerns, the NINFA EU project aims to mitigate water resource contamination and implement effective mitigation measures. This study contributes to the project's objectives by developing a comprehensive flow and reactive solute transport model. Leveraging advanced modelling techniques, including the USG groundwater model, the hydrological and dynamics of the basin are simulated. The model accounts for topographical nuances, discretizing the domain into grids ranging from 961 sq. m to 0.25 sq. km. Furthermore, vertical stratification of the shallow aquifer into 17 layers enables detailed representation of physical, chemical, and depositional environmental changes. Calibration of the model against extensive monitoring data yields high accuracy, with goodness-of-fit statistics of R2 = 0.9542 and RMSE = 1.46. Insights gleaned from the calibrated model elucidate aquifer behaviours during environmental crises, offering invaluable guidance for water resource management strategies.

Keywords: surface water interaction; agriculture; climate change; groundwater contamination