WQ06

VULNERABILITY ASSESSMENT OF GROUNDWATER RESOURCES IN THE JAFFNA PENINSULA, SRI LANKA: A MODEL STUDY FOR NITRATE DISTRIBUTION

H.A.M. Prasadani[1,2*], R.R.G.R. Rajapakse[2] and A.M.N.P.B. Abeysinghe[2]

[1]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka*
[2]*Water Resources Board, Rajagiriya, Sri Lanka*

The assessment of groundwater vulnerability has become indispensable in the realm of hydrogeological science. It plays a crucial role in assessing, monitoring, conserving, and managing groundwater resources, especially in the Jaffna peninsula, where the water demand is mainly fulfilled by groundwater which exists in a hydrogeologically sensitive setup. In this study, a modified DRASTIC model, one of the most accurate overlay and index methods, was employed for the assessment of groundwater vulnerability. This modification considered the land use data from the WaPor open access web portal consisting of remote sensing satellite data, thereby providing a more relevant, updated, and accurate representation of vulnerability. The primary objective of this study was to delineate susceptible zones for groundwater pollution within the peninsula by integrating assessed hydrogeological layers or formations within the GIS. During the process, eight parameters (depth to water, net recharge, aquifer media, soil media, topography, impact of vadose zone, hydraulic conductivity and land use) utilized from temporal groundwater level fluctuation over ten years, borehole information of 102 tubewell constructions and test pumping and land use were manually evaluated according to a rating criterion and developed raster layers within a GIS database. The raster layers were overlaid according to the weight allocation and the groundwater vulnerability map was prepared. The resulting index map revealed a wide range of index values (100 to 250), which were categorized into five distinct classes, namely very low, low, moderate, high, and very high. The vulnerability assessment of a region covering 1025 km^2 classified 26% of the area as moderate, 35% as high and 39% as very high vulnerability zones. Groundwater recharge is notably heightened in shallow karstic aquifers, particularly in Jaffna, Nallur, Karaveddi, and Kopay, rendering these areas more susceptible to contamination. Soil textures, ranging from sandy loam to Solodized Solonetz and Solon Chaks, play a crucial role in groundwater permeability, in areas like Vadamarachchi and Pachchilapallai being more vulnerable to contamination due to easy percolation. The aquifer media, primarily limestone formations, exhibit high permeability and karst features, increasing vulnerability to contamination. Variations in hydraulic conductivity, flat topography and diverse land uses further contribute to the region's groundwater vulnerability. Urbanized areas, such as Jaffna and Nallur, exhibit higher aquifer vulnerability. The model validation provides how accurately the simulated conditions match the actual condition of the model area and the ultimate step for assessing the model accuracy. It demonstrated a strong correlation between nitrate levels which were measured before and after the monsoons over 10 years and the resulting DRASTIC-LU index. This validation not only enhances the credibility of the model but also underscores the practical utility of the assessment. The results of this vulnerability assessment on groundwater contamination can be used as a decision-making tool for policymakers and local authorities in land use management and planning.

Keywords: Aquifers, DRASTIC index, Groundwater, Nitrate, Vulnerability

prasadihan@gmail.com