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Estimating Groundwater Seepage Rates: Case Study at Zegveld, Netherlands

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Abstract : This study aimed to identify and estimate dynamic groundwater seepage rates using four comparative methods; the Darcian approach, the water balance approach, the tracer method, and modeling. The theoretical background to these methods is put together in this study. The methodology was applied to a case study area at Zegveld following the advice of the Water Board Stichtse Rijnlanden. Data collection has been from various offices and a field campaign in the winter of 2008/09. In this complex confining layer of the study area, the location of the phreatic groundwater table is at a shallow depth compared to the piezometric water level. Data were available for the model years 1989 to 2000 and winter 2008/09. The higher groundwater table shows predominately-downward seepage in the study area. Results of the study indicated that net recharge to the groundwater table (precipitation excess) and the ditch system are the principal sources for seepage across the complex confining layer. Especially in the summer season, the contribution from the ditches is significant. Water is supplied from River Meije through a pumping system to meet the ditches' water demand. The groundwater seepage rate was distributed unevenly throughout the study area at the nature reserve averaging 0.60 mm/day for the model years 1989 to 2000 and 0.70 mm/day for winter 2008/09. Due to data restrictions, the seepage rates were mainly determined based on the Darcian method. Furthermore, the water balance approach and the tracer methods are applied to compute the flow exchange within the ditch system. The site had various validated groundwater levels and vertical flow resistance data sources. The phreatic groundwater level map compared with TNO-DINO groundwater level data values overestimated the groundwater level depth by 28 cm. The hydraulic resistance values obtained based on the 3D geological map compared with the TNO-DINO data agreed with the model values before calibration. On the other hand, the calibrated model significantly underestimated the downward seepage in the area compared with the field-based computations following the Darcian approach.

Keywords : groundwater seepage, phreatic water table, piezometric water level, nature reserve, Zegveld, The Netherlands
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