GIS coupled Water Budget for Spatial and Temporal Analysis of Water Resources: Horowhenua, New Zealand

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Abstract

A spatially and temporally enhanced water budget was developed for and applied for Horowhenua, New Zealand for 2007, 2008 and 2009. High resolution daily precipitation surfaces were generated in ArcGIS along with daily actual evapotranspiration derived from the FAO Penman-Monteith equation. Gauged stream flows were used to derive surface outflows from a regression model. Groundwater level data were used to derive potentiometric surfaces, storage change from water table fluctuations (WTF) and hydraulic gradient which in turn were used to calculate groundwater outflow via Darcy's Law. Annual groundwater storage change varied significantly with mean estimated values of -53.8, -23.9 and 42.5 Million cubic meters (Mcm) estimated for 2007, 2008 and 2009 respectively. Monthly storage had a higher variability, with values being greater in magnitude than net annual change. Total volume and rainfall pattern were identified as key explanations for the storage change behaviour. A low rainfall year inclines towards a negative storage change and a high rainfall year towards a positive storage change. However, a high rainfall year may have a negative recharge if storms occur whereby rainfall intensity is increased resulting in larger surface outflow as a percentage of rainfall. Resolution of GIS surfaces is very important for evapotranspiration which is affected by landuse, thus retention of spatial integrity with an appropriate resolution is important. Data availability was a major limitation to the potential of the GIS-coupled water budget technique, specifically a nonexistence of stream gauging stations in locations near the coast. Likewise, an absence of daily information for groundwater levels and water consumption data impeded the temporal resolution that could be achieved. This research has displayed the potential of a water budget coupled with high resolution GIS data to provide valuable information for water resources.

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