UNIVERSITY OF COPENHAGEN
FACULTY OF SCIENCE

Catchment Investigation of Letsitele, Limpopo Basin, South Africa: Groundwater-Surface Water Estimation and Catchment Modelling

Master of Science Thesis
by
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Abstract

This Master thesis is built upon an earlier study lead by IWMI (International Water Management Institute) as a part of the GRECHLIM project. The main focus of the GRECHLIM project was to get an understanding of the groundwater-surface water interaction in the Limpopo River Basin and thereby also investigated the groundwater recharge. The GRECHLIM project started 1th of January 2016 until December 31st of 2018. This Master thesis is working with data from 01-04-2008 until 01-04-2019. The goal for this thesis is to use and illustrate new and old data from the Letsitele catchment.
Objectives:

1. Collect stream measurements and estimate the groundwater inflow of a 3km test segment of the Letsitele River by using the Differential Flow Gauge Method. The purpose of the method was to improve and apply EVT-correction to the rating curve, found in the previous study. The improved rating curve was used to estimate the groundwater inflow to the 3km segment over a period of 56 days.
2. Create a simple numeric groundwater model of the Letsitele catchment. The purpose of the groundwater model was to investigate the seasonal variation between the surface water-groundwater interaction over a period of 11 years (01-04-2008 to 01-04-2019).

The improved rating curve was used to convert river stages into discharge, for a period of 56 days. The 3km test segment is located in the outlet area of the catchment, between the Temporary and Permanent Gauge. The groundwater inflow to the segment, after evaporation- correction for the 56-day period was 30.27 m^3/sec. The evaporation- correction resulted in a change of 0.4 m^3/sec in the groundwater inflow over the 56-day period. The total flow measured for the 56-day period (48.34 m^3/sec or 0.86m^3/sec per day) consisted of 62.62% groundwater and 37.38% surface water.
Two models was designed for the catchment, a steady state and a non-steady state model. Both models were manually calibrated. Both models contain long-term observation data and was calibrated against the catchments groundwater heads. The purpose of the water models was to investigate the seasonal variation between the groundwater and the surface water. None of the two models are perfect. The models are in general simulating to much water. The non-steady state model has a RMSE of 9.9m, where the steady state model has a RMSE of 11.4m. The seasonal variation was seen in the groundwater flow for the non-steady state model. The groundwater outflow to the surface water are controlled by spontaneous rainfall during the wet season. In the summer months, where the rainfall and recharge are high, the amount of groundwater supplying the surface water are larger. Over the 11- year model period, the water budget for the two models (steady and non-steady models) showed that the groundwater systems are building up groundwater.

Keywords: Groundwater-surface water interaction, field investigation, Differential Gaugin Method, groundwater system, numeric modelling, ModelMuse, Sub-humid climate, Limpopo river Basin, South Africa.