Workplan MSc Thesis

Groundwater Head Time Series Analysis with Non-Linear Recharge Models Using Pastas

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December 29, 2020

1. Introduction

Time series analysis is becoming a more popular method to analyze head measurements in an observation well. The Python package Pastas applies time series analysis with transfer function noise modelling using predefined response functions (Collenteur, Bakker, Caljé, Klop, & Schaars, 2019). This makes the models often much simpler, with the extra benefit of better fits than regular groundwater models. To do this successfully the response function of each stress has to be estimated, including the uncertainty (Bakker & Schaars, 2019).

The most commonly used stress for these models is the recharge flux which is approximated by a linear function of the precipitation and the potential evaporation. This is a simplification of the many non-linear processes that are present in the system. For instance the non-linear relation between degree of saturation and the hydraulic conductivity and as a result the percolation to the water table in the root zone (Feddes, Kabat, Van Bakel, Bronswijk, & Halbertsma, 1988).

There has been research in the past to implement non-linear models in time series modelling. For instance the model of Berendrecht, Heemink, van Geer, & Gehrels (2006) which introduced non-linearity by modelling the degree of water saturation of the root zone. Other research from Peterson & Western (2014) investigated a flexible soil moisture model which allowed for 84 different non-linear models to be calibrated. The most recent article on this topic is from Collenteur, Bakker, Klammler, & Birk (2020), with a non-linear recharge model loosely based on the FLEX conceptual modelling framework (Fenicia, Savenije, Matgen, & Pfister, 2006). In this research the estimate of the recharge could be contrasted to lysimeter data which were in reasonably good agreement.

All these models showed a better performance of the implemented non-linear model compared to the linear model. The problem however is that the non-linear unsaturated zone implementations are site specific which makes them unlikely to be appropriate for different climates and geologies (Peterson & Western, 2014).

The aim of this thesis is to test these non-linear models on a large scale and specify the conditions under which the use of non-linear recharge models improves the head estimation of the time series analysis.

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