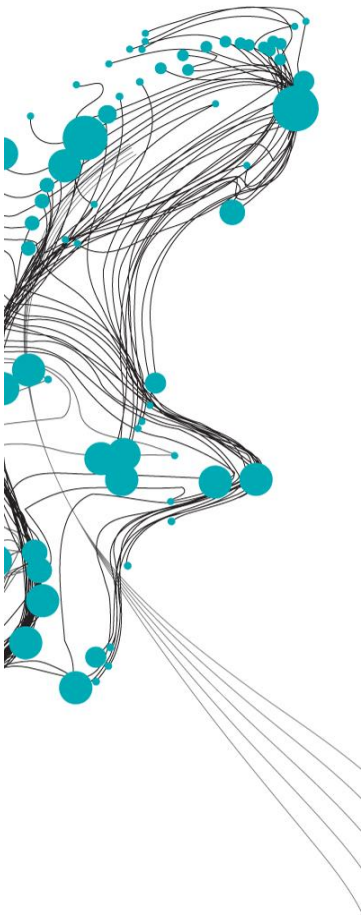

DROUGHT SEVERITY

REAL-TIME EVALUATION OF DROUGHT SEVERITY BY MEANS OF ARTIFICIAL NEURAL NETWORKS AND DAMAGE FUNCTIONS

Real-time insights in the socio-economic drought severity and its spatial variations can improve the drought crisis management of the Vechtstromen Water Authority. Tools to evaluate the socio-economic impacts of hydrological conditions are available, but a lack of groundwater input data limits their use for real-time drought severity evaluation. This because only point measurements are available in real-time, while spatial groundwater patterns are required. From a literature review regarding the spatial interpolation of groundwater depths, it is concluded that Artificial Neural Networks are likely able to interpolate the non-linear groundwater patterns. This research, therefore, aims to operationalize the socio-economic drought severity in real time, by using Artificial Neural Networks to obtain daily spatial groundwater data as an input for drought impact models. For this it has been studied how accurate ANNs can interpolate groundwater depths and if this accuracy is sufficient to reliably evaluate drought severity.

To study the ability of ANNs to accurately interpolate groundwater depths, two experiments have been setup: one in which the Vechtstromen region is interpolated by a single ANN and one in which two regional ANNs are used. This because the water systems of the northern and the southern region function differently. All three ANNs have been optimized individually by finding the optimal combination of input variables, learning epochs and number of hidden neurons (see Figure 1). Their interpolation accuracy has subsequently been determined by testing the ANNs for an independent dataset that consisted of locations that were not used during model training and validation.

To assess whether these ANNs can be used to obtain reliable severity evaluations, the socio-economic severity of 2019's drought in the Vechtstromen area has been evaluated (in a code green, yellow or red) at 72 drought sensitive locations. These evaluations have been performed for both the upper and the lower confidence limits of the groundwater depth predictions, to see how the uncertainty affects the severity evaluation. Subsequently, the differences between these two evaluations were analysed to evaluate the reliability of the severity evaluation. When at any of the locations a difference of two colour codes was found, the severity evaluation would be considered as unreliable.

From the first research step it was found that, regardless of the hydrological functioning, ANNs provided spatial groundwater depths with a higher accuracy than the currently available numerical models. The second research step concluded that these ANNs are also sufficiently accurate to produce reliable severity evaluations. For none of the 72 locations a difference of two colour codes was found and for 58 locations the colour code evaluation was consistent. Water managers are, therefore, advised to further develop and explore the application of ANNs to operationalise drought severity.

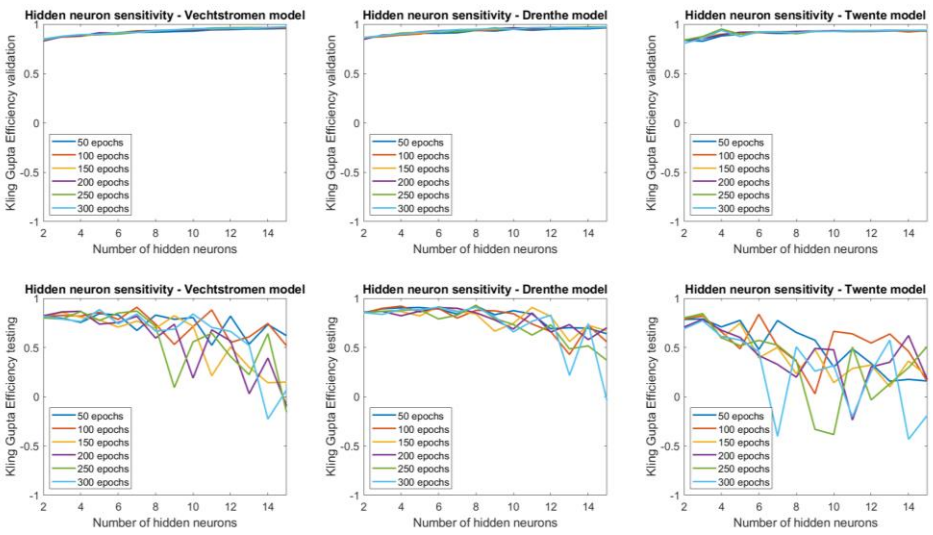

Figure 1: Sensitivity of the Vechtstromen and the regional (Drenthe and Twente) ANNs, to the number of hidden neurons and number of learning epochs plotted for the validation and testing set.

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