THE UNCERTAINTY OF FUTURE ANNUAL LONG-TERM GROUNDWATER TABLE FLUCTUATION REGIME IN LATVIA

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Introduction

The aim of this study is to model the long-term annual regime of shallow groundwater levels using 14 climate scenario groupings and additionally to analyze it according to the dominance of continentality in Latvia. Various annual regimes of shallow groundwater levels significantly and differently affect agricultural and forestry production. Such regimes can be constructed and compiled if groundwater level monitoring is used and the groundwater levels are known.

Materials and Methods

Water-level measurements from observation wells are the principal source of data. In this study chosen wells were calibrated and then groundwater levels were modelled based on these calibrated wells. Data was obtained from the well and groundwater level database of Latvian Environment, Geology and Meteorology Centre that met certain conditions. Altogether data from 182 wells was used in this study. All wells were clustered in 29 different groups (fig. 1.), but 3 groups were discarded due to the data inconsistency. In each group there was at least one well with observed groundwater level time series data, which represents the reference period (1961-1990).

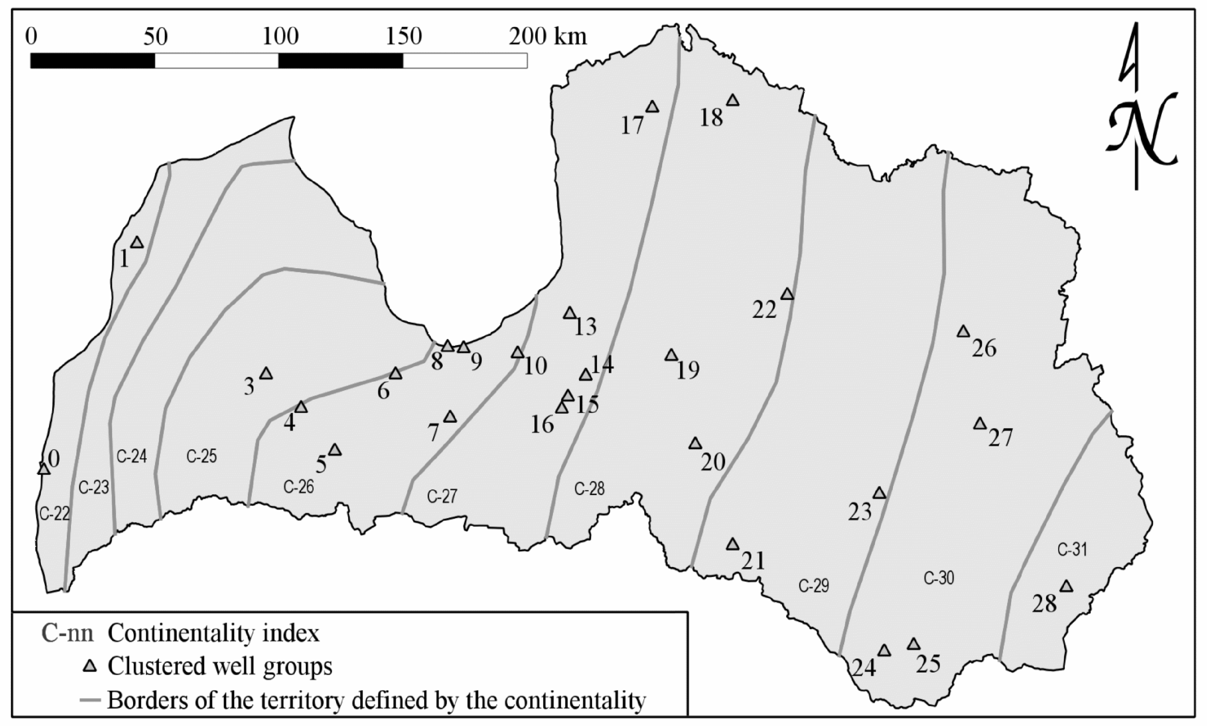

Fig. 1. Map of the clustered well group geographically weighted centres and continentality index

The mathematical model METUL [1] was chosen as most appropriate model for Latvian climate conditions for modelling future (2070-2100) daily groundwater levels using daily temperature, precipitation and humidity which were derived from previous regional climate studies[2]. Statistical methods focusing on percentile analysis were applied thus allowing to analyze all possible calculated time series as an uncertainty of all chosen models, e.g. model ensemble. Relative long-term monthly mean values (observations for reference period, modelled groundwater levels for freely chosen climate model and calculated percentiles from model ensemble) were interpolated using inverse distance weighting interpolation method thus allowing to create raster statistics over chosen territories and create maps and 3D models.

Results and Discussion

The classical Latvian long-term groundwater level fluctuation regime can be described as M-shaped function which represents two groundwater level maximums and minimums (fig. 2., reddish color series.). Using only one freely chosen future climate scenario the data showed that in the territories with degree of continentality greater than 24, the regime will stay the same classical Latvian M-shaped groundwater level regime and in the autumn period groundwater levels are extremely high (fig. 3., blue line). Such results suggested to test freely chosen scenario with observations and modelled results on observations. Even in reference period freely chosen climate scenario showed inconsistent results in autumn months (fig. 3., green series). Describing future groundwater time series altogether using lower (17%) and upper (83%) percentiles, the possible regime uncertainty space can be obtained (fig.4.) and 3D representation created (fig.5.). The results show changed regime with only one maximum and minimum. There are temporal differences which are spatiotemporally correlated with continentality (maximums are reached earlier in the territory with lower continentality index). It can be seen (fig. 4.) that upward slope is steeper and downward slope is less steep in territories with lower continentality index which is additional characteristics of model ensemble.

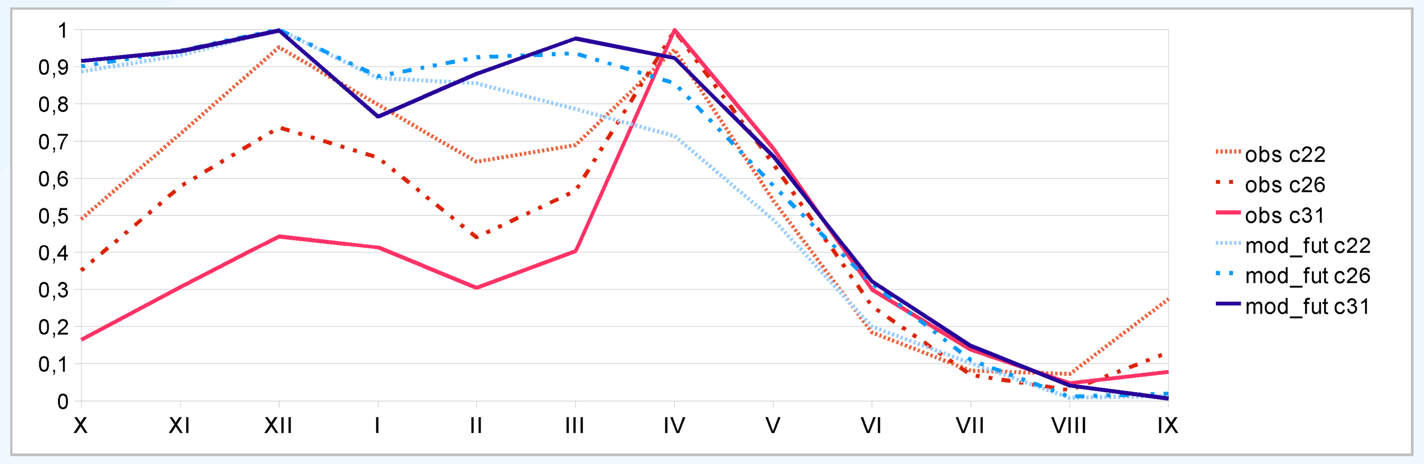

Fig. 2. Observed and modelled future groundwater levels by continentality index

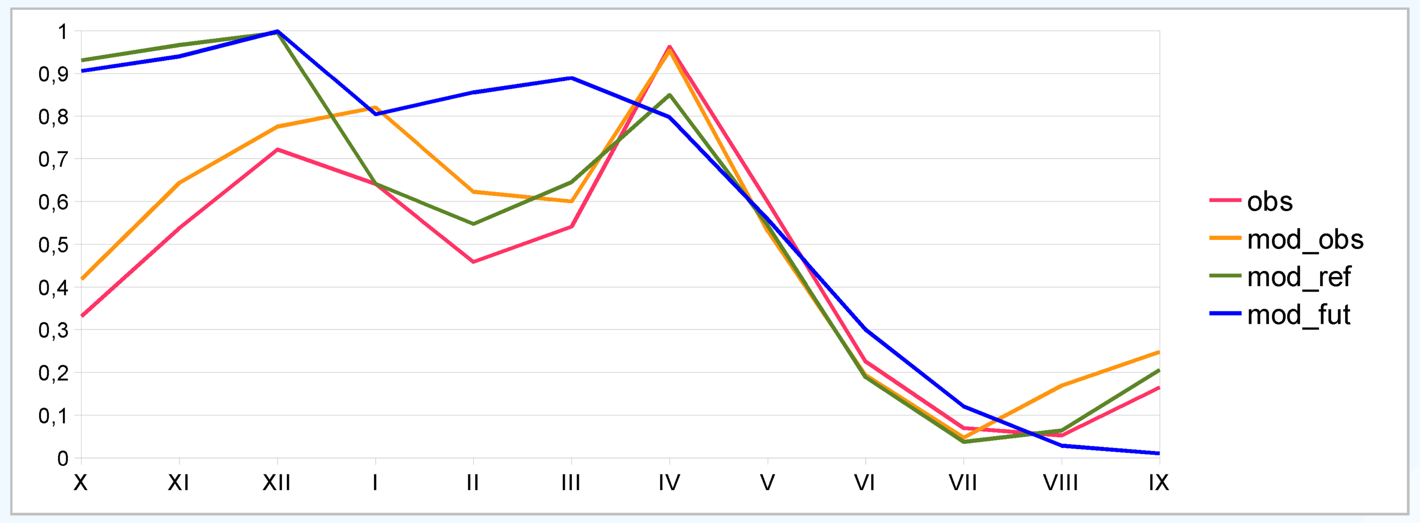

Fig. 3. Observed and modelled groundwater levels averaged all over the territory of Latvia

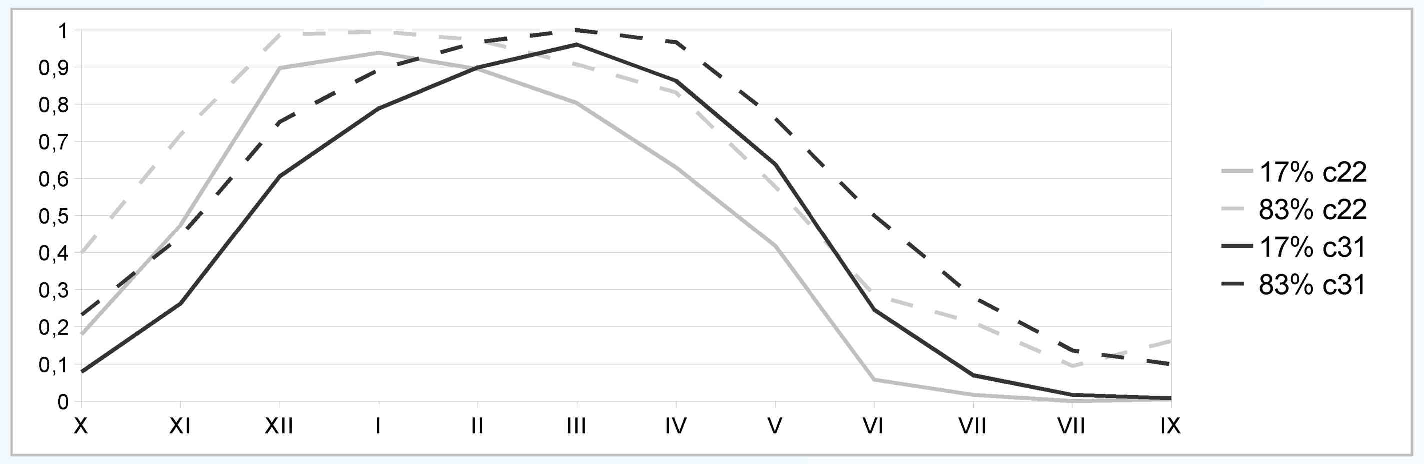

Fig. 4. Groundwater level model ensembe uncertainty characterised as 17 and 83 percentiles and within different continentality index

Fig. 5. 3D representation of groundwater regime over time and uncertainty width in Latvia with additional cross-section from NW to E

Conclusions

In both periods, observed and modelled data shows that there is a temporal offset between territories with different continentality from the spring to the end of the summer. The results show changes in groundwater regime shape in the future period (2070-2100) compared to the reference period (1961-1990) over the entire Latvia. The future Latvian long-term groundwater level fluctuation regime can be described as A-shaped function with one maximum and one minimum. Spatiotemporal differences are similar in both periods with gradual transition adjusted for continentality, being most apparent in the spring months.

References

1. Krams, M. Ziverts, A.,. Experiments of conceptual mathematical groundwater dynamics and runoff modelling in Latvia. Nordic Hydrology. 24, 243-262. (1993)
2. Sennikovs, J., Bethers, U.. Statistical downscaling method of regional climate model results for hydrological modelling. In:Proceedings of 18th World IMACS / MODSIM Congress.

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