Climate and surface and ground-water in the Baltic region – variability, trends, and impacts

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Book of Abstracts

Contents

Here we present our work of projected groundwater forecast for the short, middle and far future based on an ensemble of 13 EURO-CORDEX climate regional models under three Representative Concentration Pathway scenarios (RCPs) from the mildest to worst case scenario.
Future estimations of groundwater levels are based on the similarity of nowadays groundwater drought episode coincidence with surface drought indices individually estimated based on groundwater and surface water regime interaction during climate normals period.
Results show that overall increase of groundwater levels compared to recent climate normals period is expected without significant seasonal bias or spatial conformity. Gained results show that predictability of dry and wet periods during the autumn in most wells has the best results, therefore autumn can be also forecasted the best. Overall groundwater drought will be less frequent and less severe. Still, more extreme conditions are expected in the closest future period 2011-2040 with bias towards droughts and floods are expected in the period 2071-2100. There are indications that extreme conditions might occur more frequently during summer and autumn seasons. Also, wells with a trend towards dry condition are situated in the North-Eastern coast of Estonia while wells with less expected changes at all are typical in the central upland of Estonia.
Even though, the results are relevant solely to the Baltic region the used methods can be easily adopted worldwide.

IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, in: Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem, A., Rama B. (eds.), Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, New York, pp. 3056.

Climate change and its impacts / 8

Alterations of ecological flow variables in Lithuanian rivers under climate change conditions

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Ecological flow determines the water quantity needed to sustain river functions and healthy fluvial ecosystems. This measure is important when managing rivers and aiming to meet WFD requirements of good ecological status. In Lithuania, only the definition of environmental flow is defined and this value is quantified as either an 80% or 95% probability of low flow (Q30) during the warm period. However, the ecological flow is in the first step of its determination. Existing anthropogenic pressures and changing climate are expected to bring new stresses on rivers, and new challenges for sustaining ecological flows in fluvial ecosystems. The aim of this study is to evaluate the effects brought by different climate change scenarios (RCP2.6, RCP4.5 and RCP8.5) on potential ecological flow variables (minimum, average and maximum of Q30) of Lithuanian rivers. Four low-land rivers, namely Verknė, Širvinta, Šešupė, and Bartuva were studied. All of these rivers represent different hydrological regions and feeding characteristics. The study was based on hydrological modelling performed by HBV software, assessing the temporal changes in flow regime as well as changes in ecological flow variables. The projections were made for the near future (2021-2040) and the far future (2081-2100). The results have shown that Šešupė, which is highly dependent on surface runoff (snow melt and precipitation), was the most vulnerable to climate change. It would experience the greatest decrease in discharge during the low-flow periods (30-60%). In the near future, the duration of Q30_min in Šešupė would face an increase by 4-9 days and an increase by 8-32 days in the far future. RCP8.5 scenario would have the greatest impact on flow regime patterns. The other studied rivers would experience less dramatic changes in low flow parameters in the near future. The Bartuva River as a precipitation-fed river would have an increase in minimum and average low flow

discharges. Verknė and Širvinta, both having groundwater feeding as a dominant component, in the far future will face a medium decrease in discharge (lower by 20% and 30% respectively) and a moderate increase in the duration of Q30_min by 7-16 and 6-15 days for each river respectively depending on RCP scenario. Although modelling flow regimes is a very important approach for projections of potential ecological flow variables, further studies incorporating additional parameters of river health, such as changes in water temperature, would give a better picture and deeper understanding of the behaviour of ecological indicators in the future.

Keywords: ecological flow, low flow, Lithuanian rivers, climate change, projections

Water in forest and agrarian systems / 9

Effectiveness of water protection structures in forest drainage system: two years after construction

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Maintenance and renovation of the drainage network is carried out to ensure the functionality of the drainage system – to preserve high-quality forest stands, as well as provide safe access to forest resources. Nevertheless, the water quality of related waterbodies may be affected because of erosion during drainage network maintenance (DNM) operations. Therefore, water protection structures should be used to limit potentially negative effects by reducing the water flow velocity and minimizing the amount of eroded material and plant nutrients exiting a system.

This study was carried out in Latvia, in experimental forests of the Kalsnava Forest district in a catchment with dense drainage ditch network dominated by drained peatland forests. The effectiveness of two custom water protection structures – a peak flow control (PFC) structure and a sedimentation pond (SP) constructed during DNM was tested for two years. The catchment area of the forest drainage system is 791.3 ha.

Structures were built from August 2020 to January 2021 with sizes corresponding to related catchment size before proceeding with DNM operations upstream. pH, dissolved organic carbon, nitrate nitrogen, ammonium nitrogen, total nitrogen, phosphate phosphorus, total phosphorus and total suspended solids were measured in monthly water samples above and below the water protection structures.

Initial results when DNM was finished with six-month observation period revealed 65% mean effectiveness for the PFC (Klavina & Klavins 2021) and 68% mean effectiveness for the SP in reducing total suspended solids concentrations. Two years after the construction of the structures the mean effectiveness averaged to 61% for the PFC and 62% for the SP. Furthermore, PFC reduced dissolved organic carbon concentrations by 10% and total nitrogen by 4% on average. Looking at the study years separately, during the second year of observations mean effectiveness in detaining total suspended solids concentration was 25%, dissolved organic carbon – 26%, total nitrogen – 13% and phosphate phosphorus – 6% for the PFC; total suspended solids – 64%, total nitrogen – 1% and total phosphorus – 2% for the SP.

Both tested structures performed well during DNM detaining majority of total suspended solids from exiting the drainage system. During the second year of observations the PFC showed considerable effectiveness to detain dissolved organic carbon, total nitrogen and phosphate phosphorus. Although, concentrations of nitrogen and phosphorus compounds were generally low during all observation period. Observations are being continued to further investigate effectiveness of the structures.

References

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