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Multi-temporal assessment of Groundwater Recharge Capacity in Protected Areas of Lithuania

Marius Kalinauskas and Paulo Pereira
Environmental Management Research Laboratory, Mykolas Romeris University, Vilnius, Lithuania
(m.kalinauskas@mruni.eu)

Groundwater recharge is one of the key Ecosystem Services (ES) supplied by protected areas (PAs). However, such drivers as biodiversity loss, climate, and land use change affect the capacity for groundwater recharge (GRC). National-scale PA studies focused on GRC ES are scarce, thus leaving a knowledge gap on a global scale. Therefore, it is critical to map and assess the groundwater recharge spatiotemporal dynamics in supporting human wellbeing. In this study we mapped and assessed GRC at different timeframes (1990, 2000, 2012, 2018, 2022) in the PAs of Lithuania at national scale. For the model we used 15 indicators such as annual average evapotranspiration and precipitation, topographic properties (slope inclination, topographic position index, topographic wetness index, roughness index, curvature index, drainage density, lineament density), lithology, geomorphology, soil (texture, depth, imperviousness), land use (Corine Land Cover, Esri Land Cover). The results show that the highest GRC is observed in PAs to the west of the country, closer to the Baltic Sea, and PAs located in the eastern part of Lithuania with dense network of lakes, less intensive agriculture, fewer impervious areas, and soil properties more suitable for water infiltration. Lesser GRC is observed in urban PAs with higher imperviousness (Vilnius city). PAs in south and southwest of Lithuania with more intense agriculture practices, higher drainage density, and less water bodies also show lower GRC, as well as coastal PAs with sandy soils, no freshwater bodies, and higher roughness. The Kruskal-Wallis test showed no significant difference between GRC spatial distribution through different years due to low variation of evapotranspiration and precipitation values, and lesser land use changes within the PAs. Our findings contribute to a better understanding the spatiotemporal dynamics of one of the key provisioning ES in the Lithuanian PAs – the GRC. Mapping and assessing groundwater recharge support better management of the PAs, and contributes to achieving global and regional (e.g., Sustainable Development Goals, EU Biodiversity Strategy for 2030) policy targets.