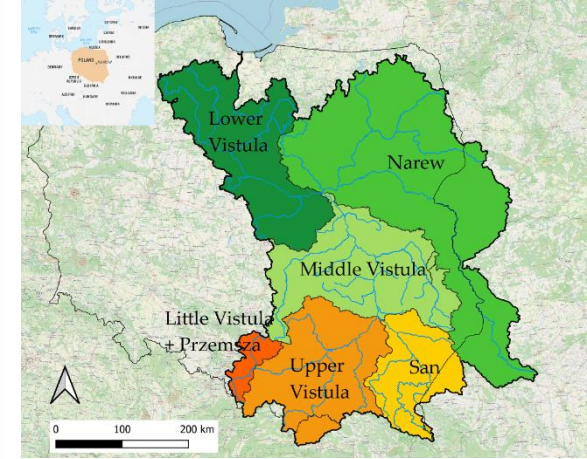




Are we getting dry?

A satellite-based analysis of water conditions in the Vistula River

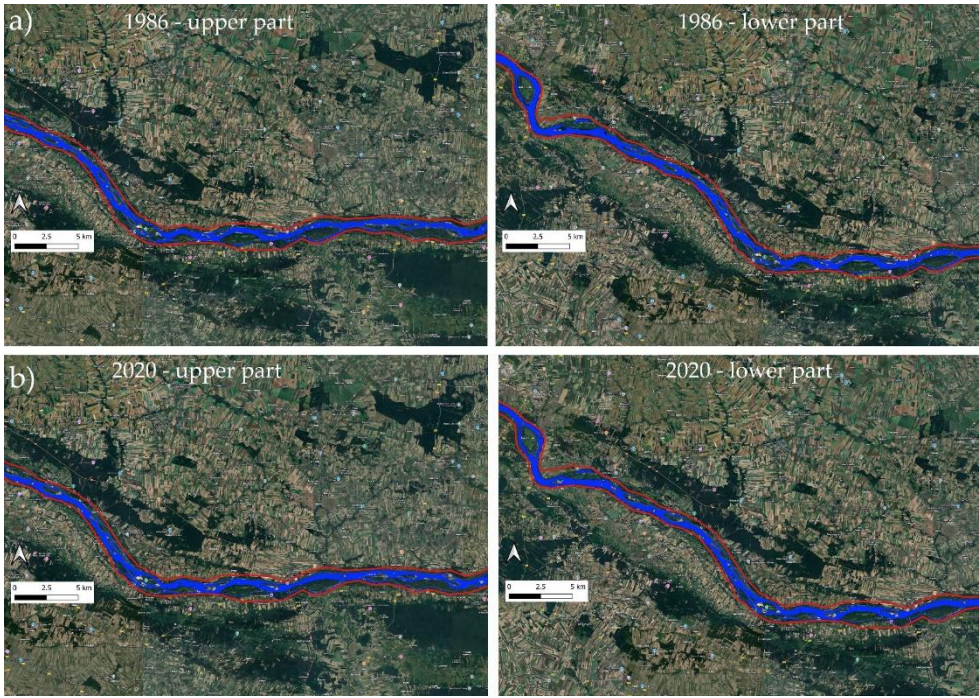
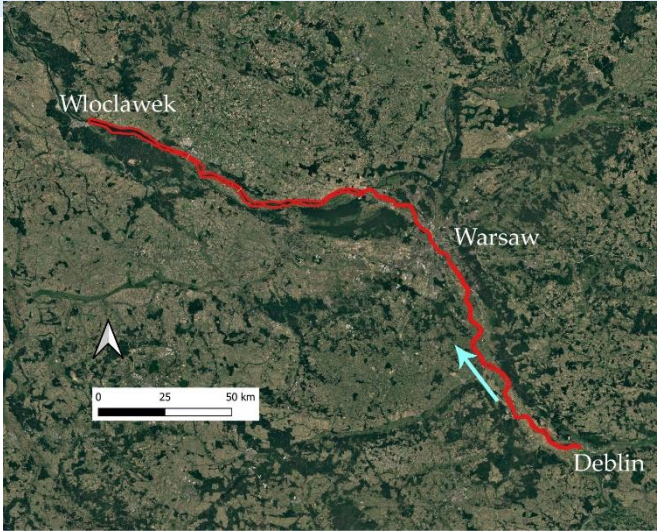
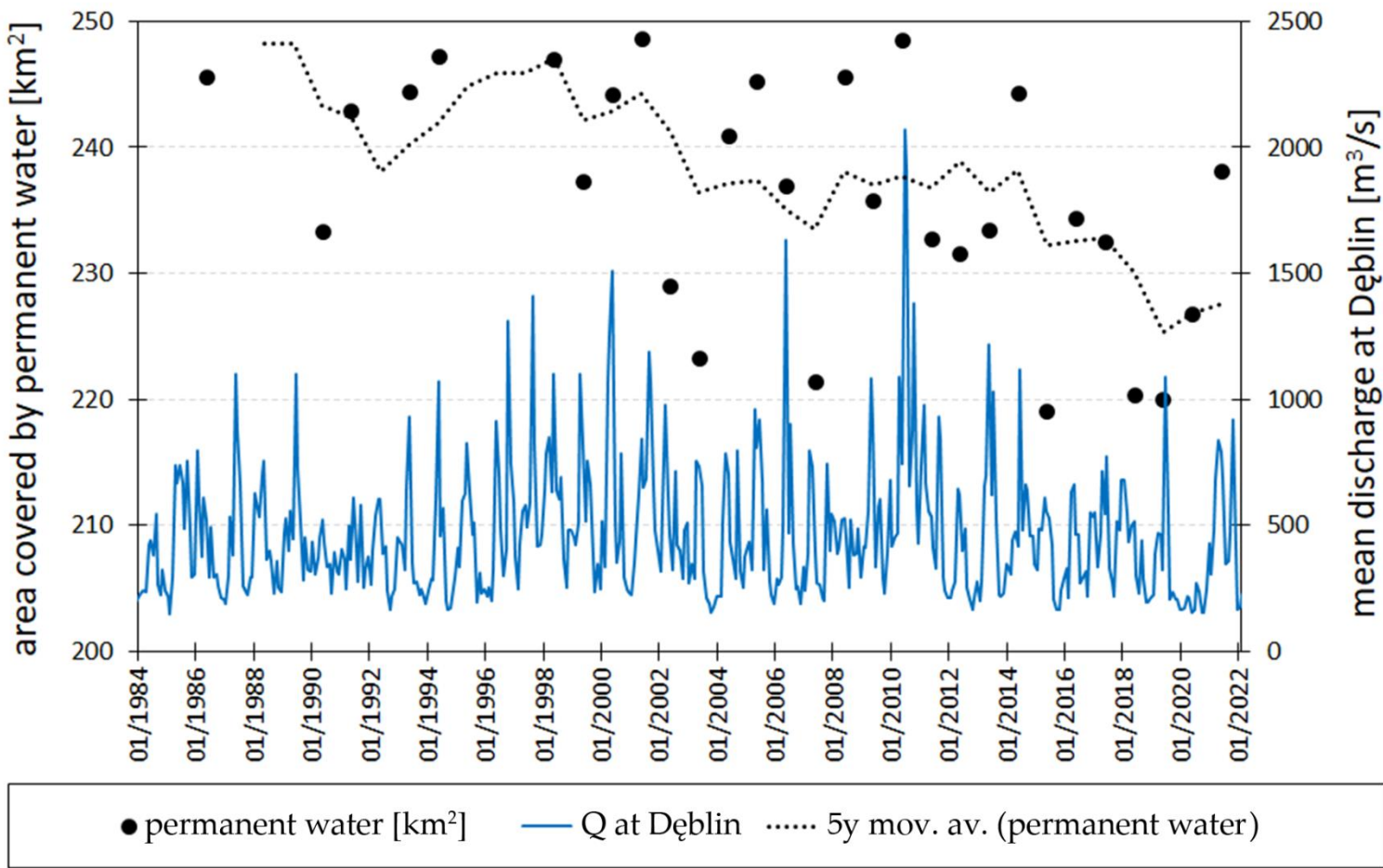


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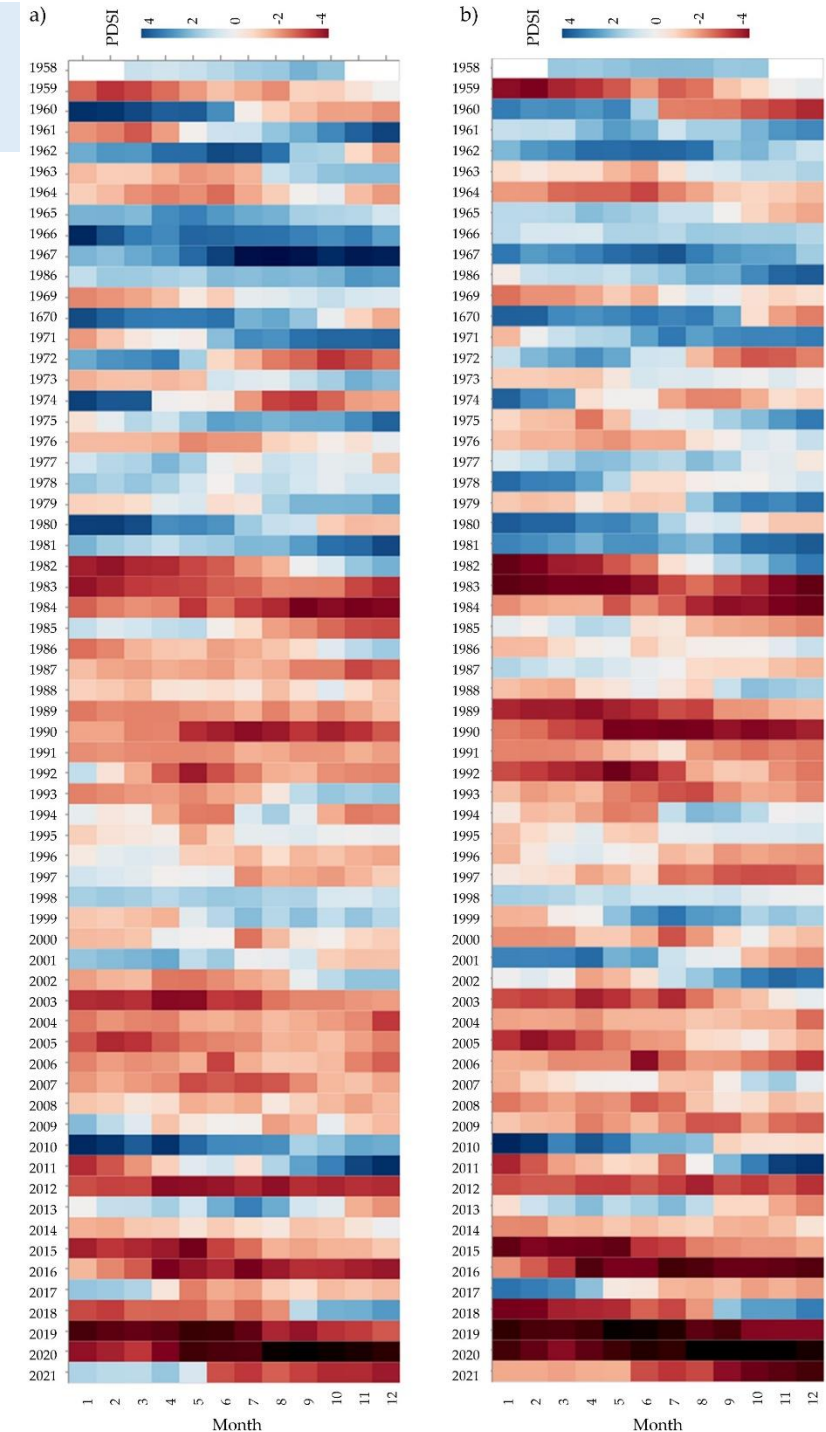
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JRC Yearly Water Classification History - changes 1984-2021



Why?

- Combination of natural (climate change) and anthropogenic (population density) drivers.
- During the last couple of decades, the number of months with dry conditions (negative PDSI, red colours) outnumbered the wet months, depicted in blue. This connects well with the reduction of water resources, in particular with permanent surface waterbodies, as they are among the first to be impacted by climate change.



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Abstract

The present study takes advantage of Google Earth Engine and the JRC's Yearly Water Classification History dataset to depict temporal changes in permanent water conditions along the reach of the Vistula River from Dęblin to Włocławek. The JRC dataset contains maps of the location and temporal distribution of surface water from 1984 to 2021, as well as statistics on the extent and share of those water surfaces. Results show that, along the investigated reach, a decrease in permanent water conditions is visible starting from the late 1990s, which is somewhere not fully correlated to the slight decrease in flow discharge observed at the Dęblin gauging station. Indeed, the observed significant decrease of the surface occupied by permanent water is likely due to other natural and anthropogenic drivers, such as global warming and increased population density. Despite being only a preliminary analysis of permanent water conditions in a selected reach of the Vistula River, the present analysis shows the potential of remote sensing for depicting changes in the availability of flowing water across multiple spatiotemporal scales.

Study Area

The study focuses on the Vistula River basin, characterized by an area of 193,960 km², of which 87% (169,000 km²) lies within Poland. The study reach between Dęblin and Włocławek crosses the middle and lower part of the river, where the land use structure is dominated by arable land (66%), with forests and semi-natural ecosystems covering around 29% of the territory, and only 3% classified as urban areas.

The analysis uses the JRC's Yearly Water Classification History, v1.4. This dataset contains maps of the location and temporal distribution of surface water from 1984 to 2021, with correlated statistics on the water surface extent and changes (Pekeć et al., 2016). The data were generated using more than 4 million scenes from Landsat 5, 7 and 8 acquired between 16 March 1984 and 31 December 2021.

Each pixel was individually classified into water/non-water and collated into a monthly history. This yearly seasonality classification collection contains a year-by-year classification of the seasonality of water based on the occurrence values detected throughout the year.

Results

- In 1986, water covered a larger area with respect to 2020, despite no significant variations of maximum and mean water discharge measured at Dęblin (Nosis, 2021).
- In the more natural part, upstream of Włocławek, some secondary channels disappeared over time, eventually reducing the river.
- The river's anthropogenic part downstream of Włocławek does not show these changes in seasonality, as the water is already somewhat confined in a single main channel in the case of small to medium discharges.
- Considering the 5-year moving average, the area covered by water tends to decrease over time, and it does not seem very impacted by variations in water discharge. Lower and higher discharges are connected with small and large areas covered by water, but it is hard to find a correlation between medium-intensity discharges and surface water coverage, eventually calling for a more in-depth analysis of the key drivers of such alterations in water resources.

Drivers

- Combination of natural (climate change) and anthropogenic (population density) drivers.
- During the last couple of decades, the number of months with dry conditions (negative PDSI, red colours) outnumbered the wet months, depicted in blue. This connects well with the reduction of water resources, in particular with permanent surface water bodies, as they are among the first to be impacted by climate change (Kutikow-Więcaszka and Machajda, 2020).
- Changes in PDSI are a good representation of variations in temperature, evapotranspiration and precipitation across Poland.
- There is a slight increase in population density over time, potentially indicating increased stress on local water resources used e.g. for agriculture, forest and livestock management.
- The results reported here are in line with similar investigations that show an increasing trend in terms of air and water temperatures and prolonged dry conditions.

References & Code

Kutikow-Więcaszka, M., Machajda, S. (2020). Influence of climate changes on the state of water resources in Poland and East Europe. *Geosciences*, 10(9), 512.

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Pekeć, T., Corman, A., Corineau, N., Dubreuil, A.S. (2016). High-resolution mapping of global surface water and its long-term changes. *Nature* 540(7673), 418–422.

The GEE script is available at <https://code.earthengine.google.com/1v6G77033d90W6WqGQ5C03dUd>

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