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Editorial

Effects of Oceanic–Atmospheric Oscillations on Rivers

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1. Introduction

In this Special Issue, we invited scientists devoted to research on the impacts of the ocean and atmosphere oscillations on the climate and weather patterns, resulting in disturbances in the hydrological phenomena. In our view, the main goal has been successfully reached. This Special Issue received investigations based on measurements, modelling and experiments, related to a wide array of changes in river and lake hydrology on different scales, from local and regional to global approaches. We strongly believe that the readers of journal *Water* can benefit from these new findings and learn more about effects of the ocean and atmosphere on hydrology using the published papers and share the presented results with the scientific community, policymakers and stakeholders.

2. Summary of the Special Issue

Plewa et al. [1] assessed correlations between water levels in six Polish lakes located along the southern coast of the Baltic Sea and the water levels of the Baltic Sea using the bivariate Archimedean copulas. The study proved strong and statistically significant relationships between the maximum annual water levels in the lakes and in the Baltic Sea at the investigated gauge stations. The results were confirmed by the synchronicity analysis carried out with the help of the copula function. Moreover, positive trends of the maximum water levels in the Baltic Sea were detected. Based on these findings, the authors concluded that the relation strength may increase due to sea level rises caused by climate warming.

The study by Plewa et al. [2] was based on the mean monthly water levels of 15 lakes in northern Poland from 1976 to 2015 and identified relationships between lake water levels and indices of macroscale atmospheric circulations: the Arctic Oscillation (AO), the North Atlantic Oscillation (NAO), the East Atlantic (EA) and the Scandinavian pattern (SCAND). The correlation analysis revealed the most important relationships in the case of AO and NAO, especially in winter, and slightly weaker for EA and SCAND. It was found that these teleconnection patterns affected air temperature in particular and, to a lower degree, precipitation. Therefore, they may indirectly affect the conditions of the lake alimentation. In the positive phases of AO and NAO during warmer winters, the type of alimentation changes from nival to pluvial. Due to winter snowmelts, also more frequent in that period, the alimentation increases, and water levels in the investigated lakes are higher.

Kundzewicz et al. [3] carried out a meta-analysis of results of studies reported in the world scientific literature and examined the climate variability indices of the El Niño-Southern Oscillations (ENSO), the North Atlantic Oscillations (NAO), the Atlantic Multidecadal Oscillation (AMO) and the Pacific Decadal Oscillations (PDO). The authors collected the published results and classified them into different categories, taking as criteria regions, climate variability modes, as well as flood-related variables: precipitation, river flow and flood losses. On these grounds, the spatially defined oscillations in the ocean–atmosphere system have been found to affect the climate and various climate impacts over large areas, covering the oceans and adjacent continents but also more remote regions via teleconnections. The authors revealed that the link strength can vary from region to region, and one can identify zones of influence where the climate variability mode (e.g., ENSO, PDO, NAO or AMO) affects variables related to floods.

Bednorz et al. [4] described and classified atmospheric processes triggering summer floods in the Polish Sudeten Mountains in the multi-annual period from 1971 to 2013. The constructed maps of anomalies enabled recognizing an early formation of negative centers of sea level pressure and also allowed distinguishing areas of positive departures of precipitable water content over Europe. The authors assigned five cyclonic circulation patterns of different origin and various extent and intensity, responsible for heavy, flood-triggering precipitation in the study area. The research confirmed a direct impact of heavy precipitation on extremely high runoff episodes, and proved an essential role of synoptic conditions in triggering abundant rainfall. It was concluded that most cyclones bringing rain to the Polish Sudeten Mountains formed over the Mediterranean Sea, while some of them over the Atlantic Ocean.

Wrzesiński et al. [5] described the influence of the North Atlantic Thermohaline Circulation (NA THC) on the observed changes in climate and river flow in Poland. In the research the mechanism of impact of the NA THC changeability on the elements of the catchment water balance variability was explained and discussed. It was determined that the positive and negative phases of the DG_{3L} index characterizing the NA THC intensity were strongly correlated with the heat anomalies in the upper layer of the North Atlantic waters, and that the NA THC changes had significant impact on weather conditions and selected climate elements in Poland. Statistically significant positive correlations were found between the DG_{3L} index and average annual air temperatures, particularly in April, July and August, while negative between the DG_{3L} index and the total cloud cover. Consequently, in the years with the positive values of the DG_{3L} index, there are favorable conditions for the strong increase in evaporation and evapotranspiration from the ground surface. This has impact on flow of rivers in Poland, which is characterized by noticeable regional differences.

Graf and Wrzesiński [6], based on daily water temperature for 96 water gauges located on 53 rivers and air temperature for 43 meteorological stations in the multi-annual period from 1971 to 2015, determined the effects of the large-scale circulation types, such as NAO, AO, EA, EAWR, SCAND and AMO, on the water temperature of rivers in Poland. The percent shares of positive and negative coefficients of correlation of annual, seasonal and monthly circulation type indices with air and river water temperature were determined, demonstrating the character of teleconnection. It was found that relations between the temperature of river water in Poland and macroscale circulation types were not strong; however, they were noticeable, sometimes even statistically significant, and both temporally and spatially diversified. The NAO, AO, EA and AMO indices were characterized by a generally positive correlation with temperature, whereas SCAND and EWAR indices by a negative correlation.

Wrzesiński and Sobkowiak [7], based on the example of the Vistula River in Poland, identified transformation of the flow regime of a large allochthonous river in Central Europe. The authors used data recorded by 22 gauges on the Vistula mainstream and 38 gauges on its tributaries in the multi-annual period from 1971 to 2010. The transformation of the Vistula flow regime was reflected in the identified different sequences of hydrological periods in the average annual cycle. It was found that while transformation of the Vistula River regime occurred along its whole course, the most frequent changes were detected in its upper, mountainous reaches, under the influence of the flow characteristics of its tributaries. This allowed the Vistula to be considered the allochthonous river.

Cerón et al. [8] investigated the impact of the Atlantic Multidecadal Oscillation (AMO) on the variations in the streamflow in the Atrato River Basin in Northwestern Colombia in the multi-annual period from 1965 to 2016. The cold (1965–1994) and warm (1995–2015) phases of this oscillation were analyzed. The results showed a significant increase in the streamflow means at Bellavista in May to June and November to December, and in the rainfall means in November to December from the first to the second analyzed period. It was found that the Atlantic Ocean played an important role in modulating the rainfall and streamflow variability in the Atrato River Basin. At the low frequency time scale, the Sea Surface Temperature (SST) and the Sea level Pressure (SLP) anomalies in this Oceanic sector created the east–west SST and SLP gradients between the tropical Atlantic and eastern Pacific Oceans, which, during the warm Atlantic Multidecadal Oscillation (WAMO) phase, favored the La Niña event establishment.

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