Abstract for the general public

Drought is one of the major natural hazards that brings about, particularly to agricultural and energy sectors, billions of dollars in loss around the world each year. Droughts, as natural phenomena, have been occurring in Poland on a regular basis for centuries. Among several types of droughts distinguished in literature, agricultural (soil moisture) and hydrological (low flow) droughts are particularly important in the Polish context. However, these two drought types have been often treated as if they were separate problems, whereas they are different facets of the same drought phenomenon. Furthermore, due to ongoing climate warming and due to several droughts that occurred in recent years (e.g. 2015, 2018, 2019), it is commonly believed that this natural hazard is now gaining in strength. There is, however, lack of studies at large scale (not counting global and continental scale studies) that could support this hypothesis for the area of Poland.

The main objective of this project is to increase the understanding about the current and future agricultural and hydrological drought variability and drought effect on crop losses in rain-fed agriculture in the Odra river basin. This area has been selected since it is characterized by high drought vulnerability, a large fraction of highly intensive agricultural area and because it is large enough to analyse spatial variability in drought occurrence. Three specific research questions posed in this project are: (1) How are agricultural and hydrological drought characteristics changing in the context of current and future global climate change? (2) To what extent are model-based soil moisture deficit indices capable of explaining variability of drought-related crop losses in rain-fed agricultural areas? (3) Can supplemental irrigation help to counteract future drought hazard in currently rain-fed agricultural areas and what are its hydrological consequences?

The project will characterize drought evolution (from meteorological through agricultural to hydrological drought) by the analysis of observed and simulated data for the historical period 1951-2018 and future climate scenarios. Comprehensive, up-to-date climatic, remote sensing, geospatial, observational (streamflow and soil moisture measurements) and agro-economic data will be assembled and integrated for the study domain. Using these data will lead to increased reliability of the models applied in this project: a hydrological model and a statistical crop model. Hydrological modelling will focus on simulation of soil moisture on agricultural land as well as of low river discharges in the rivers of the Odra river basin. Statistical crop yield modelling, primarily focused at capturing the effect of droughts on crop yield, will be performed for two economically important cereal crops cultivated in the Odra river basin: wheat and maize. Both types of models will then be used for the assessment of future climate change impacts on different characteristics of drought (e.g. intensity, duration and frequency) as well as wheat and maize yield magnitude and variability. Finally, anticipating a possible increase in agricultural drought hazard in the future, the SWAT+ model will be applied in order to test the effectiveness of supplemental irrigation as a drought mitigation measure, but also to analyse the hydrological and environmental effects of increased water withdrawals for irrigation.