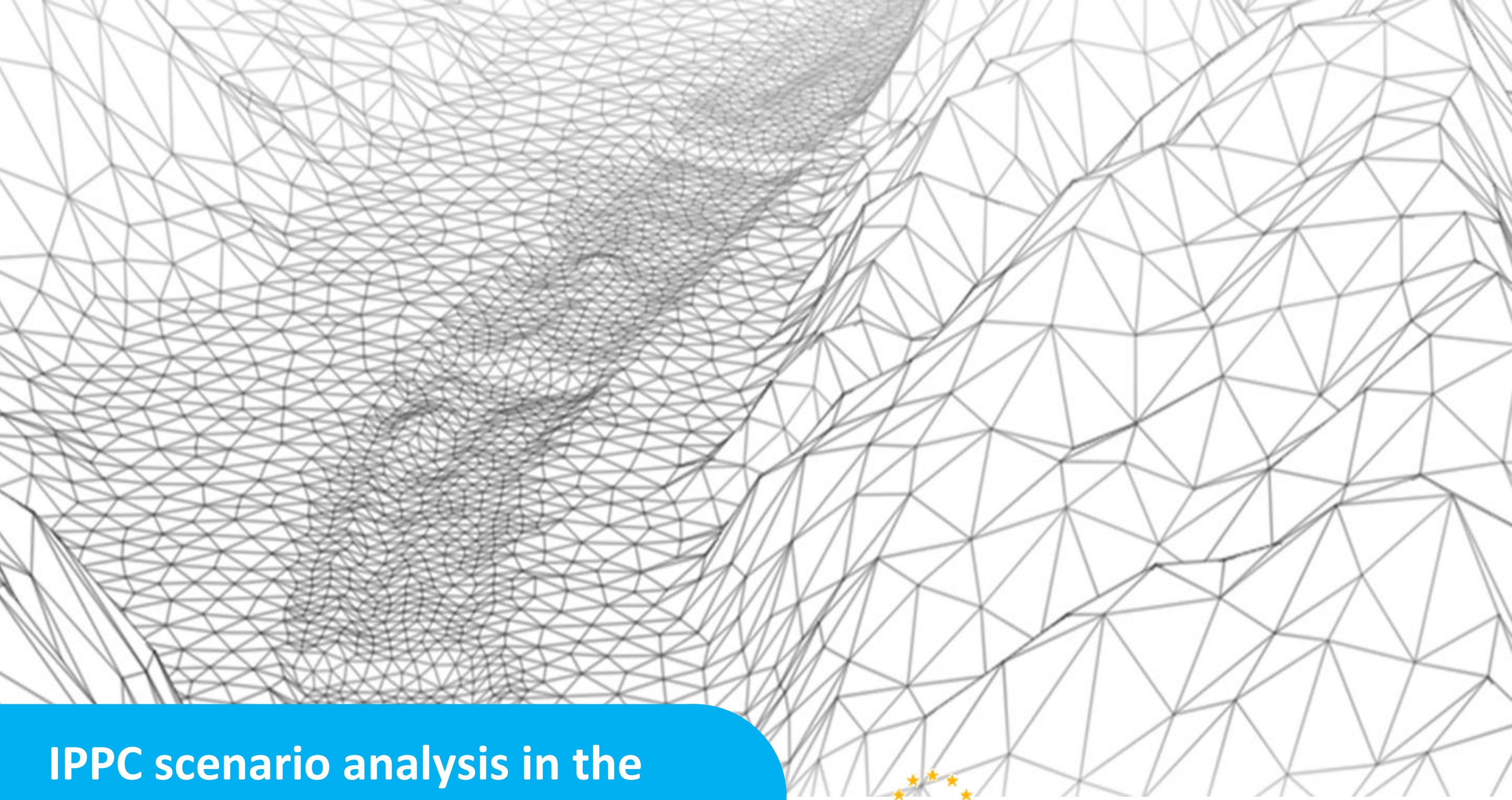

IPPC scenario analysis in the context of discharge changes

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Case Study Skawa Catchment (Poland)

Analysis of the IPPC scenarios in the context of discharge changes

Paweł Gilewski, Warsaw University of Technology
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1 Introduction

1.1 Study area

The Upper Skawa river basin is located in the southern part of Poland, in a region called Ma³opolska. It is a right tributary of the Vistula, the longest river in the country. The Skawa rises in the Western Carpathians and flows through several towns: Jordanów, Maków Podhalański, Sucha Beskidzka, Wadowice and Zator. In 2014, a dam was built in the village of Świnna Poręba to prevent flooding and serve as a water reservoir for the local population. The physical characteristics of the study area are shown in Figure 1.

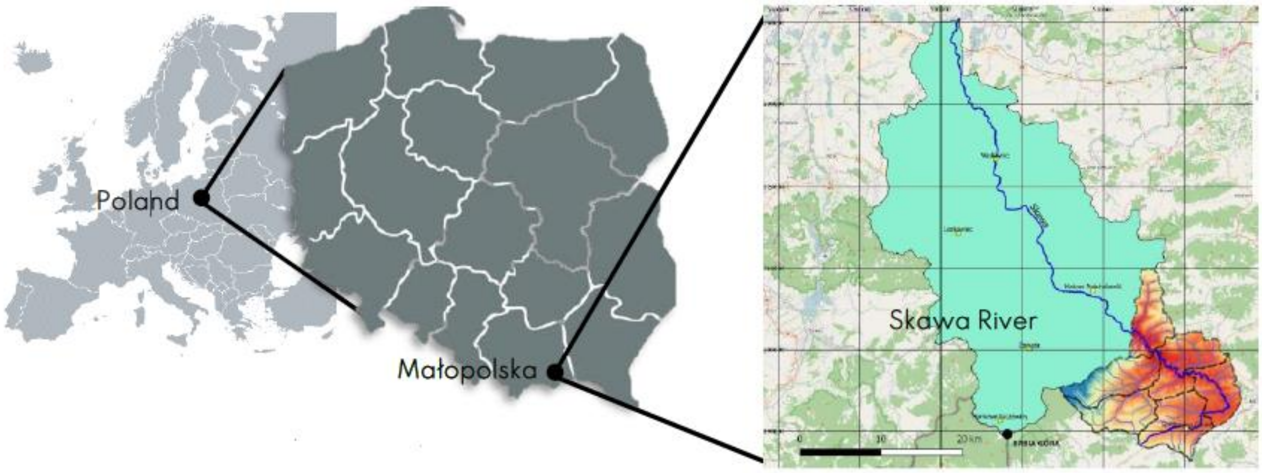


Figure 1. Main characteristics of the Upper Skawa River catchment.

The Skawa River is of great importance in the region as one of the main sources of drinking water. The mountainous character of the river results in highly variable discharge. In recent years, the region has experienced many flash floods due to excessive precipitation. Given current and future global climate change, there may be a significant change in precipitation patterns that will likely affect the flow in the river.

1.2 Calibration of the hydrological model

The hydrological catchment model provided for the task should be used. To ensure that the model is representative, it must first be calibrated for several flood events, and the optimized values can be averaged later. The model uses a rainfall field modeled by first-order polynomial interpolation based on rainfall measured by rain gauges. Rainfall is assigned to each of the six sub-basins in the model.

Calibration Process

The calibration process is performed for the flood event period from 2014 to 2015, which includes a total of three selected flood events.

1. For each of the analyzed flood events, a separate calibration scenario should be created with the same optimization objective function.
2. To calibrate the model, identify the parameters that have the greatest influence on the modeled flow based on previous experience.
3. Then, perform calibration for each flood event and average the resulting parameter values for use in model validation. Enter the averaged values into a new model, preferably on a new copy of the model.

Below is an example of a table to be filled with calibrated parameter values and averaged over all analyzed flood events.

Table 1. Sample table with calibration parameters to be filled for validation purpose.

	Calibrated parameter			AVERAGE
	CN Value			
	Event 1	Event 2	Event 3	
Sub-catchment 1				
Sub-catchment 2				
Sub-catchment 3				
Sub-catchment 4				
Sub-catchment 5				
Sub-catchment 6				

2 IPPC scenarios analysis

2.1 Available scenarios

IPCC has many different publications, the most recent is the AR5, so the scenarios presented in this last publication are the bases to estimate the percentages of change applicable to the observed precipitation data to establish the possible future precipitation values for different scenarios. The AR5 introduces 4 new emission scenarios, two of which were selected to be represented in the precipitation changes, the RCP 4.5 and the RCP 8.5. These scenarios not only represent the most optimistic and the most pessimistic, respectively, but also have the two highest numbers of model ensembles from CMIP5; 42 models (RCP 4.5) and 39 models (RCP 8.5). CMIP5 "presents an unprecedented level of information on which to base projections, including new Earth system models with more complete representation of forcings, new RCP scenarios, and more output available for analysis".

2.2 Timescale for future precipitation

The WGIAR5 dedicates two chapters to future projections, where two timescales are proposed and give the names to the chapters: Chapter 11 Short-Term Climate Change: Projections and Predictability and Chapter 12 Long-term Climate Change: Projections, Commitments, and Irreversibility. These two chapters give the periods used in almost all the climate models presented in AR5, so the same periods are used in this study.

Near term

The near term refers to the period 2016-2035. The near-term projections show sensitivity on global scales, especially to rapid changes in some short-lived climate forcing agents, and there is also an important source of uncertainty on regional scales. This period appears in the calculations and results as Near-term 1 (NT1).

In Chapter 11 a medium-term period 2046-2065 is mentioned, this period is also mentioned in Chapter 12. In this study this period appears as Near-Term 2 (NT2) proposed as a Near-Term period because we are already in the Near-Term period (2016-2035) proposed in Chapter 11 at the year 2014.

Long-term

Long-term projections of climate change attempt to forecast possible responses of the climate system to the end of the 21st century and beyond. The long-term period refers to 2081-2100 and appears as LT in the results and calculations. It is important to remember that it is not possible to make deterministic, definitive predictions of how the climate will evolve over the next century and beyond, as is the case with short-term weather forecasts.

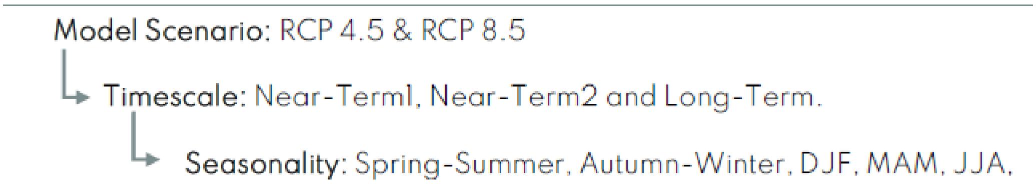
2.3 Seasonality

The seasonality varies according to the data available in the IPCC documents for the specific scenario. However, 2 seasonal divisions have been assumed:

1. From April to September, corresponding to the spring-summer seasons, and from October to March, corresponding to the fall-winter seasons. This seasonality is proposed in Figures A1.38 and A1.39 of the WGIAR5 report in the Annex section.
2. Four seasons, winter (DJF), spring (MAM), summer (JJA) and fall (SON). The acronyms correspond to the initials of the months within the seasons. This variation is included in many graphical model representations.

2.4 Percentages of precipitation change

The structure of the analysis to determine precipitation changes is as follows:



Taking into account all the assumptions resulting from the characteristics of the climate models considered, as well as seasonality, a table was created that shows the projected change in precipitation (expressed as a percentage).

Table 2. Values fort he change in [%] that should be applied to the precipitation data

Month	**RCP 4.5**			**RCP 8.5**	
	NT-1	NT-2	LT	NT-2	LT
April	5	5	10	10	20
May	5	5	10	10	20
June	-10	-10	-15	-10	-20
July	-10	-10	-15	-10	-20
August	-10	-10	-15	-10	-20
September	5	5	10	10	25
October	10	15	20	10	35

Based on the table above, modify the precipitation data for the three 2016 callouts that will be used for validation. **Tip:** You should first copy and modify the precipitation data from the model to an Excel file. Then, you must manually create a new data series in the HEC-HMS model and copy it from the Excel file.

3 Validation of IPPC scenarios in hydrological model

3.1 Validation events

The final element of the task is to verify how the application of different scenarios related to future rainfall amounts will affect the modeled flow.

Using the model based on the averaged parameters calculated during model calibration, apply the modified precipitation scenarios and see if significant differences are observed with respect to the baseline scenario, a simulation performed with unmodified precipitation data.

Evaluate the results obtained on the basis of two statistical indicators:

- maximum flow,
- volume.

Think about and try to explain why it would not make much sense at this stage to verify the results obtained with the Nash-Sutcliffe efficiency coefficient.