Watershed modelling of the Ria de Aveiro lagoon for climate impact assessment

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ABSTRACT

Ria de Aveiro in Portugal is a coastal lagoon under various anthropogenic pressures, which are increasing during the last decades. It represents an interface between terrestrial environment and coastal waters. The lagoon ecosystem may face serious threats in future with regards to the overall trends of global change and regional development. Important problems related to changes of salinity and variations in water level are driven mainly by processes taking place in the watershed. Therefore watershed modelling and impact assessment are needed, as their outcomes can provide useful information for researchers as well as for decision makers.

This study focuses on the freshwater inflow into the lagoon under different scenarios. Its purpose is to analyse the impacts of different land use and climate change scenarios on the runoff conditions in the drainage basin and on the water discharge to the lagoon. The total area of the Ria de Aveiro watershed is about 3600km². The main source of freshwater is the Vouga River, with an average annual discharge of 25m ³/s. The Vouga basin stretches over an area of about 2600km². The altitude ranges from 16m in the lower part up to 1000m in the upper mountainous part. Cropland occupies about 26% of the total area and is mainly concentrated in the lower valley of the basin.

The Soil and Water Integrated Model (SWIM) was used for hydrological modelling of the Vouga basin and the total watershed of the Ria de Aveiro. SWIM is a process based semi-distributed ecohydrological model integrating hydrological process, vegetation/crop growth and nutrient cycles at the river basin scale. The model uses a three-level spatial disaggregation by subdividing the whole watershed into subbasins and hydrotopes. The latter ones are sets of units within subbasins, which have a unique combination of land use and soil characteristics.

Three gauges measuring water level were used for the model calibration, whereas water discharge was estimated from the water level using flow curve equations. Meteorological data has a satisfactory coverage over the basin, though measurements at high elevations are missing. Weather parameters were interpolated to the centroids of subbasins using inverse weighted distance method. SWIM was calibrated based on the results of a preceding sensitivity analysis performed towards daily water discharge records. Two different quantitative statistics were used to assess the goodness of model calibration: the Nash and Sutcliffe efficiency (NSE) and the percent bias (PBIAS). The statistics showed sufficiently good results for monthly (NSE=0.7, PBIAS=1%) as well as daily (NSE=0.66, PBIAS=1%) streamflow simuations for the main gauge in the period of observation.

After the successful calibration for all three gauges the model was extended to the entire watershed of the lagoon. As a result, long term averages, seasonal dynamics as well as monthly variations of the total water inflow into the lagoon for the reference period were estimated. As the next step, different climate change scenarios from the ENSEMBLES project were applied for the reference and scenario periods, and the SWIM outputs were compared between these periods. The results of the climate impact assessment were analysed and provided to the lagoon modellers.

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KEY WORDS: *lagoon, model calibration, watershed modelling, water discharge, climate impact.*