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Identifying and quantifying the impact of climatic and non-climatic effects on river discharge

Julie Collignan[1], Jan Polcher[2], Sophie Bastin[3], and Pere Quintana Seguí[4]
[1]Laboratoire de Météorologie Dynamique/IPSL - Ecole Polytechnique/CNRS -, Paris, France (julie.collignan@lmd.ipsl.fr)
[2]Laboratoire de Météorologie Dynamique/IPSL - Ecole Polytechnique/CNRS -, Paris, France
[3]LATMOS/IPSL, Sorbonne Université, UVSQ, CNRS, Paris, France
[4]Observatori de l'Ebre (Universitat Ramon Llull – CSIC), Roquetes, Spain

In a context of global change, the stakes surrounding water availability and use are getting higher. River discharge has significantly changed over the past century. Human activities, such as irrigation and land cover changes, and climate change have had impact on the water cycle. This raises the question of how to separate the impact of climate change from the impact of anthropogenic activities to better understand their role in the historical records.

We propose a methodology to semi-empirically separate the effect of climate from the impact of the changing catchment characteristics on river discharge. It is based on the Budyko framework and long land surface simulation. The Budyko parameter is estimated for each basin and represents its hydrological characteristics. Precipitations and potential evapotranspiration are derived from the forcing dataset GSWP3 (Global Soil Wetness Project Phase 3) – from 1901 to 2010 –. The ORCHIDEE Land Surface Model is used to estimate the terrestrial water and energy balance for the past climate but assuming humans do not modify land surface processes. This is a first guess of evaporation and its evolution due to climatic factors. Not having reliable observations of the evolution of the actual evaporation, river discharge and atmospheric observations are used to reconstruct it. This provides estimates of the evolution of the catchment characteristic and the evaporation efficiency which can then be compared to the modelled natural system. The aim is to separate anthropogenic changes from the effect of climatic forcing. To better understand the sensitivity of our methodology we applyied modifications to the atmospheric forcing to see how specific climate variations impact the sensitivity of the Budyko detection.

Our results show that for most basins tested over Spain, there is an increasing trend in the Budyko parameter representing increasing evaporation efficiency of the watershed over the past century which can not be explained by the climate forcing. This trend is consistent with changes in irrigation equipment and development of dams over the studied period. However when looking at decadal trends, climatic fluctuations take precedence over non-climatic trends. In a context of climate changes, the balance between these trends could change in the future. The methodology was extended to other areas in Europe. The clear non-climatic trends were especially significant in semi-arid climate.