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

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Abstract

River discharge to the oceans in many regions of the world changed significantly over the past century. The challenge is to detect and attribute the part explained by climate factors and separate it from the impact of human water use and management.
We propose a methodology based on long land surface simulations and the Budyko framework to semi-empirically separate the impacts of climate and water usage changes on the catchment characteristics and river discharge. It is applied to observations and model simulations over the 1901-2010 period over Europe. 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. Not having reliable observations of the evolution of 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.

Both elements allow to estimate how humans have modified the evaporation efficiency of the catchments to increase water availability. The analysis shows that for Europe over the 20th century human water usage dominates the river discharge changes. Non-climatic evolutions of the basin characteristics are shown to be correlated to the development of dams. The methodology allows to deduce how much of the observed changes in river discharge can be attributed to climate and the magnitude of the impact of water management.
Such detection and attribution analysis of the continental water cycle will offer guidance as to where critical understanding gaps exist and limit our ability to explain and predict the evolution of the Earth system.

Keywords: Earth system modelling, continental water cycle, river discharge, climate change, detection

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