Geophysical Research Abstracts
Vol. 15, EGU2013-14177, 2013
EGU General Assembly 2013

Water and Climate (Henry Darcy Medal Lecture)

Georgia Destouni

Department of Physical Geography and Quaternary Geology, Bert Bolin Centre for Climate Research, Stockholm University, Sweden, georgia.destouni@natgeo.su.se

Hydrological and hydrochemical changes in the continental water system are central parts of global change. We must understand and quantify change drivers and impacts in the past and accurately project disruptive future changes. This talk discusses past and future changes in water flow, quality and availability from the land surface through the subsurface and surface parts of hydrological catchments to the coasts of different world regions.

Regional data of past hydroclimatic change dynamics show that historic developments of human land and water use for increased food and energy production have shifted evapotranspiration and runoff magnitude and variability. Comparison and synthesis of corresponding results for different world regions, and globally, show consistency, supporting cross-regional generalization of both specific numerical results and a data-driven, catchment-wise analysis approach. Spatial relations between water use efficiency (actual evapotranspiration relative to precipitation) and energy use efficiency (actual relative to potential evapotranspiration) further reveal that agricultural areas can have high water and energy uses, close to those of open water areas, similar to those of the most water/energy-using forests, and much higher than those of wetland areas. Temporal change dynamics and spatial characteristics converge in indicating that developments of increased water use for increased food and energy production are main drivers of hydroclimatic shifts in continental water systems.

Climate model simulations show inaccuracies relative to observation data and insufficiencies relative to changes of water flow and availability in hydrological catchments of widely different scales and across different parts of the world. Such inaccuracies and insufficiencies depend to some degree on insufficient resolution and/or account of impacts from land-water uses. Relevant and accurate information about continental water system change, however, is vital for both scientists and policymakers in understanding, detecting and adapting to climate change challenges ahead.

Such challenges include those impacting freshwater security and quality. Along densely populated coastal regions, for instance, many aquifers are already suffering seawater intrusion. Scenarios of future hydroclimatic change show high non-linearity in responses of seawater intrusion to rising sea level. This non-linearity implies important thresholds, or tipping points, beyond which seawater intrusion shifts abruptly, from a stable state with mild responses to even relatively large sea-level rise, to a new state with large responses to even small sea-level rise leading rapidly to full seawater intrusion in coastal aquifers. Seawater intrusion can thus greatly accelerate due to climate-driven sea-level rise and decline in groundwater recharge, combined with increased abstractions of fresh groundwater. Such acceleration is a major concern for the sustainability of coastal populations that depend on groundwater for their water supply.

In general, hydrological, climate and Earth System models must be improved to provide adequate information for research, management and policy related to water changes and their diverse drivers, based on systematic and consistent exploration of hydrological catchments and aquifers, and their function changes, on different scales and in different world regions.