Geophysical Research Abstracts
Vol. 17, EGU2015-10623, 2015
EGU General Assembly 2015

A generic hydroeconomic model to assess future water scarcity

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We developed a generic hydroeconomic model able to confront future water supply and demand on a large scale, taking into account man-made reservoirs. The assessment is done at the scale of river basins, using only globally available data; the methodology can thus be generalized.

On the supply side, we evaluate the impacts of climate change on water resources. The available quantity of water at each site is computed using the following information: runoff is taken from the outputs of CNRM climate model (Dubois et al., 2010), reservoirs are located using Aquastat, and the sub-basin flow-accumulation area of each reservoir is determined based on a Digital Elevation Model (HYDRO1k).

On the demand side, agricultural and domestic demands are projected in terms of both quantity and economic value.
For the agricultural sector, globally available data on irrigated areas and crops are combined in order to determine irrigated crops localization. Then, crops irrigation requirements are computed for the different stages of the growing season using Allen (1998) method with Hargreaves potential evapotranspiration. Irrigation water economic value is based on a yield comparison approach between rainfed and irrigated crops. Potential irrigated and rainfed yields are taken from LPJmL (Blondeau et al., 2007), or from FAOSTAT by making simple assumptions on yield ratios.
For the domestic sector, we project the combined effects of demographic growth, economic development and water cost evolution on future demands. The method consists in building three-blocks inverse demand functions where volume limits of the blocks evolve with the level of GDP per capita. The value of water along the demand curve is determined from price-elasticity, price and demand data from the literature, using the point-expansion method, and from water costs data.

Then projected demands are confronted to future water availability. Operating rules of the reservoirs and water allocation between demands are based on the maximization of water benefits, over time and space. A parameterisation-simulation-optimisation approach is used. This gives a projection of future water scarcity in the different locations and an estimation of the associated direct economic losses from unsatisfied demands.

This generic hydroeconomic model can be easily applied to large-scale regions, in particular developing regions where little reliable data is available.
We will present an application to Algeria, up to the 2050 horizon.