Geophysical Research Abstracts
Vol. 17, EGU2015-1956, 2015
EGU General Assembly 2015

Water balance estimation with the Budyko method to assess the hydropower potential of rivers in West Africa

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Small and medium hydropower has a large potential for future development in West Africa, a region that is facing a constant shortage of energy supply and thereby limiting economic growth. The river reaches suitable for small and medium hydropower development are usually located in headwater areas. Mean annual discharge (along with slope) is a key variable for assessing the hydropower potential of a river reach. As discharge gauges are typically located at larger, downstream rivers a regionalization of flow is required. In this study we use the Budyko method to establish the spatially distributed mean annual water balance for whole West Africa (appr. 5 Mio km^2), including the basins of e.g. Niger, Volta, and Senegal rivers. The spatially distributed inputs of mean annual precipitation and potential evapotranspiration are used to compute actual evapotranspiration and thus runoff. Runoff is aggregated along the river network to compute discharge. Due to the impact of different soils and vegetation cover the Budyko curve is calibrated with observed discharge data of about 100 basins covering a wide range of humid to semi-arid conditions. A framework is developed to properly account for the distinctive decadal variations of rainfall (and discharge) in West Africa. Specific challenges are (a) apparently biased discharge measurements at some gauges and (b) uncertainties in the precipitation data (station-based and satellite-based). The results of this study will give (1) an overview about the hydropower potential in each West African country and (2) the theoretical hydropower potential of about 100,000 river reaches. The results will be published on a website with interactive maps to enable the selection of regions of interest for further, detailed assessment of small and medium hydropower development.