Geophysical Research Abstracts
Vol. 17, EGU2015-11946, 2015
EGU General Assembly 2015

Assessing human impact on droughts in a tropical Vietnamese catchment using a combined modelling approach

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Historical drought frequency, drought risk and types are still poorly investigated in tropical regions and particularly in South East Asia. However, evolving drought periods during the dry season severely impact on socio economic factors such as livelihood (irrigated rice production), hydropower generation and urban water supply in such regions as in the VuGiaThuBon river basin (10,350 km^2) in Central Vietnam. Besides the increasing frequency of heat waves and prolonged dry periods without rainfall, hydropower development and over-exploitation of water resources due to demographic and socioeconomic development are the main causes for drought-related disasters and subsequent salt water intrusion.

Precipitation and runoff time series from 1982 to 2009 were used to assess drought severity and typology before hydropower development started in 2010. We applied different rainfall-runoff modelling approaches of increasing complexity (HBV light, J2000 and Mike NAM) as well as meteorological and hydrological drought indices such as the Standardized Precipitation Index (SPI) and its runoff homologue (SRI). In the scope of the BMBF funded research project "Land use and Climate Change interactions (LUCCi)" (www.lucci-vietnam.info), the impacts of the human-induced hydrological alterations on drought risk were quantified by integrating the distributed physically-based hydrological model J2000 with the reservoir operation tool HEC ResSim and the River basin model Mike Basin to simulate the runoff to the coastal system. The salt water intrusion behavior in the flat coastal area was represented by the hydrodynamic Mike 11 model relating low flow thresholds to salt intrusion.

The different discharge simulations before and after the reservoir construction were compared and evaluated regarding their relevance for the drought severity being dominated either by meteorological dry spells or hydrological alterations.

Results show a clear impact of the hydropower reservoir and resulting basin transfers on downstream water availability during the dry season. We conclude that the combination of different model concepts is useful to assess the human impact on drought-related disasters and whether such hydrological extremes are likely to become more severe and frequent in the near future.