Geophysical Research Abstracts,
Vol. 11, EGU2009-6381, 2009
EGU General Assembly 2009

Assessment of terrain slope influence in SWAT modeling of Andean watersheds

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Hydrological processes in the Andean Region are difficult to model. Large range of altitudes involved (from over 4000 meters above sea level, masl, to zero) indicates the high variability of rainfall, temperature and other climate variables. Strong runoff and extreme events as landslides and floods are the consequence of high slopes of terrain, especially in the upper part of the basins. Strong seasonality of rain and complex ecosystems (vulnerable to climate changes and anthropogenic activities) helps these processes. Present study focuses in a particular watershed from Peruvian Andes, the Jequetepeque River. The distributed watershed simulation model, Soil and Water Assessment Tool (SWAT) is applied to model run-off and sediments transport through the basin with data from 1997 to 2006. Specifically, the study focuses in the assessment of the influence of considering terrain slope variation in the definition of Hydrographical Response Units within SWAT.

The Jequetepeque watershed (4 372.5 km2) is located in the north part of Peru. River flows east to west, to the Pacific Ocean. Annual average precipitation ranges from 0 to 1100 mm and altitude from 0 to 4188 masl. The "Gallito Ciego" reservoir (400 masl) separates upper-middle part from lower part of the watershed. It stores water for supplying the people from the big cities on the coast and for extensive agriculture uses. Upper-middle part of the watershed covers 3564.8 km2. It ranges from 400 to 4188 masl in no more that 80 km, with slopes up to 20%. Main activities are agricultural and livestock and mining and about 80% of the population are rural. Annual mean temperature drops from 25.4 ºC at the reservoir to less than 4 ºC in the upper part. Also the highest rainfall variability is found in the upper-middle part of the watershed.

Erosion produced by extreme events like 1997/98 "el Niño" Phenomenon is silting the reservoir faster than expected. Moreover, anthropogenic activities like agriculture and extensive mining in the upper part may be contributing to it. For this reason, the Jequetepeque watershed was the object of several studies from the government and NGOs. In particular, the "CESAH" study (WWF, CARE and IIED 2007) constitutes the first serious effort to model hydrological basin behavior. It includes a compilation of the data needed to run the SWAT model and an analysis of the first results. In this study, model is calibrated. Model version "ArcSWAT 2005" is used. A sensitivity analysis of terrain slope influence in HRU definition and model results is included. Results confirm the relevance of an accurate calibration process as well as the pertinence of including a fine description of slope variation in the modeling of Andean watersheds.

Reference:
WWF, CARE and IIED 2007. Compensación Equitativa por Servicios Ambientales Hidrológicos, "CESAH". Análisis biofísico (modelo SWAT). Cajamarca, Perú.