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Application of a single hydrological model for two remote watersheds in tropical and cold climates

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The results of runoff simulations for two mountainous watersheds in rain tropical forest and permafrost taiga will be presented. The objective is to demonstrate the possibility of application of a single hydrological model in various climate conditions.
The distributed hydrological model "Hydrograph" developed by Prof. Yu.B. Vinogradov in the State Hydrological Institute (St. Petersburg, Russia) was applied. This model has physically based parameters and proved to be able to provide good simulations of runoff at spatial scales ranging from a few square km to watersheds of over 2.4 Million km2. The model uses only existent and common information concerning forcing data and parameters which should be available for any territories.
The tropical watershed (Reventazon-Parismina river, Palomo – 371.1 km2) is located in Costa Rica (9°50'N, 83°53'W). The elevation is within 2000-3100 m range. The precipitation distribution is uneven and varies from 2000 up to more than 7000 mm of annual rainfall. The original vegetation is dense tropical wet forest. The physical characteristic of main soil types developed at volcanic materials which affects the hydrology is high infiltration rates associated with their high porosity.
The watershed of the Timpton River at Nagorny (613 km2) is situated in Eastern Siberia (55°58'N, 124°23'E) in zone of continuous permafrost. Continental climate, continuous permafrost, and mountainous structure (the elevation range within 900 – 1500 m) are the main factors determining the runoff formation processes. The average annual temperature is -7.8[U+F0B0] C, precipitation – 650 mm. The main types of landscapes depending on elevation are mountainous tundra and taiga.
The following information was available for both watersheds: the digital elevation model, the watersheds borders, the river network, the distribution of soils and vegetation, the location of meteorological and runoff gauges. Meteorological data included daily precipitation for 5 stations for tropical watershed; and daily precipitation, temperature and relative humidity for 1 station in case of permafrost watershed.
The simulation experiments revealed strong dependence of the results for both watersheds on forcing data (precipitation) and the parameters of soil strata. Although a qualitative description of the soil types was readily available for both watersheds, no quantitative parameter values corresponding to those soil types could be obtained. Those parameter values had to be estimated from similar soils (Ultisoles, Inceptisoles and Andisoles for tropical conditions; permafrost soils in taiga zone) by literature sources.
Continuous simulations of runoff formation processes with daily step were performed. Average absolute error is 31 %, Nash-Sutcliffe efficiency is 0.58 for Reventazon-Parismina river at Palomo (2001–2008); 58 % and 0.61 for Timpton river at Nagorny (1975–1984) correspondingly.
The Hydrograph model provided good simulation results in terms of river runoff for tropical and permafrost watersheds in conditions of poor information support. There are no doubts that the model performance could be increased if any calibration technique is used. But the value of those results would be refuted by incomplete physical validity and necessity of parameter calibration for any new object. For PUB tasks and in changing environments the advantage of following the principle of universality in hydrological model development is evident.