Eco-hydrological modelling

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Estimating the impact of climate variability and anthropogenic forcings in hydrological processes

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The eco-hydrological model:

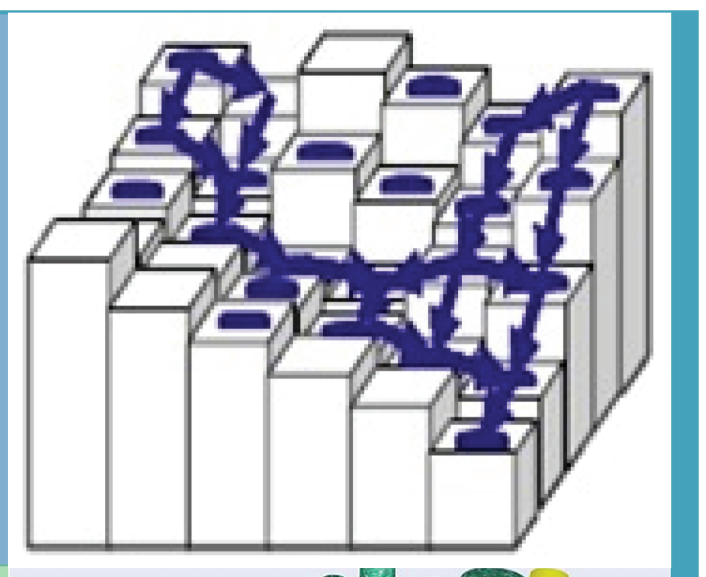
The main goal of the eco-hydrological model is to simulate the changes of the hydrological response due to land-use changes and climate variability.

- The core module will be the physically based distributed hydrological model, TOPKAPI-ETH which is derived from the original model proposed by (Ciarapica and Todini, 2002; Liu and Todini, 2002; Liu et al., 2005). It will be integrated with new components to simulate specific hydrological ecosystem services related to vegetation dynamics and transport of nutrients and pollutants.
- For the vegetation component, we will use the LPJ-GUESS model (Smith et al., 2001; Sitch et al., 2003) which is appropriate for describing the evolution of vegetation in response to climate conditions.
- Transport processes of nutrients and pollutants will be modelled at the basin scale following a mass-response function approach proposed by Rinaldo et al., 2006 a, b.

Eco-hydrological modelling: 1. Theoretical Framework

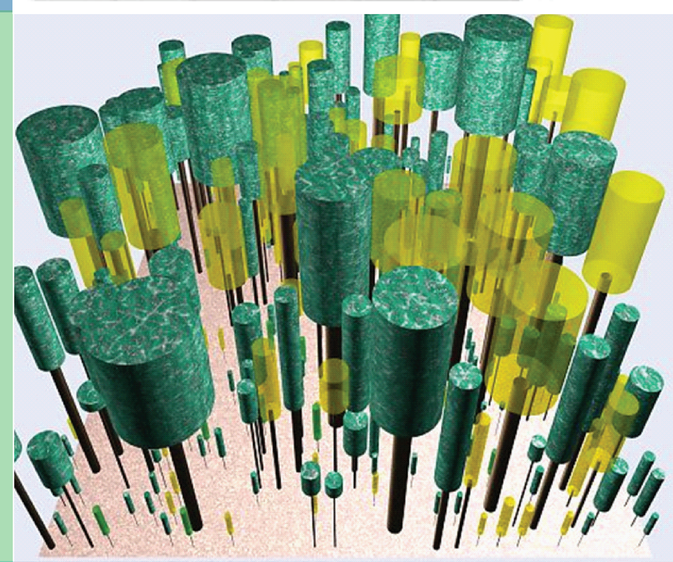
a. Core module: hydrological model TOPKAPI-ETH

TOPKAPI-ETH is a raster based model which allows for **spatially** and **temporally** explicit simulation of the **basin processes**, such as soil water dynamics, overland and channel flow, surface and channel erosion, evapotranspiration, snowmelt, etc.



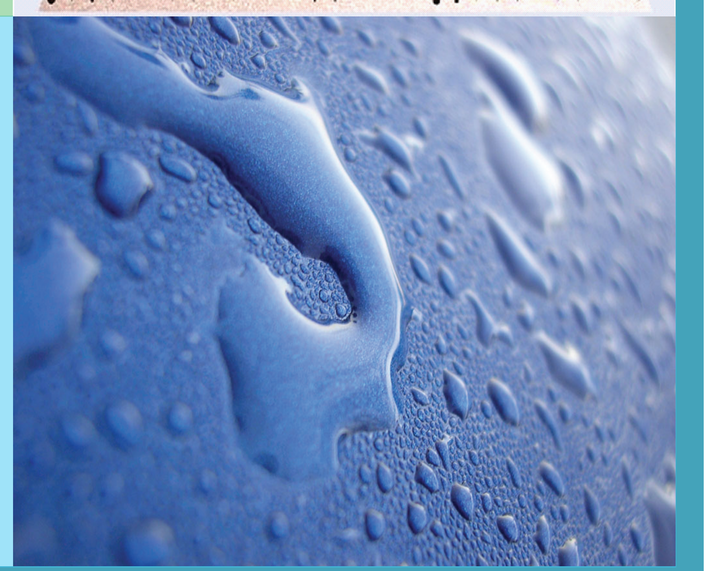
b. Forest-landscape model: vegetation dynamics

A vegetation dynamics module will be embedded in the final version of the eco-hydrological model and will allow to mimic the catchment response accounting for the **dynamic evolution of the vegetation**.



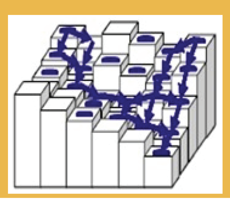
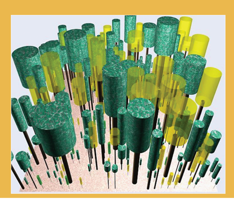
c. Water quality model: nutrients and pollutants

The eco-hydrological model will be interfaced with an approach describing the transport processes of **nitrogen** and **phosphorous** on the basis of residence and travel time.



Eco-hydrological model = a + b + c

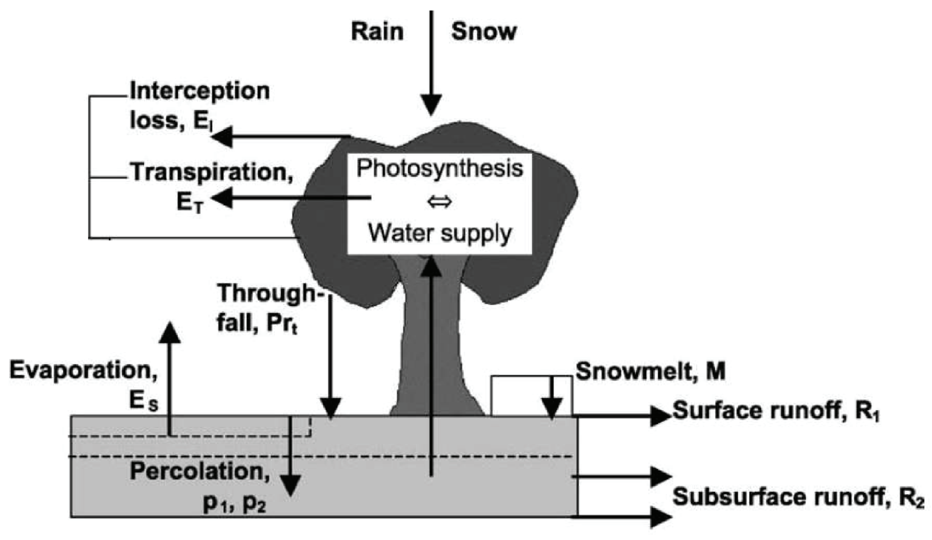
Coupling the hydrological model with the vegetation component

 + 

Eco-hydrological modelling: 2. Coupling TOPKAPI-ETH with LPJ-GUESS

1. Sensitivity analysis of LPJ-GUESS

Investigate the most important - sensitive parameters of the model



***Source**: Gerten et al. 2004*

2. External coupling

The models will run separately, but TOPKAPI-ETH will be fed with some selected fluxes from LPJ-GUESS simulation (throughfall, interception evaporation and transpiration) and will return to LPJ-GUESS the soil water content.

3. Full coupling based on constant values of biomass and leaf area index (LAI)

The evapotranspiration component will be calculated within TOPKAPI-ETH following the approach of LPJ-GUESS but using constant values of biomass and LAI for a period of 5 years.

4. Full coupling

Include calculations of biomass and LAI in TOPKAPI-ETH and enable long-term runs without inputs from LPJ-GUESS.

Research Question

To understand the joint effect of climate and land use changes on catchment hydrology and the related ecosystem services, including feedback mechanisms.

Expected Results

Interfacing distributed watershed models with landscape and vegetation models as well as with transport models can provide an integrated modelling tool to mimic the complex interaction between hydrological and ecological systems and to explore the effects of anthropogenic forcings on it.

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