Simulating the Effects of Land-Use Changes on Landscape-Scale Water Cycles in Alpine Landscapes

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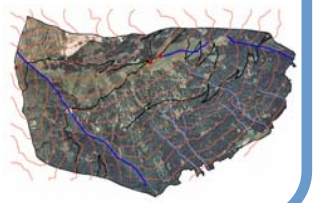
Introduction

Alpine areas are highly sensitive to land-use and climate changes and therefore demand particular attention. Effects on ecosystem services of vital importance are obvious, but detailed information on attached processes is still missing. The current study aims at the **better understanding of the effects of land-use changes on the water budget** and consequently river run-off and associated services (e.g. waterpower) or arising risks (e.g. floods).

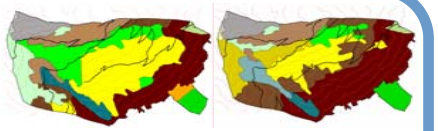
Research Area

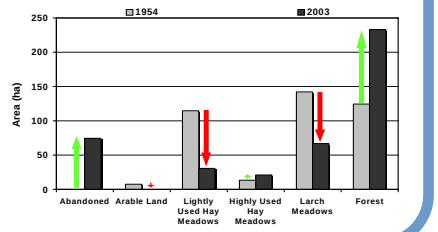
Kaserstattalm, Stubai Valley, Tyrol
located above villages Neder & Neustift

Size: 5 km²; **Altitude:** 1000 – 2280 m a.s.l.
Drained by 2 streams



Land Use Change





Methods

To simulate landscape-scale water fluxes we focus on **coupling** the topography-based hydrological model (**TOPMODEL**) with a state-of-the-art **SVAT** (soil-vegetation-atmosphere-transfer) surface scheme. The meteorological input and evapotranspiration output of the SVAT-model is used to drive an extended version of TOPMODEL. To exploit our detailed data on changes of physiological and soil physical properties by different land-uses (pasture, meadow, abandoned area) we will calculate a combined evapotranspiration-soil-topographic index. Therewith the semi-distributed nature of TOPMODEL will be extended towards distributed hydrological modelling (cf. Ludwig & Mauser 2000). In a next step, our data from soil moisture measurements will be used to validate modelled soil moisture distribution and to improve the knowledge of rainfall-runoff modelling in ungauged basins.

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LudwigR & Mauser W (2000). Modelling catchment hydrology within a GIS based SVAT-model framework. *Hydrology and Earth System Sciences*, 4, 239-249.

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Multi-component SVAT-model

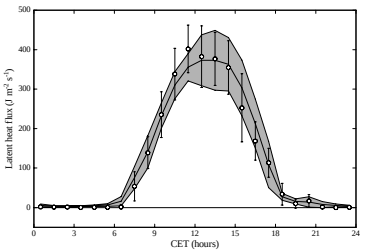
(Wohlfahrt et al. 2001, 2004)

INPUT

radiation
air temperature
wind speed
plant area index (PAI)
water vapour pressure deficit
water table depth (water content)

OUTPUT

Evapotranspiration (ET)



Comparison between measured and simulated latent heat flux. (SVAT-model, hourly bin-averages for five days, meadow) Error bars represent one standard deviation of measurements, shaded areas one standard deviation of model results.

water table depth (z_i)

ET

TOPMODEL

(Beven et al. 1995, Beven & Freer, 2001)

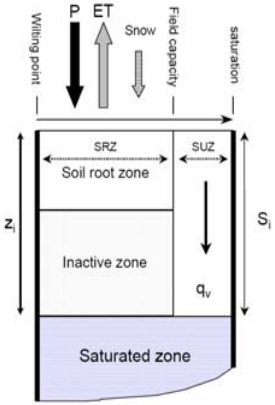
ET
precipitation
soil depth
field capacity (SRZ)

INPUT

saturated hydraulic conductivity (K_s)

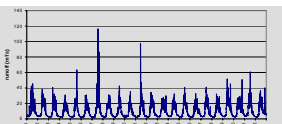
Topographic Index (ln a/tanβ)
hydrological similarity

runoff (for calibration)



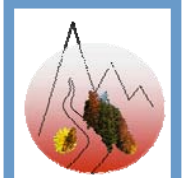
OUTPUT

runoff
surface runoff
Spatially explicit:
water table depth
saturated areas



Interstorm period

Storm period



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