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Using remote sensing and scaling techniques for modeling water resources in mountain catchments

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The manifold management issues of water resources in alpine areas deal with different time scales, such as the event-based forecasting of hazardous floodings or the development of long-term management plans based on scenario simulations. Under conditions of accelerated global change, such applications depend on modeling schemes with predictive capabilities. Distributed modeling of hydrological processes in alpine watersheds is usually performed at microscale grid spacings to achieve adequate approximations of the spatial heterogeneities in mountainous terrain. These simulations are demanding in terms of computation and examination time.

To mitigate these drawbacks, the concept of Geocomplexes has been developed to attempt for equivalent model results across spatial scales. This approach hierarchically aggregates microscale data to any given grid size, while maintaining the substantial hydrological information. Resulting mesoscale raster elements comprise hydrologically homogenous areas, for which calculated energy and water fluxes can be linearly summarised according to areal fraction. Sensitivity analyses has identified land use to be the determining factor for energy and water fluxes near the land surface. An accurate retrieval of land use information is thus of utmost importance for the construction of Geocomplexes. This is achieved by applying a fuzzy rule-based maximum likelihood classifier to relief- and illumination corrected Landsat-TM imagery. The procedure utilizes ancillary geographical information consisting of elevation, slope, soil information and meteorology at any given point in the area of interest to effectively limit the potential local occurence of certain land use classes and thus reduce uncertainty in the classification result. Several studies have demonstrated that Geocomplexes lead to a very close approximation of microscale results for evapotranspiration, soil mois-

ture, surface runoff and groundwater recharge in areas of little to moderate topography. However, as the hydrological behaviour of alpine catchments is strongly dominated by lateral fluxes due to the steep gradients, the scaling approach reveals larger deviations. It was thus regionalized to spatially adapt to the dominant hydrological process.

The methodology is presented and the achievements in terms of improving model results and reducing model uncertainty are demonstrated for selected alpine watersheds. Multi-criteria validation of model results shows good correspondence to in-situ measurements, discharge data and independent satellite imagery. The potential of applying this modeling and scaling scheme for the management of water resources in mountainous areas is discussed.