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Spatial downscaling of snow cover as a tool for projections of snow availability for winter sports in 2030 in the Black Forest using Remote Sensing and GIS methods

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Winter tourism is traditionally the most fundamental economic factor in the German Low Mountain Ranges which significantly affects the economic prosperity and development of these regions. Winter tourism has to adapt to changing climatic conditions due to global change scenarios. In the GIS-KliSchee project accurate areal scenarios of snow coverage in the German Low Mountain Ranges are derived using statistical downscaling methods. In the first project implementation phase the results are assessed for the southern parts of the Black Forest (7.42°-8.62°E, 47.47°-48.28°N) based on satellite data (NOAA-AVHRR and MODIS), weather data from the German Weather Service (DWD), DEM data and land use classification data. The integration of the results into a Geographic Information Systems (GIS) provides an expert system for further strategic investment decisions.

Besides meteorological data, satellite data (NOAA-AVHRR) with a spatial resolution of 1.1 km over a 6 year period (2001 - 2007) were used to develop a statistical extrapolation and downscaling approach for spatial coverage. Using a subpixel snow fraction algorithm the mean monthly snow cover per pixel is detectable. The results clearly display the topography of the Black Forest with the highest snow coverage values around the region of Feldberg summit (1.493 m a.s.l.) and the lowest values in the Rhine Valley (200 - 250 m a.s.l.). Due to varying cloud coverage a pixel-based sample size for cloud coverage was calculated and integrated into further analysis with highest sam-

ple sizes at higher topographic regions and lowest sample sizes at lower topographic regions caused by weather situations with stratus clouds at low altitudes. Satellite derived snow cover data were fed to a Neuro-Fuzzy Network in order to simulate the mean number of days per month with snow depth larger than 9 cm. The model results were compared to measured snow depth at weather stations. Mean deviations of +-2 days per month between measured and modelled snow covers are observable. The calibrated Neuro-Fuzzy Network will be used to estimate monthly mean snow cover in German Low Mountain Ranges for 2030 by applying it to CLM model runs for future regional climate, provided by the Deutsches Klimarechenzentrum, Hamburg (DKRZ) driven by IPCC scenarios.

The inclusion of GIS enables the integration of data on existing infrastructure, ecological precedence areas and economic parameters, so that a GIS-based expert system (Spatial Decision Support System, SDSS) will be available, which can be used for spatial planning. Using this tool, investment decisions in winter tourism can be prepared and different adaptation strategies can be suggested depending on the modelled snow cover availability and further ecological and socio-economic data. The adaptation strategies are derived from expert-knowledge combined with the results of workshops together with local stakeholder.