Mountain Ecosystem Goods & Services
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On a 1 km^2 grid DTM, mountains cover nearly 25% of the land surface. They carry nearly a third of the global forests. On the other hand less than 10% of human population. Fresh water is one of the main services provided by mountains and through valleys and dams, water flow out of the mountain is regulated. 50% of humanity depends on water provided by mountains. Forest ecosystems provide major services such as protection against natural hazards as well as goods such as food & fiber. The large forest area and forest regrowth following abandonment contribute to carbon storage. Mountain landscapes attract tourists. Finally, biodiversity is important, especially in the temperate zone where it is concentrated in mountainous areas.

Potential drivers for change in the provision of these services can be classified into four broad categories. Socio-economic drivers include the evolution of the energy consumption (use of wood), agriculture (abandonment...) and tourism. Political drivers include the demand for forest functions such as carbon storage within the Kyoto protocol. Chemical drivers include CO_2 concentration and N deposition. Physical drivers can be divided into chronic changes on averages and disturbances such as extreme events.

Mountain forests are closely linked to land-use history. They play an important role in protection from natural hazards such as avalanches, rockfalls, erosion & flooding. However, they were overexploited in the 19th century and disappeared. This explains why today we see even aged stands that could die back within a short time frame and loose their protective function. Extensification of management since the 1950s has translated into an increase in standing volume, in forest area and in the accumulation of dead wood. This means an increased fire hazard. Also, natural forest dynamics are playing a more important role today.
Predicting the impacts of climate change is hard. Mountain landscapes are very complex with a strong dependency on upslope processes and lateral flows of matter. Global change will impact ecological and hydrological processes in mountains for which mathematical models are needed.

Forest "gap" models show that a 3°C increase during the first 100 years of the simulation leads to the emergence of new species over a 1000 year period whereas a stable temperature leads to a different climax. Forest dieback is rare as a consequence of climatic change. Usually, no analogue of the future can be found because altitudinal forest strips don't just move up with increased temperature. The information obtained on changed species composition doesn't either...

The ATEAM project has a mountain component. Apart from the common goals of the ATEAM project, the lecturers goals were to look at the coupling of carbon & water fluxes. The project couldn't focus on all ecosystem services and so a selection was made: water, carbon, slope stability and tourism. Stakeholder dialogue (6 stakeholders chosen based on ecosystem services) was undertaken. On the first round, the project team wanted to learn what the experiences and major concerns of the stakeholders were. They also wanted to identify ecosystem goods & services and relevant indicators. On round 2, the team wanted to critically evaluate the first research results, discuss the strategies for the vulnerability assessment and also obtain guidance from the stakeholders. This resulted in the publication of a report entitled "Mountain Stakeholder Workshop". The final round of the stakeholder dialogue hasn't happened yet but bilateral discussions and meetings will be organized. The aims will be to critically evaluate results of the simulations and the VA and provide feedback on adaptive capacity and sectorial vulnerability.

Spatially explicit simulations of ecosystem service provision change were made based on coupled vegetation (Biome BGC), hydrology (hydro Top) and climate (MT CLIM) models. Input into the models was GIS information (DEM, soil types, vegetation and drainage networks) set up as a hierarchical landscape representation. Output were maps and time series. A question was asked concerning the use of gap dynamics in the vegetation model and the answer was that vegetation in the BGC model is basically "green slime".

A number of case studies were selected but only German speaking parts of the central and eastern Alps ended up in the assessment. However, these sites could be considered representative of different climatic zones within the Alps (Baumgartner et al. 1983). The simulations were not scenario-based and the project team only looked at climate variability. They looked at increased temperatures (+2°C and +4°C) and their consequences on river flow (more in winter, less in summer). The following section goes into more detail about the different ecosystem goods & services that have been studied.

WATER ecosystem service
Changes in total precipitation only brought about decreased flow and so were considered uninteresting. On the other hand, increased temperature had interesting effects.
As these results were presented to the stakeholders, they told the project team that water was very important and that seasonal changes matter most even though storage is possible. Different "water" stakeholders were worried about different things: hydropower (winter but also summer), drinking water (year round) and irrigation (summer).

CARBON storage ecosystem service
Concerning C storage in vegetation, a one-factor sensitivity analysis was undertaken and afforestation above 1400m asl (land-use change) proved to have a much stronger impact on carbon storage than temperature change. The "carbon" stakeholders recognized the increasing importance of carbon issues and their political importance. They expect land-use change to be the most important driver of change and stated that large land-use changes were going on today. They wondered about the relevance of natural disturbances such as fires, insects, windthrows....

TOURISM ecosystem service
Four drivers of "mountain tourism" were identified: "summer", "winter", "wellness" & "healthcare". These had different requests and different relevant ecological indicators. One indicator the lecturer insisted on was "snow safeness". This relates to the risk of having not enough snow during the winter season (more than 30 cm of snow, during 100 days between 1/12 & 15/05 at least 8 years out of 10). Stakeholder dialogue changed the project team´s view on what was important for tourism. They stated that infrastructure and accessibility were the most important issues: "can people get there?" Ecosystem services were considered secondary. A new strategy was adopted by the project team which was to look at slope stability in priority as "protection is crucial".

SLOPE STABILITY ecosystem service
Slope stability depends on a number of elements: topography, soil moisture, root carbon and land-use patterns.

The conclusion to the talk was that mountains are globally significant, that spatial interdependency of processes and systems is high and this needs to be taken into consideration at high resolution. Sensitivity is considerable and is mainly driven by land-use change on the short term (10 - 50 yrs) and climate change in the longer term (over 100 yrs). Stakeholder dialogue has helped shaping the project and can be considered successful. Adaptive capacity was shown to vary by service and by region. Water has a high vulnerability through undesired changes whereas carbon sequestration has low vulnerability.

Few questions were asked: Is there a summer/winter compensation in tourism. The answer is "no" and stakeholders agree that winter tourism brings in much more revenue than summer tourism. Another question was why biodiversity wasn't considered and the answer was that a sister project within ATEAM took care of that.

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