Vegetation dynamics in high mountain regions under impact of natural disturbance regimes[1]

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Summary

Vegetation dynamics in high mountain regions are driven by natural disturbance regimes to an exceptional extent. Here, the concept of natural disturbance provides an appropriate background for studying exogenous vegetation dynamics. Permanently disturbed plant communities are basically driven by exogenous cycles. However, within certain subalpine and alpine plant communities, some sites are rarely influenced by disturbance regimes. In order to estimate the ratio between exogenous and endogenous vegetation dynamics it is important to decipher vegetation pattern, process and mechanism at one site. Typical ecosystems of humid high mountain regions - alpine sedge mat, alpine heathland and subalpine forest - were selected to explore the driving forces of vegetation dynamics.

The alpine sedge mat *Caricetum curvulae* in the Glatzbach area (Hohe Tauern, Austria) shows a long lasting stability. In undisturbed parts of the sedge mat, the foundation species *Carex curvula* puts enormous competitive stress on other species. Other vascular plants are unable to establish when the *Carex population* is well developed. The endogenous vegetation dynamics shown here can be called 'mosaic cycle' or **'**carousel dynamics'. These dense sedge mats can only be destroyed mechanically, as a rule by frost dynamics (e.g. cryoturbation, solifluction, etc.) or bioturbation (marmots).

Cryoturbation creates small areas of disturbance within the apparently homogenous ecosystem. Clearly distinctable vegetation zonation is formed by a concentricly decreasing intensity of disturbance. The majority of plant species of the sedge mat community is limited to these disturbed areas, or is mainly abundant there. The disturbance regime creates a diversified community series (*Cryptogam* stage, *Luzula* stage, first *Primula* stage, second *Primula* stage), which develops after a climax-like transitional phase into a herbal phase with some *Carex curvula* („herbal climax"). This phase alternates cyclicly with a monodominant *Carex curvula* phase („absolute climax") and a phase with additional abundance of *Oreochloa disticha* („grass climax").

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The alpine heathland (*Loiseleurietum*) at the Saualpe (Carinthia, Austria) is the result of an inherent disturbance regime. The foundation species *Loiseleuria procumbens* succeeds sustainably because the permanent influence of the disturbance factor „wind“ impedes the establishment of strong competitors. Thus, a wide-spread stable and species poor plant community occurs, showing a strong *Loiseleuria procumbens* dominance.

Within the dense spots of *Loiseleuria* clones vegetation dynamics are driven internally: *Loiseleuria* regenerates constantly, occasionally accompanied by *Vaccinium gaultherioides*. Given stronger impact of disturbance, the *Loiseleuria* dominance dissolves into sickle-like patches („wind sickles“). These phenomena may be described as a cycle made up of four distinctive phases: hollow, building, mature, degenerate. Alpine pioneer-species contribute to these phases as external specialists.

Analysing catastrophic events such as glacier advances, a series of five regeneration phases may be described for the subalpine forests (*Laricetum*) located in a glacier forefield in the Gressoney valley (Aosta region, Italy). First, there is a species poor initial phase, characterized by a sparse vegetation cover. It is followed by a first constitution phase with appearance of woody species. This phase shows a high species and site diversity. Within the second constitution phase woody species spread and establish, preparing a multi-layer structure. The third constitution phase is characterized by a continuous closure of the canopy, accompanied by a diversification of the stand structure. Within the fourth constitution phase young cohorts of *Larix decidua* densify by generative reproduction. *Larix decidua* is, by trend, replaced by *Picea abies* and/or *Pinus cembra*. The following development is disturbed by human or glacio-fluvial impact.

In all three of the analyzed ecosystems, the specific disturbance regimes prove to be decisive for the resulting species diversity. There is a clear correlation of disturbance magnitude and frequency with species diversity: a strong disturbance impact results in low diversity. Highest diversity is formed under intermediate disturbance conditions within intermediate successional stages.

For the purpose of nature conservation it has to be concluded that there is no way of permanently ensuring high diversity within these ecosystems without allowing the impact of disturbances. Disturbance has to be perceived as integral factor of conservation management, as far as the maintenance of biodiversity is a declared goal of nature conservation.

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