

Abstract

The global forest ecosystems play an important role in the global carbon cycle and in the preservation of biological diversity. The dissertation presents a qualitative analysis of non-sustainable civilisation-nature interaction patterns relevant for global deforestation and forest degradation. Since this problem is closely linked to other core problems of Global Change (GC), e.g. Soil Degradation, World Food security, Climate Change, etc., it is not to be tackled separately. Therefore a novel transdisciplinary approach to analyse non-sustainable civilisation nature interactions in the context of GC is utilised in the investigation. The approach rests on the decomposition of the intricate dynamics of GC into patterns of problematic civilisation nature interactions ("Syndromes") by an iterative process of observations, data and system theoretical analysis, and GIS based modelling attempts. These Syndromes characterise endangering and risky developments of civilisation nature interaction and represent a baseline for measuring and indicating 'non-sustainability' - in order to have a sustainable development it is necessary to have a far-reaching absence of Syndromes. The patterns are defined as characteristic constellations of interacting socio-economic and physical phenomena ("Symptomes" of GC), which build complex dynamical systems of civilisation-nature interaction. The cause-effect schemes of Symptomes and their interrelations are constituted as complex phenomena resulting from interactions over the different spheres of the Earth System. The approach is illustrated by a detailed analysis of those civilisation nature interaction patterns relevant for global deforestation.

Human activities cause a wide extent of deforestation and threaten the important role of the remaining global forest within the earth system. Global deforestation and forest degradation is made up by a limited number of cause effect patterns observed in different parts of the world. The main syndromes identified causing large scale deforestation are:

- The overexploitation of natural ecosystems - the OVEREXPLOITATION SYNDROME. Examples of this pattern are the exploitation of forests for timber or fuelwood and charcoal.
- The rural poverty driven overuse of natural resources - the SAHEL SYNDROME. Examples are the exploitation of forests via slash and burn cultivation by smallholders, particular in tropical developing countries.
- Non-sustainable agro-industrial use of soils and bodies of water - the DUST BOWL SYNDROME. Examples are the conversion of forest for large cattle farming or cash crop agriculture.

Besides these mayor cause-effect schemes of global deforestation, there are several other Syndromes that contribute on a minor scale, e.g. the development and destruction of nature for recreational ends (MASS TOURISM SYNDROME), the environmental damage of natural landscapes as a result of large-scale projects like dams (ARAL SEA SYNDROME), the environmental degradation related to mining and extraction of non-renewable resources (KATANGA SYNDROME) or the environmental degradation through large-scale diffusion of long-lived substances (SMOKESTACK SYNDROME) as in the case of acid rain.

The geographical analysis of a Syndrome is performed in several steps integrating GIS with concepts of fuzzy logic and qualitative reasoning. In the first step a syndrome specific network of interactions is formulated by analysing case studies, theories and expert assessments. Based on this systemic representation the natural and socio-economic conditions under which the syndrome specific mechanisms can be active are identified. This evaluation is called the disposition of a region towards a specific Syndrome. The resulting indicator can be used as an early warning indicator for the possible germination of a non-sustainable development. Based on the constituting elements of the Syndrome, a complex indicator for the intensity of the active Syndrome is derived in the next step of the analysis. This indicator assesses the critical states in the dynamical evolution of the non-sustainable patterns of civilisation nature interaction.

Complete Syndrome analyses are performed for the main Syndromes of deforestation. The resulting spatial distribution of the combined dispositions and intensities of the different Syndromes present a unique global assessment describing the current damage and future regional threats to forests by their underlying global cause-effect patterns of civilisation-nature interaction. Specially the assessment of the threat by coupling of momentarily active and potentially active cause-effect patterns provides a previously not achieved systematic insight into the complex interaction of different patterns of global deforestation and forest degradation.