“Human driving forces for ecosystem services in the Himalayan region”

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Human driving forces for ecosystem services in the Himalayan region

Abstract

Environmental, socio-cultural and economic variations supplied by natural ecosystems in the Himalayas have led to the evolution of traditional agro-ecosystems mainly in areas of Pakistan, India, Nepal, Bhutan and China. A multitude of natural resources aids traditional mountain farming societies to sustain themselves. However, driven by large-scale population expansion, the Himalayan environment has suffered the effects of agricultural encroachment, deforestation and consequent soil erosion. *Deforestation* and *land degradation* appear to affect a far greater proportion of the population than previously thought, contributing to floods and stagnating agricultural output. Through this paper we will discuss the main drivers for the maintenance of ecosystem services of the Himalayan region, i.e., the benefits to humankind from the resources and processes that are supplied by natural ecosystems. The authors proposed to develop a holistic approach to link the ecological and social ecosystem services. The LULC (land use/land cover) analysis can be used as a joint platform to integrate natural sciences with humanities, and optimize trade-offs between ecosystem services.

Keywords: ecosystem services, Himalayas, land use, sustainability, trade-off.
JEL Classification: Q01, Q15, Q18, Q24, Q56, Q57.

Introduction

Human population and economic growth as major drivers of natural resource degradation. Rapid population growth is the main driver of land use change (Rawat et al., 1996; Sankhayan and Hofstad, 2001; Singh, 2006). The majority of the population still depends on agriculture. For example, in their study area in the Indian Himalayan state of Uttarakhand, Munsi et al. (2009) found that anthropogenic disturbances are the main drivers of land use change in the form of increased agricultural activities and human settlements. The Asian Development Bank/ICIMOD (2006) estimated that while 47% of the denudation and landslides are of natural causes, the remainder is man-made.

Historically, Nepal has demonstrated a trend in which the initial immigration from the lowland areas to the mountains has been replaced by an accelerating migration from the hills to the plains, i.e., the so-called 'Great Turnabout'. With this trend, increasing numbers of local people moved to the Terai plain regions from hill and mountain areas, which left many agricultural fields abandoned. The socio-economic consequences of such abandonment, in particular among the marginal and small farm households include an increase in food shortages and a decline in livelihood options (Hrabovszky and Miyan, 1987). The trend of population migration in the Himalayan region of northern India also reflects the situation in Nepal. With the decline of agricultural productivity, young men are migrating to the plains and urban areas in search of livelihood. In many places, uneducated women are unable to properly manage scarce agricultural lands. Food security and poverty result from such intrinsic factors as small farmland holdings, out-migration and a lack of entrepreneurship (Kuniyal, 2003).

The pressure on forests in overpopulated immigrated areas has shown a clear increase since 81% of the people's fuel requirements are met using firewood (CBS, 2003), a rising trend set to continue until alternative fuels are developed. In Nepal, 50 million tons of green grasses are required to meet the daily necessities of man and animals. Although irrigation facilities, electrification, deforestation and road construction are essential for the economic and social development in the Himalayan region (Figure 1), these activities may also increase pressure, directly or indirectly, upon the soil. It is the fact that the environmental problem to receive most concern is the landslide issue, due to deforestation. During monsoons, fertile soils lacking vegetation cover are washed out by rivers (Naithani et al., 2007; Geneletti and Dawa, 2009). In Nepal, the desertification of approximately 10,000 ha in the mountainous districts of Dolpa and Mustang has begun, with further ecological deterioration indicating also a spread to other areas (Asian Development Bank/ICIMOD, 2006).

Fig. 1. Human impact and development that are visible on the steep slopes of Nadid village, Dharamsala, India.

Aged and condemned vehicles have increased air pollution in urban areas (Tiwari, 2008, Singh et al., 2008). For example, there is now a strong indication that the ecology of the Kathmandu Valley is greatly affected by industrialization (Asian Development Bank/ICIMOD, 2006). Without the provision of adequate facilities for drinking water, drainage, sewerage and electrical supply, such uncontrolled and ill-managed urbanization increases the pollution of water and air, leading to an increase in the variety of diseases suffered (Chakraborti et al., 2008; Geneletti and Dawa, 2009).

1. Management initiatives on sustainable livelihood: forest and medicinal plants

In conjunction with the sustainable development movement in the late 1970s and early 1980s, there was an increased recognition of the actual potential value of forests to both provide products and services to the people of the Himalayan region. For example, in Himachal Pradesh and Uttarakhand, very little fodder is grown on agricultural land and livestock graze mainly in pastures and forests. In these regions, tree fodder is predominant and it is mainly women who manage lopping and fodder collection. As many of these regions have a high degree of male migration, the responsibility for both agriculture and animal husbandry lies with the women (Kaur, 1991).

Since medicinal plants are important for traditional health care, as well as in their large-scale collection for trade, the decline of high-altitude medicinal plants induced by changed land use has also been of concern throughout the Himalayan region (Ram et al., 2004; Bhattarai and Karki, 2004; Saxena et al., 2005; Ghimire et al., 2006; Kala, 2006; Singh and Mal, 2009). The maximum number of medicinal plants (i.e., 1717 species) has been reported to occur in Uttarakhand, followed by Sikkim and North Bengal, at an elevation range of approximately 1800 metres. Of the total medicinal plant species in the Himalayas, 62 are endemic, with 208 extending their distribution to adjacent areas and are therefore, classified as near endemic. The indigenous communities use some medicinal plant species as a source of food, fodder, timber as well as various other ethno-botanical purposes. For example, apart from the use of *Myrica esculenta* and *Terminalia bellirica* as medicines, the fruits of these species are edible, the leaves are used for fodder and the wood is used as fuel (Singh, 2009). The issues of sustainable forest management have become increasingly important as it is becoming an increasingly challenging task on how best to utilize the non-timber forest products to improve livelihoods (Venkatesh, 2002).

The further depletion and degradation of forest can be saved at the local level by proper management of existing forest resources, involving people, government and non-government organizations, as well as other research institutions. In particular, the active involvement of local people is an important factor in reducing deforestation. For instance, in their study area in the Indian Himalayan state of Himachal Pradesh, Sharma et al. (1997) stated that a participatory approach is needed for forest protection in an environment where people themselves could realize the ecological and socio-economic benefits of forests, rather than adopting a one-sided prohibitive approach. Moreover, in the Uttarakhand Himalayan region, the grass-roots level "Chipko Andolan" (Hindi, Hug the tree) became a world-renowned ecological movement (Guha 1989, 1993; Dehradun Forest Division, 2000), leading to an increased environmental consciousness among local people. This was also a question in the recently established Kanchenjunga Conservation Area of northeastern Nepal, which is based on the principles of the participatory concept of nature conservation (Müller-Böker and Kollmair, 2000). The main aims are to protect the unique environment and meanwhile to help local communities improve their standard of living.

2. Reconciling ecosystem services, development and conservation

Food security cannot be achieved without enhancing livelihood options. In turn, the livelihoods of poor communities cannot be improved unless the resources for ecosystem services other than food provisioning, such as water, land, forest, range land and the natural environment are conserved and both their access and optimal utilization ensured. From the perspective of a mountainous area it is therefore necessary to take a holistic approach concerning not only food provisioning services but also other ecosystem services (Saxena et al., 2001). A sustainable strategy for improving food security calls for a package of measures, including strengthening the up- and downstream relationships along a geo-gradient in the mountain area, such as the Himalayan region (Tiwari, 2000).

An agricultural system is considered to be sustainable if its productivity is maintained in the long run, the natural resources driving the agricultural production process are preserved and the profitability of production and therefore, financial income of farmers is guaranteed (Neher, 1992; Kessler, 1994). Some studies proposed that a reconciled trade-off between satisfying the immediate human needs while maintaining natural resources is key for the sustainable land use, in terms of both securing food production, as well as maintaining biodiversity and the natural environment (Yong et al., 2005; Steffan-Dewenter et al., 2007). Much discussion has been made for the necessity of sustainable agricultural land use (Ives and Messerli, 1989; Mehta, 1990; Sharma and Singh, 1997; Sharma and Chaudhry, 1997; Singh, 2006; Steffan-Dwenter et al., 2007; Marston, 2008).

In the Himalayan region, some case studies have contributed to sustainable issues. For instance, Rawat et al. (1996), Sankhayan and Hofstad (2001) and Sitaula et al. (2005) found that overpopulation in hill regions in relation to poor land productivity and cultivation in less fertile lands resulted in land degradation and deforestation. The growing demand for more food production and the increasing need for more direct cash have forced hill people to cultivate all kinds of land, resulting in the denudation of land resources and soil erosion. These changes resulted in an out-migration of the area's human resources. Moreover, in the above mentioned studies, a management system was proposed for the revival of natural resources and the sustainable utilization of the area's human population and livestock. This system involved active local participation to change the existing land use to one based on the soil fertility scale. The relationships between agriculture, livestock and tourism as the main sources of livelihood in Upper Mustang in Nepal were studied by Chhetri (2006), who considered that the key strategies for sustainable development lay in reducing the crop loss to pest and diseases, improving animal health and range lands, as well as an equitable sharing of the revenue generated from tourism and its reinvestment in the area.

New methods must be developed to address these trade-off issues. De Aranzabal et al. (2008) applied numerical analyses, which associated the territorial structure with both economic and socio-cultural structures to predict changes in a semi-arid Mediterranean landscape. They found that the procedure highlighted the importance of landscape scenarios as a useful tool for linking landscape ecological science to policy design and ecosystem management. Balancing the inherent trade-offs between satisfying immediate human needs and maintaining the natural resources for other ecosystem functions requires a quantitative yet holistic approach about ecosystem responses to land use (DeFries et al., 2004). One hypothesis is that in complex ecosystems, it is unlikely that there is a linear response of ecosystem services to land use change. By contrast, this non-linear response makes it possible to identify a balanced trade-off for a "small loss-big gain" scenario. Although the potential non-linear responses of ecosystem to land use would offer management options with limited ecological losses, there would be satisfying economic gains. According to Singh (2006), strategies for sustainable development in the Himalayan region must be based on reliable and comprehensive data of natural and socio-economic resources, as well as from the environmental set-up. This holistic ecosystem service-based idea was applied for a sustainable study in the region. Moreover, in terms of energy and economic efficiency of different land use types constituting the landscape, Nautiyal et al. (1998) analyzed a mid-altitude village (i.e., 700-1200 m amsl.), in Garhwal Himalaya. They found that land use changes in the region are driven by the interaction of ecological, policy and human factors. The recommendation of the study was that the present scheme of treating forests and agriculture as closed and independent ecological or production systems needs to be replaced by an integrated land use policy.

We believe that the ecosystem services-based approach is highly applicable for developing the new integrated paradigm. Further research questions concerning the holistic approach for the trade-off study are proposed: at what scale and with what platform can the ecological and social/economic system be quantitatively linked? We need a joint platform on a common scale as a bridge to transform between natural sciences and the humanities. The LULC (land use/land cover) GIS analysis has previously been used as a quantitative platform (Burel and Baudry, 1995; Van Mansvelt and Stobbelaar, 1997; Farina, 2007) to link the ecological and social system. In addition, efforts have been made to analyze changes in broad land use types in the Himalayas, within the framework of the LULC (Virgo and Subba, 1994; Thapa and Weber, 1995; Schweik et al., 1997; Rao and Pant, 2001; Gautam et al., 2002; Wakeel et al., 2005; Munsi et al., 2009). The watershed, as a functional research unit that covers both natural resources (forest, water, biodiversity) and a societal section (village, population structure, fields) has been mainly concerned with soil and water protection in GIS mapping (Neupane and Young, 1997; Tiwari et al., 2005; Sharma et al., 2007). Moreover, watershed management has two aspects, i.e., conservation and production, which makes the watershed area the best potential unit to study the trade-offs between human development and natural conservation.

Conclusion

We propose an ecosystem service-based approach, which will not only emphasise economic development but also other pillars of development equally, including ecological and social capital in the Himalayan region. Sustainability cannot be achieved in part, but instead should address the whole system (Tulachan, 2001). If the government is committed to ensure non-decreasing social welfare, this may not necessarily improve all deciles of households equally, due to a huge disparity of income and resource endowments. Therefore, the government should plan to meet the minimum requirements of the ecological system that may involve structural changes within the economy and society (Singh et al., 2008). De Aranzabal et al. (2008) proved that the formalization of the landscape socio-economic dependence enables us to

consider scenarios of socio-economic change and to deduce variations in the landscape. They simulated landscape changes using socio-economic variables and found the scenarios to be useful tools for predicting changes in landscape typology and in the heterogeneity of the landscape matrix.

The Himalayan region needs a holistic structural change in its socio-political and economic systems to correct environmental injustices, which include essential legal, political and social provisions for improved participation, access to information and access to justice. While such development is a dynamic process, it may suffer due to the lack of local people's involvement in decision-making processes (Rai, 2007). The reconciled trade-off between development and nature conservation can be achieved through the participation of local people (Müller-Böker and Kollmair, 2000). In this context, the role of Mahila Mandal, a community-based rural women organization is appreciated (Kuniyal, 2003).

Finally, the major challenge for landscape scientists in the Himalayan region is to ensure that in their work their native cultural values should be modernised by a careful, step-by step transformation into well-adapted, comprehensive, planning and land use strategies to provide lasting, synergistic benefits for the local people, their economy and culture in rural and urban landscapes.

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