Himalayan Nature
Representations and Reality

Edited by Erika Sandman and Riika J. Virtanen

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Cover photo
Nakza Drolma: "mTho ris la, a mountain pass at the top of Brag dkar sprel rdzong, and a Buddhist pilgrimage site in Xinhai County, Qinghai Province, People's Republic of China."

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CONTENTS

THE MAIN FACTORS OF BIODIVERSITY CHANGES IN EAST TIBET

Juha-Pekka Reilin

ABSTRACT

This paper is based on my preliminary botanical studies on the physical environment of the Himalayan range, particularly the forested areas of the Tibetan Plateau. My interest in the subject was aroused during two field trips (2005 and 2007) to Eastern Tibet – Kham and Amdo – after observing the apparent lack of forests in places where, according to altitude and other local climate conditions, trees should have been widely covering the mountain slopes. My visit to the high altitude grasslands of Zeku (Amdo), so badly dried that they will unlikely ever again recover for grazing, also inspired my efforts to find out what has caused such conditions. I have since started to collect information in order to understand the relationship between the general environmental conditions of Tibet, the patterns of their ecosystems, and the interdependence between local communities there and the environment. The predominant man-made factor in the Tibetan areas during the last sixty years has been the scale of deforestation carried out by the P.R.C. government from 1950 until the 1980s. It also appears, however, that deforestation has a much longer history in this region. During the last decades, increased awareness about how reducing forest coverage can cause serious environmental problems has resulted in many reforestation projects in these areas. In this paper, I have tried to form a general picture from the multiplicity of phenomena having an effect on the nature of conditions and peoples' lives in these areas of Tibet.

1. PEOPLE AND ENVIRONMENT

1.1 Land use patterns

Herding and farming has been the basis of the nomad lifestyle in Tibet for thousands of years. Cultivated areas are situated in valleys below 3,800 metres, being terraced on the lower parts of mountain slopes and along riversides, beyond the

Studia Orientalia 109 (2011), pp. 105–117

reach of spring floods. The yaks graze on high altitude grass plains, as well as on steep mountain slopes, with summer pastures often reaching an altitude of above 4,000 meters. By winter, the herds graze on lower pastures. Movement of the herds between summer and winter pastures may take them more than 20 kilometres.

The land cover of the Tibetan areas in China mainly consists of large mountains and desert areas, forests, grasslands, and rivers. Compared to this natural environment, roads, towns and other built-up areas make up a very small percentage of the total. The majority of changes in land use are found with conversion from forests to fields for grain production or to pastureland.

1.2 Land cover change and other direct drivers of changes

In biological terminology, the concept of "biodiversity" (biological diversity) reflects the number, variety and variability of living organisms and their changes by location and through time. Natural and human-induced factors that directly or indirectly cause a change in biodiversity are referred to as drivers. The most important direct drivers of change in terrestrial ecosystems are land cover change (mainly through conversion to cropland), deforestation and forest degradation. While the latter two are particularly extensive in the tropics, they are found locally in boreal forest zones as well. (GFSB 2006)

With the main focus now on forest degradation in Tibet, one finds that not only forestry policy but other human activities as well have caused deforestation. As the number of animals has grown over time, the need for grazing lands has increased accordingly. In 1948, the forest cover of Qinghai province was 1,456,000 hectares. The extent of suitable land with forest cover was stated at the same time to have been 34,225,000 hectares. (Wang 1999) As Winkler points out, in the past when nomads were faced with the need for more pastures, they even used fire to convert forested land. (Winkler 1998) In more recent history, when replanting was not done after clear-cutting, land that was formerly forest was often used for grazing. It can be said that, in this way, Tibetans themselves are also responsible of the disappearance of forests.

Forests in Amdo are strongly fragmented, appearing as random spots in the mountainous landscape. Only 10–15 per cent of the area suitable for growth is covered with forests. The Kham area has survived better, with less clearcutting due to poor access to logging places. A significant part of Kham's forests are located on precipitous mountainsides and in gorges.

Table 1 Forest Coverage in Tibetan Areas (Wang Hongchang: *Deforestation and Desiccation in China*).

	Forested areas (1000 ha)					
	Pre-historic*	**1948/1**	**1948/2****	**1976**	**1981**	**1988**
Gansu	12,839	2,285	2,285	1,870	1,769	2,029
Qinghai	4,940	1,456	191	190	195	266
Sichuan	32,050	8,289	8,700	7,460	6,811	10,872
T.A.R.	12,777	1,493	6,320	6,320	6,320	6,320

* Based on the assumption that all present farmland as well as all modern roads and built-up areas were covered by forests, and on the estimated density of population which is calculated by using special formula.

** Alternative estimate, source not given

Contradictions in the table above indicate the difficulties in finding reliable official data in China. However, one can see the start of a trend in reforestation in the 1980s, as well as the fact that already in 1949 only 20–30 per cent of the potential forestland of Tibetan provinces was still covered in trees. It seems that this was due to the combined long-term effect of the increasing herds and a lack of any sustainability policies regarding forest use.

> Forests were traditionally regarded as a common asset by Tibetan communities and were primarily utilized as a resource for construction timber and firewood besides many forest by-products such as medicinal plants and mushrooms. The disappearance of forests in wide areas of the region indicates a lack of sustainable forest use traditions. Thus, deforestation and forest fragmentation has a long-standing history on the Tibetan plateau. (Winkler 2002)

Recently, some nomad families now using houses in order to remain over the wintertime have converted their pastures to grain production. This was visible in Amdo, around Lake Kokonor, in May 2005. The local government had previously shared the pastureland, providing an area for each family, with an order to build fences around it. My assumption is that some families found this arrangement too complicated for grazing purposes, compared to the traditional manner in which each family had their own historical territories where they could graze the herds. Inside the fenced area there would not have been enough grass for adequate grazing for a larger number of animals over the course of the year. They may have simply decided to instead try grain production on the fields next to

their winter houses. The local government may also have supported this change in land use.

1.3 Species diversity

Tibet has very rich and diverse flora, a wide range of vegetation types, and spectacular landscapes. Its great botanical richness, with at least 5,766 species of flowering plants, is a result not only of the immense size of Tibet, but also because Tibet lies in the biodiversity "hotspot" of the Himalayan range (which also includes Nepal, Bhutan, and Sikkim) and the biodiversity "hotspot" of western China. The flora of Tibet is about 19 per cent of the total flora of China, which itself represents 12 per cent of the known flora of the world. To put this in context, the whole of former Tibet supports about 2.5 per cent of the world's known flora. (EECRG 2008)

The southern parts of Tibet are a botanist's treasury. The "hotspot" of western China (consisting of parts of Kham province, Northwest Yunnan province, the southeast tip of Qinghai, the southernmost part of Gansu province, and some eastern parts of T.A.R.) forms the most diverse temperate forest ecosystem in the world. Even in Qinghai, where most of the area is highland pastures and deserts, plant diversity is high. Qinghai's flora includes some 3,500 taxons, of which more than 420 are woody plants. (Liu S.-W. et al. 1996–1999)

1.4 Nature as the source of additional income

The economy of Tibetan nomads and farmers is based on products of herding and farming, such as meat, milk, wool, and the crops of cultivated plants. Families traditionally consume these products themselves, with overproduction being exchanged for other indispensable products. The amount of yearly crops tends generally to provide just enough to survive. Extra income is needed for healthcare, children's education, transportation, and offerings to the monasteries. According to Buddhism, it is not suitable to kill more animals than necessary. Most families follow this advice, which means that selling animals for slaughtering is out of the question. So what are the ways of making additional income?

At the present, family members with vocational skills, such as fluency in different languages or mechanics, may work in the labour pool or run their own business. The growth of tourism gives additional possibilities locally, while one also finds projects for developing agricultural areas, such as planting fruit trees where the climate is suitable.

Figure 1 Fragmented forests in Labrang (Ch. Xiahe), South Gansu, April 2007. Access to the nearest forest adjacent to Labrang monastery was restricted with a metal fence. Rumour holds that there is a crowd of angry dogs running wild behind the fence, protecting the trees from illegal logging.

Figure 2 Mixed forest at elevation of 3,400m near Repkong (Ch. Tongren), Amdo, May 2007.

Figure 3 One of the world's highest coniferous forests at an elevation over 4,500 metres in Dzogchen, Kham, April 2005.

Figure 4 Spruce seedlings growing in a nursery near Repkong, Amdo, May 2007.

Traditionally, however, most additional income in remote areas has come from the surrounding nature. Cash income has been generated through the collection and sale of medicinal plants, mushrooms, and wildlife-derived substances like deer antlers.

> The most important market for these non-timber forest products (NTFP) has been Traditional Chinese Medicine (TCM), although some were also utilized in Tibetan Medicine (TM). This activity greatly expanded following economic reforms in China after 1981 and with the increase of dispensible income of China's new urban middle class. Additionally, international market demand for wildcrafted plants, particularly medicinal herbs has increased due to growing use of TCM, TM and alternative herbal formulas and remedies. (Winkler 2002)

Outside of the forest, medicinal plants and mushrooms are generally collected from meadows, pastures and riversides. Additional local income from these natural products can be of great significance in the remote mountain areas. In Nepal, for example, medicinal and aromatic plants are the most important non-timber forest products. Processed export products (such as resin, turpentine, and Lokta-paper made from the bark of shrubs belonging to the *Daphne* family) are comparatively less in value, according to reports from the United Nations' Food and Agriculture Organization. (Vantomme, Markkula & Leslie 2002: 137–146)

On the other hand, people living in the most remote areas are still highly dependent on traditional medicine and medicinal plants for their healthcare needs. Dramatic changes in the local environment may not only result in a lack of cash, but also health problems.

2. CLIMATE CONDITIONS IN NORTHWEST CHINA

2.1 Varying conditions

The Qinghai-Tibet Plateau and mountainous areas of Kham include a variety of climate zones. In Qinghai, one finds dry continental highland areas and deserts in the west and river valleys with high annual precipitation in the east. In southern Kham, there are areas of temperate forests.

As is characteristic of mountain regions, climate conditions can vary greatly by altitude, even over a short distance. At high altitude, ultraviolet radiation is very strong and the difference of temperatures between night and day is often great. Looking only at statistical averages of annual temperatures, the climate of this area appears quite similar to that of northern Scandinavia. However, annual rainfall decreases from east to west, being lowest at Qaidam Basin in the western

part of Amdo. In some areas in the east, annual precipitation is almost equal to that of Finland. (Reilin 2008: 133) The relative humidity of the air is relatively low, being again lowest at Qaidam Basin. The highest forests on Earth are found in Kham (at an elevation of 4,700 m).

2.2 Effects of climate change in Tibetan areas

Accelerated climate change is affecting weather around the entire world. In China, the most fragile ecosystems are the highlands in the West. Official weather statistics on the Tibetan plateau (1961–2003) show that the growing season has lengthened seventeen days during that period as frost-free days have increased. Compared to the other regions, climate change has been the most pronounced in high plateau areas. (Liu X. et al. 2006)

> Recent changes in climate, such as warmer temperatures and reduced rainfall in certain regions, have already had significant impacts on ecosystems. They have affected species distributions, population sizes, and the timing of reproduction or migration events, as well as the frequency of pest and disease outbreaks. (GFSB 2006)

Knowing no borders, relatively small changes in long-term weather can break the resistance of local ecosystems. Changes in vegetation have various effects in people's lives. For example, if yaks cannot use their old summer pastures, they have to be moved to grazing lands further away. If this is not possible due to practical or political reasons, the worst-case scenario means people having to find an alternative source of livelihood.

> Degradation of vegetation and changes in the ecosystem result in a more fragile environment for livestock production, worsen the situation and create another vicious cycle. Variable and sometimes insufficient pasture and inadequate management capacities of herder households, hamper the development of livestock production into a more intensive system. (Swift, Baas & Liu 2005: 7)

Increasing desertification, a combined effect of the changing climate, has reached such an extent that huge dust clouds from the direction of Qaidam have occasionally covered the capital of Beijing.

3. BIOLOGICAL PATTERNS ON THE FOREST ECOSYSTEMS IN CONTEXT OF CLEAR-CUTTING AND THE ENVIRONMENTAL EFFECTS OF DEFORESTATION

3.1 Interdependence of different species in the forest ecosystem

Different types of plants support each other within the ecosystem. For example, trees give shelter to groundcover plants, which in turn protect the roots of the trees. Even closer relations between plants exist, such as mycorrhizal symbiosis between vascular plants and soil fungi. In fact, forests as they appear today would not exist without this co-operation of fungus and tree rhizomes.

> Mycorrhizas are symbiotic associations essential for one or both partners, between a fungus (specialised for life in soils and plants) and a root (or other substrate-contacting organ) of a living plant, that is primarily responsible for nutrient transfer. Mycorrhizas occur in a specialised plant organ where intimate contact results from synchronised plant-fungus development. (Brundrett 2008)

This association increases the plants' ability to absorb nutrients from the soil by making use of the mycelium's immense surface cover. Correspondingly, the fungus is provided with a renewable source of food. The presence of mycorrhiza is especially significant in poor soil. The lack of it likely hinders the thriving of forests in their early stage of development. The mushrooms that take part in these symbiotic processes are also often those that are also used as human food resources and medicines.

3.2 What happens to the ground when clearcutting destroys a forest?

In general, if an area is logged by clearcutting and the shade forest is lost, the radiation of the sun reaches the ground. And as trees no longer lift water upwards, the water table descends. This increases evapotranspiration, lessening the moisture of the soil. Ground-covering plants, which require shaded conditions to thrive, become stressed. Fungi that live in symbiosis with the original vegetation begin to disappear. Grasses that tolerate dry conditions become dominant. Gradually all the original ground cover vanishes. Some shrubs may stay alive and reproduce and, if there are any trees left, pioneer species may start to breed by dropping seeds.

It is not easy for young seedlings to thrive in extreme conditions, such as on the high altitude mountain slopes of the Himalayas or in the extremely cold climate of a boreal forest zone. After the Second World War, large clearcuts were made in the state-owned forests of Finland by Metsähallitus. Subsequent reforestation

efforts in Lapland have been the subject of much criticism. Totally logged areas did not recover by themselves. When replanting was done, young plants seemed twiggy, producing only low-quality wood unsuitable for industrial use.

Reforesting projects in mountain slopes of Amdo have also faced problems, largely because the investment to artificial irrigation would prove very expensive to the community. Newly planted trees often simply dry out due to a shortage of water.

Serious problems can be traced back to the disappearance of forest cover. It is easy to understand that trees and other vegetation maintain the integrity of the groundcover of the earth. After clearcutting, precipitation does not stay on the mountain slopes, evaporating back into the atmosphere through vegetation to fall again, but instead runs directly to streams and rivers. This free flow of water causes soil erosion and temporal floods during riversides, resulting in decreased humidity of the air and a depletion of moisture in the soil on the slopes.

> The forests of the Tibetan Plateau are of the greatest importance to regional and international water regimes. Nearly a billion people live downstream in the basins of Yangtze, Yellow River, Mekong, Salween and Tsangpo-Brahmaputra, all originating on the plateau. In recent decades the forests were considered primarily as a source of timber. (Winkler 1999)

3.3 Aims for restoration

The United Nations has created a categorization of nationally protected areas (IUCN categories I–VI) and periodically collects information from national agencies legally charged with the administration and management of these areas. The World Conservation Union (IUCN) assigns each protected area to one of six categories, depending on the level of protection. The data set includes strict nature reserves, wilderness areas, national parks, national monuments, habitat/species management areas, protected landscapes, and sustainably managed ecosystems. Marine and littoral areas are excluded from this total.

Overall knowledge about the interdependence of human activity and nature, as well as projections of threats to the environment, has increased over the last decades. The international community, as well as various scientific organizations and NGOs, have launched and participated in various environmental programmes of research and restoration in Tibetan regions.

> Although protected areas serve a vital function in protecting the earth's resources they face many challenges, such as external threats associated with pollution and climate change, irresponsible tourism, infrastructure develop-

> ment and ever increasing demands for land and water resources. Moreover, many protected areas lack political support and have inadequate financial and other resources. (IUCN 2004)

In 1984 the Standing Committee of the National People's Congress promulgated the Forest Law of the People's Republic of China. It included seven chapters: General Provisions, Forest Management, Forest Protection, Tree Planting and Afforestation, Forest Felling, Legal Responsibilities and Supplementary Articles. (Vajpeyi & Ponomarenko 2001: 98)

In 1990s and after, People's Republic of China has started projects for reforestation. For example, since the late 1990s, the Chinese government has implemented intensive land protection policies in the hotspot areas mentioned above, with huge financial investment, including the logging ban, the Grain for Green Project (with conversion of sloping farmland to forest and grassland now underway in the provinces of Sichuan, Shaanxi, and Gansu), and the Endangered Species and Protected Areas Program. Millions of hectares of land are expected to turn into forests. Also many new areas are protected, or they are included in protection plans.

4. CONCLUSIONS

Due to the large-scale effects of changes in forest coverage – both worldwide and locally – there is a great need for launching more reforestation projects, as well as supporting existing ones. Efforts are still needed for restoration of the existing forests in the continental areas of Qinghai-Tibetan plateau and the high altitude forests of the Tibet Autonomous Region and Kham. It would also be beneficial to increase knowledge of the forests' great significance to the ecosystem on a wider scale and to share information of the benefits and techniques of sustainable forestry within local communities.

New, more specified planting methods should be tested and adopted to achieve the best results in reforestation projects. These experiments could, for example, be for preventing new-planted seedlings from drying or planting mixed forests to test different plant species as pioneers of succession in different soil or light conditions. Plants have already been used as technical elements against dust storms, erosion and so on, but more attention should be addressed to selecting certain plant species according to their best ability to thrive in particular conditions.

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