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Change and Persistence: Contemporary Landscape Transformation in the Nanga Parbat Region, Northern Pakistan

The regional land use system in northern Pakistan is based on irrigated crop cultivation on valley floors, combined with animal husbandry and forest utilization in the upper altitudinal belts. Local communities subsist on this agropastoral economy to a considerable extent. Environmental conditions and the ecological risks of resource utilization are intimately linked in this high mountain region. Rapid population growth, a corresponding increase in pressure on natural resources, and the consequent danger of environmental degradation raise questions about sustainable resource management in relation to contemporary land use and land cover change. The present study investigates vegetation changes and the development of land use patterns in the Nanga Parbat region (Northwest Himalaya) using matched pairs of photographs. A comprehensive collection of historical landscape photographs, taken by members of the German Himalaya expeditions of 1934 and 1937, forms a valuable baseline data set for the area. Recent fieldwork made it possible to reproduce a number of these photographs from viewpoints identical to the earlier ones. Direct comparisons illustrate change and persistence in the cultural landscape over a span of 60 years. The development of the cultural landscape is characterized by the enlargement of settlements and the expansion of cultivated areas in most valleys. On a local scale, intensified irrigation has led to an increase of groundwater-dependent thickets along the water channels and below the cultivated terraces. The montane coniferous forests are characterized by gradual decline, though change is drastic in some places due to local overexploitation. The submontane Pinus gerardiana *and* Juniperus semiglobosa *forests in the vicinity of the villages and near the lower timberline have been seriously degraded.*

Keywords: *Landscape transformation; human ecology; repeat photography; Nanga Parbat; Northwest Himalaya; Pakistan.*

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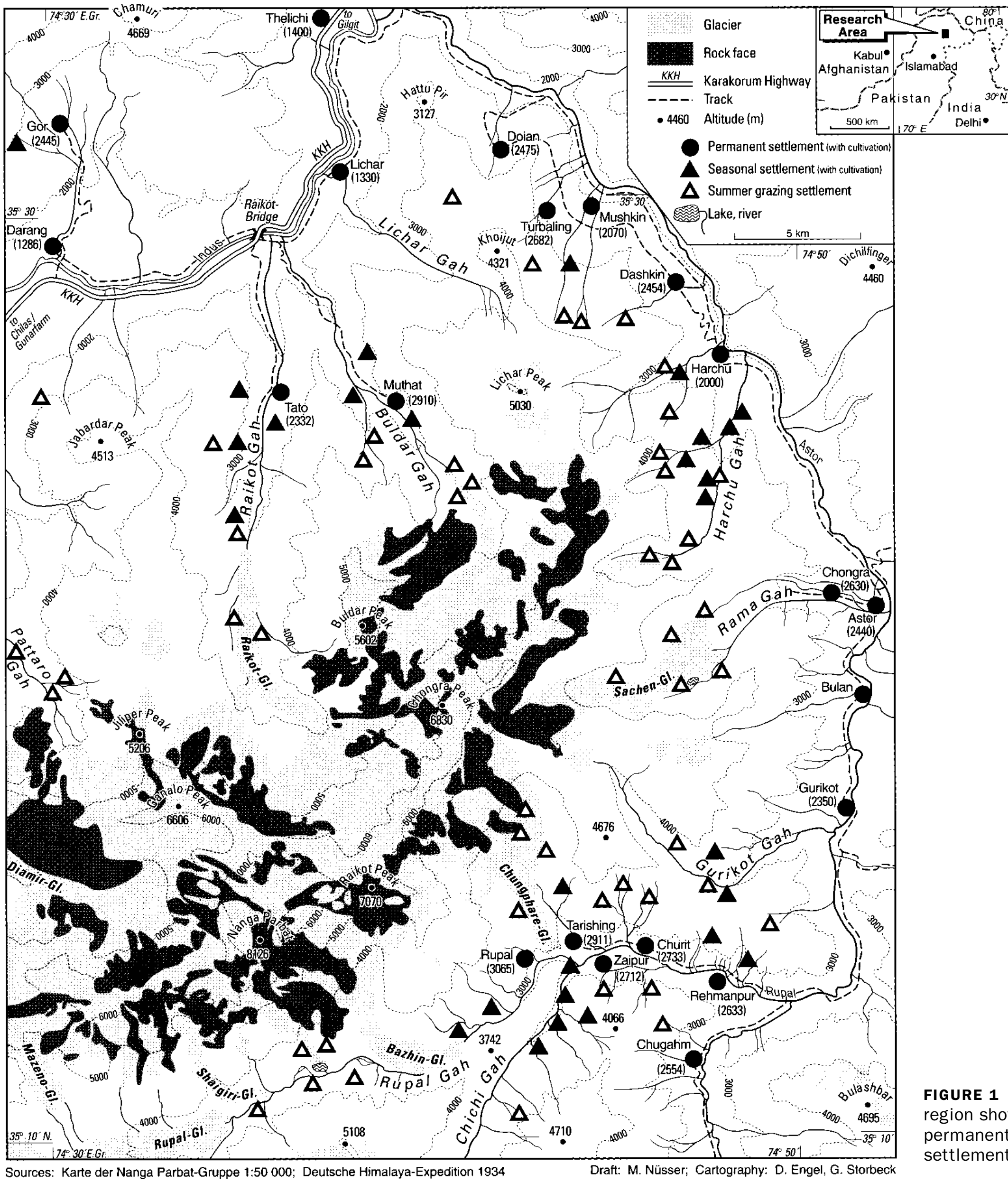
Introduction

The issue of land use and land cover change is widely recognized as a key issue in contemporary research on global environmental change (eg, Turner et al 1994; Lambin et al 1999). Whereas land use change addresses the shift to a different type of use or intensification of an existing one, land cover change deals with the conversion or modification of the physical state of the land (Turner and Meyer 1994: 5). The concept of landscape transformation encompasses both components, which are closely connected. In the course of the past 15 years, regional assessments of land use and land cover change by multitemporal interpretation of aerial photographs and satellite imagery have increasingly gained importance. Like remote sensing, repeat photography can serve as a basis for detecting landscape transformation (eg, Rogers et al 1984). Comparing terrestrial photographs of the same landscape taken many years apart provides an effective means for assessing land cover and land use change. This method of investigating change has been widely used by geographers and ecologists in various regions, especially in the United States (eg, Rogers 1982; Vale 1987; Veblen and Lorenz 1991; Webb 1996) and in South Africa (Hoffmann and Cowling 1990).

Winiger (1996) and Byers (2000) discuss methodological aspects and shortcomings of repeat photography in the general context of high mountain research. Especially in the context of uncertainty about the extent of contemporary vegetation and landscape changes in the Himalaya (Ives and Messerli 1989), repeat photography might help cope with the problem of different interpretations of vague terms such as “landscape degradation” and “sustainable resource utilization.” Unfortunately, this method has rarely been used for the Himalaya in the past (eg, Byers 1987: 78–79; Ives 1987: 82–85; Ives and Messerli 1989: 56–59). In this context, Byers (1987: 80) states, “It is to be hoped that photographic materials for other regions in the Himalaya will soon become available, and that repeat photography will eventually become a standard component of future land use assessments and studies.”

Members of the German Himalaya expeditions of 1934 and 1937 took many landscape photographs in the Nanga Parbat region. These comprehensive collections form a valuable database for repeat photography. Scientific work in the 1930s resulted in two prominent maps (1:50,000) showing the topography (Finsterwalder 1938) and vegetation (Troll 1939) of this Himalayan massif. Whereas the metric photographs by Finsterwalder and Raechl were mostly taken from exposed viewpoints (ridges, rock spurs) in order to obtain panoramic views for the topographical mapping survey (Finsterwalder et al 1935), most of the photographs by Carl Troll show aspects of vegetation, land use, and settlement patterns. In 1992–1995, the present study repeated 20 of these photographs from viewpoints identical to the earlier ones. These replicates make it possible to illustrate changes in land use and land cover over the past 60 years. Current vegetation and land use dynamics can be discussed on the basis of visual interpretation of this bitemporal photographic material.



Sources: Karte der Nanga Parbat-Gruppe 1:50 000; Deutsche Himalaya-Expedition 1934

Draft: M. Nüsser; Cartography: D. Engel, G. Storbeck

FIGURE 1 The Nanga Parbat region showing the location of permanent and seasonal settlements.

Regional aspects

Nanga Parbat (8126 m, 35°14'N, 74°35'E) constitutes the northwestern corner of the High Himalaya. The mountain massif towers more than 7000 m above the adjoining gorge of the Indus River (ca 1100 m) and more than 4500 m above the upper Rupal Valley, lying south of the summit (Figure 1). High relief energy and steep climatic gradients result in a distinct altitudinal zonation of vegetation belts (Troll 1939; Nüsser 1998; Dickoré and Nüsser 2000). The ecological zonation of resource potential in the area stipulates a vertical and seasonal migration pattern between permanent and seasonal settlements as part of an adapted agropastoral economy (Troll 1973; Nüsser and Clemens 1996a,b; Clemens and Nüsser 1997). The spheres of irrigated agriculture and livestock rearing are not only related but interdependent within mixed mountain agriculture (Rhoades and Thompson 1975) or combined mountain agriculture (Ehlers and Kreutzmann 2000: 17–19), form-

FIGURE 2 Villages in the Gor region with the Indus Valley. (Photo by C. Troll, 21 May 1937)

FIGURE 3 Villages in the Gor region with the Indus Valley. (Photo by M. Nüsser, 4 September 1995)

ing the economic basis of regional livelihood strategies in the mountain areas of the Western Himalaya, Karakorum, and Hindukush. In the last century, demographic development in the Nanga Parbat region was characterized by high population growth (sometimes over 4% a year; see Clemens and Nüsser 2000: 165). This significant increase in the total population raises questions of environmental degradation as well as questions about contemporary land use and land cover change.

The dynamics of contemporary landscape transformation

Visual interpretations of landscape transformation are based solely on qualitative evaluations of matched pairs of photographs. Repeat photography, however, calls for comprehensive consideration of various influences resulting from difficulties in data collection. These difficulties include accuracy of viewpoint, the congruence of the historical photograph and the replicate, and problems of visibility caused by shadows, clouds and snow cover. Furthermore, seasonal differences in the phenology of crops and vegetation must be considered in order to assess changes in cultivated areas and vegetation. In this light, repeat photography provides a valuable tool for assessing contemporary changes in various human–ecological spheres.

The 4 examples together with 2 graphic illustrations of visual interpretation of repeat photography presented here are spread over a broad altitudinal range and represent situations in different valleys north, east, and south of Nanga Parbat. The matching pairs of photographs focus on the development of cultivated fields as well as forest change in the submontane and montane belts.

The region of Gor

The first pair of photographs (Figures 2, 3), taken from 2600 m, shows villages in the Gor region (ca 2450 m), with the colline and submontane belts of the Indus Valley and the northern declivity of Nanga Parbat in the background. The lower southeast-facing slopes of Gor are covered with open forests, dominated by *Quercus baloot* and *Pinus gerardiana*. The evergreen oaks in the vicinity of the villages are used as a common pool resource and offer additional winter fodder for livestock. No significant decline in dry forest cover appears to have taken place over the span of 58 years. In both photographs, identical *Quercus baloot* trees can be identified. These still exist, but their physiognomy has changed because of lopping for fodder. Traditional regulations and institutional arrangements, such as the ban on forest pasturing and on the lopping of branches and leaves before mid-November, have succeeded in preserving these woodlands until the present day (Clemens and Nüsser 2000: 158–160).

Seasonal differences must be taken into consideration when examining the cultivated fields. Whereas the original photograph from 1937 shows ripening winter wheat in May, the replicate was taken in early September, shortly before harvesting of maize, the second crop. Shortage of water has prevented any further expansion of the irrigated area in the region of Gor. Expansion of fruit trees can also be detected: especially mulberries (*Morus alba*), apricots (*Prunus armeniaca*) and walnuts (*Juglans regia*) spread over the irrigated area.

The Astor Valley

The second bitemporal photographic comparison (Figures 4, 5) shows the upper portion of the irrigated fields of Dashkin (ca 2450 m) within submontane *Artemisia brevifolia* dwarf shrub communities. The mosque in the foreground has clearly been replaced by a new one on the same spot. The development of the arable land is characterized by the expansion of irrigated crop and fruit tree cultivation and an increase in hygrophilous trees (*Populus caspica, P. nigra, Salix sericocarpa, S. wallichiana*) along the new terraces and irrigation channels. Colonial sources refer to the cultivated fields of Dashkin as a relatively large area when compared with other villages (Gazetteer 1890: 286; General Staff India 1928: 124). The matched pair of photographs proves that the cultivated area has been further expanded during the past 60 years. The background shows a part of the Mushkin Forest, the largest coniferous forest (*Pinus wallichiana, Picea smithiana*) in the Nanga Parbat region. The ecological importance and resource potential of this forest have been pointed out in colonial reports (eg, Drew 1875: 404; Duthie 1893: 12; Singh 1917: 6) and recently by Schickhoff (1996). Visual comparison reveals pressure due to overutilization of the forests in the vicinity of Dashkin. As a result of cutting, the lower timberline on the right side of the photographs has moved approximately 50 m further upward while the middle section has changed very little.

The third example (Figures 6, 7) shows the expansion of irrigated areas in the villages of Luskum and Harchu at ca 2000 m, especially on the lower river terrace. More fruit trees can also be detected in the fields. While the photograph from 1937 shows the prepared fields at the end of May, the replicate was taken before the crops were harvested. On the spur between the Astor and Harchu Valleys, one can detect extreme cutting of the open *Pinus gerardiana–Juniperus semiglobosa* forests that covered the slope in 1937. The replicate shows the replacement of these dry forests by dwarf shrub communities on the scree slope and a new irrigation channel above Harchu (in the background). The degradation of the montane forest becomes obvious on the top of the ridge. Troll (1939: 169) and Schickhoff (1996: 181) arrived at similar results for the lower timberline in the Nanga Parbat area. The main results of the visual interpretation of this matched pair of photographs are summarized in Figure 8.

FIGURE 4 Cultivated fields above Dashkin, Astor Valley. (Photo by C. Troll, 14 May 1937)

FIGURE 5 Cultivated fields above Dashkin, Astor Valley. (Photo by M. Nüsser, 6 September 1995)

FIGURE 6 Cultivated fields of Harchu and Luskum, Astor Valley. (Photo by C. Troll, 31 May 1937)

FIGURE 7 Cultivated fields of Harchu and Luskum, Astor Valley. (Photo by M. Nüsser, 6 September 1995)

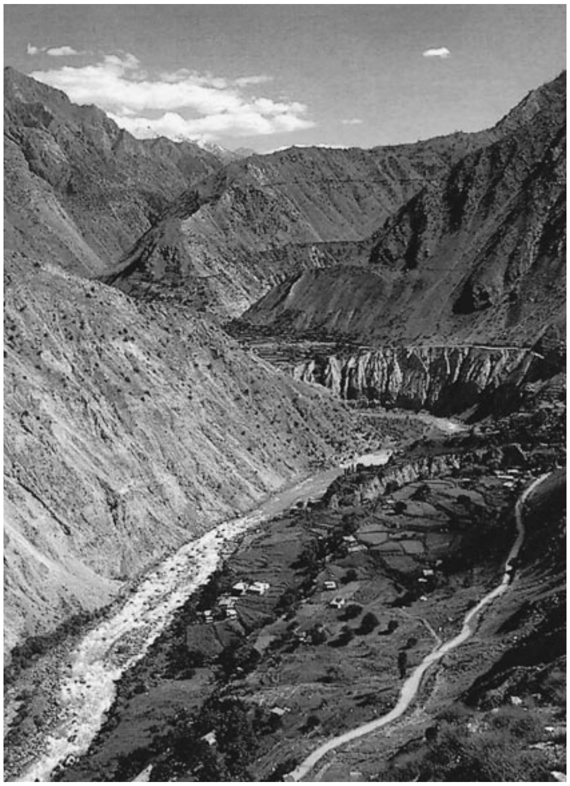
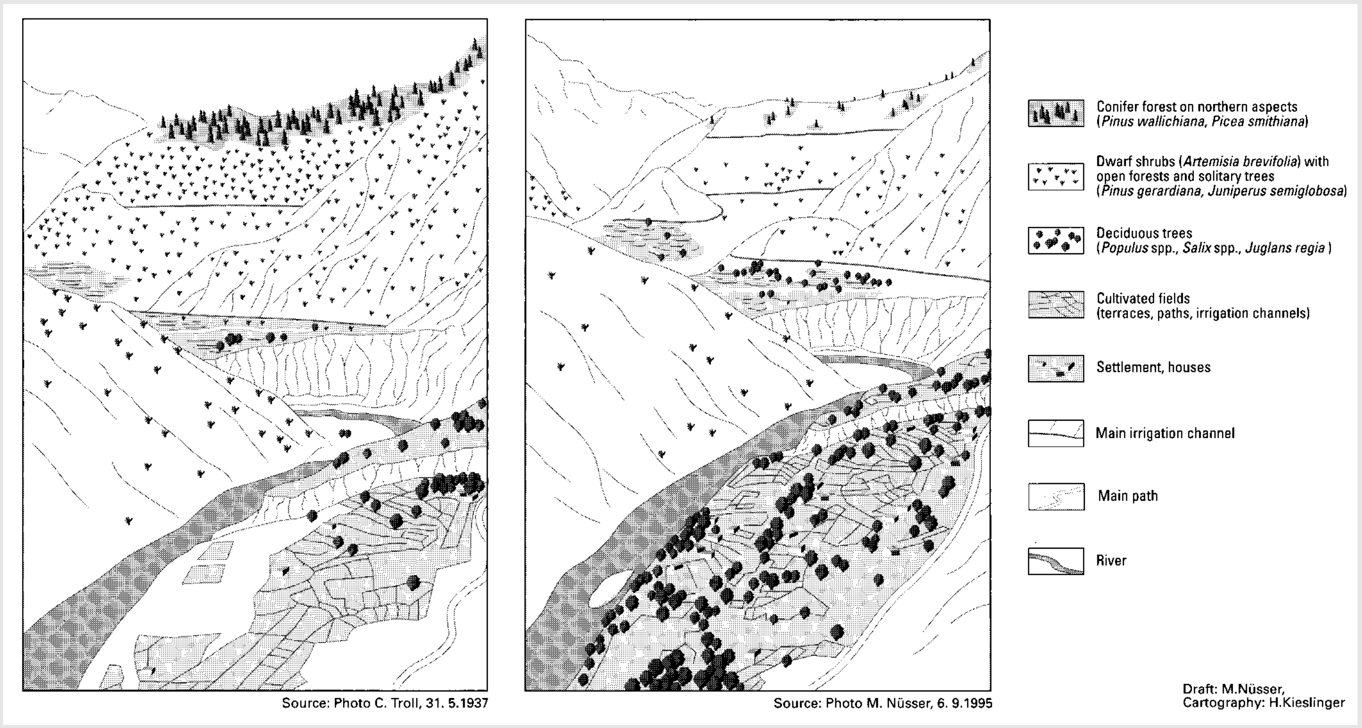


FIGURE 8 Harchu and Luskum (visual interpretation of matched pair of photographs).



The Rupal Valley

The fourth bitemporal comparison (Figures 9, 10) shows the lower Rupal Valley with the villages of Churit (ca 2730 m) and Zaipur (ca 2710 m, in the foreground), together with smaller settlements on higher morainic terraces. On both sides of the Rupal River, this pair of photographs confirms the expansion of settlements through dispersion and scattering as well as the extension of irrigated fields. No extension of fruit trees can be detected, however. The sparsely distributed *Juniperus semiglobosa* thickets and trees on the slopes facing southward, detectable on the photograph from 1934 as easily distinguishable dark spots near the settlements, are an important fuelwood of high value. Due to the relatively lighter snow cover and its earlier melting time on these southern slopes, these trees are collected as fuelwood between winter and spring (Clemens and Nüsser 1997: 254–256). Consequently, these relatively easily accessible woodlands have been felled to a great extent. Moreover, the montane coniferous forest in the right foreground has been heavily exploited, as further clearances are evident. The visual interpretation of land transformation in the lower Rupal Valley presented in Figure 11 is based on another matched pair of photographs, taken from a viewpoint further east. It lends support to arguments that the settlements and cultivated fields have expanded and degradation of forest resources has continued.

A further pair of matched photographs from the village of Rupal in the upper valley shows similar results for the montane forests. Whereas Troll (1939: 158) describes Rupal as a summer field settlement, it has become a permanently inhabited village within the last 60 years. This functional change has led to an increasing demand for fuelwood and building materials. The subsequent pressure on these forests in the vicinity of the village results from the scarcity of accessible alternative forest resources. Comparative interpretation of the photographs from 1934 and 1994 shows a gradual degradation of coniferous forests.

FIGURE 9 Lower Rupal Valley from 4040 m. (Photo by R. Finsterwalder, 21 June 1934)

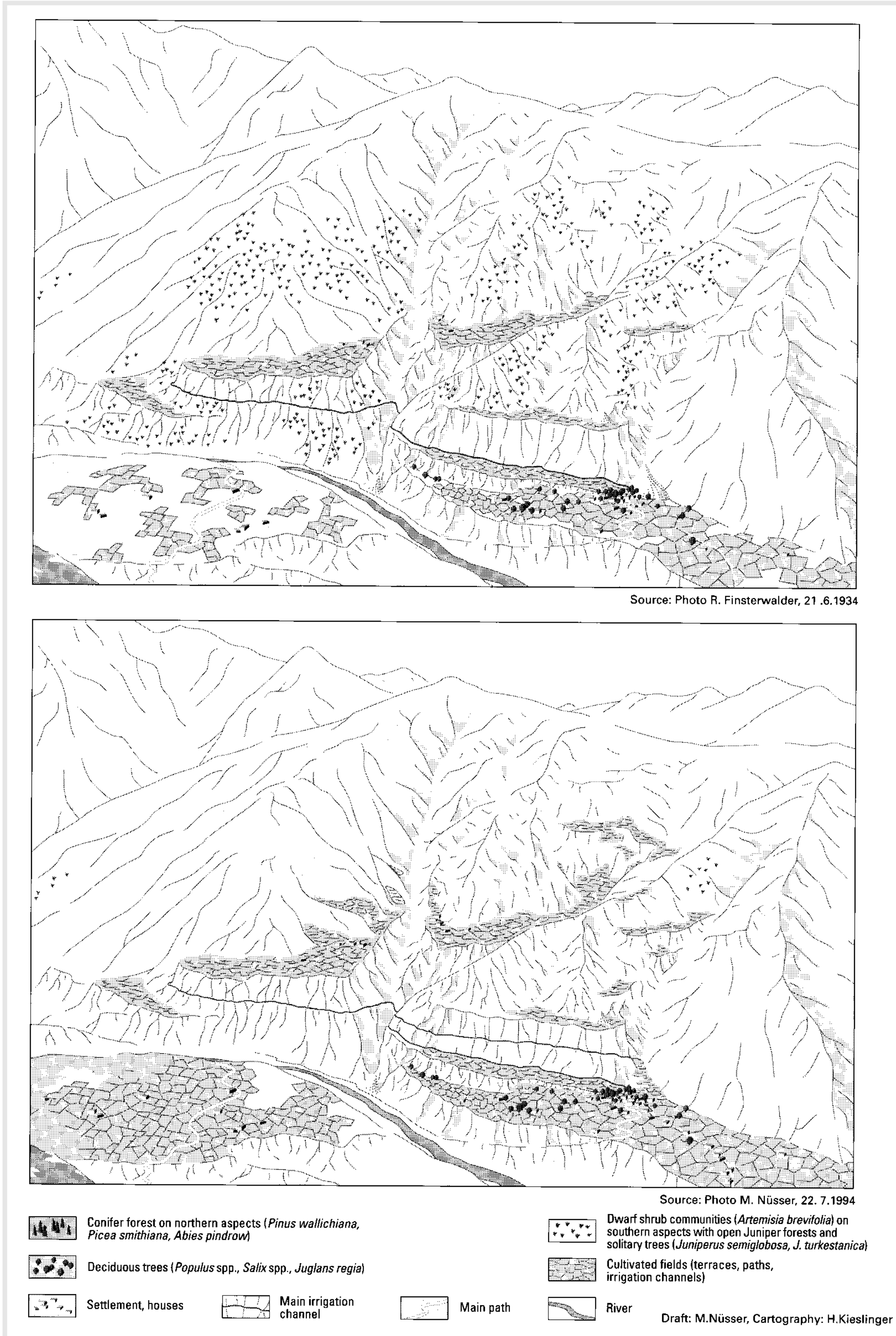
FIGURE 10 Lower Rupal Valley from 4040 m. (Photo by M. Nüsser, 22 July 1994)

Conclusions

The matched pairs of photographs presented reveal that the extent of land use and land cover change in the valleys of Nanga Parbat varies greatly. This calls for a research perspective that takes into account environmental resources as well as historical processes and socioeconomic aspects of land use systems. Furthermore, photographic documentation of landscape transformation proves that changes between the 1930s and the 1990s have not reached an extent that can be described in general terms such as "environmental deterioration" or "ecological disaster." Until now, development of the cultural landscape in the Nanga Parbat region has been characterized by a land use system that is highly adapted to natural resource potentials but also reveals increasing pressure on forest resources. In particular, the relatively accessible forest stands in the vicinity of the settlements and near the lower timberline have been seriously depleted due to uncontrolled exploitation and intensive forest pasturing. In comparison, the situation of submontane oak forests in the Gor region looks more positive. Rules and regulations controlled by institutional arrangements have so far led to sustainable utilization of common pool resources.

Due to general population growth, the development of the cultural landscape is characterized by the expansion of settlements and cultivated areas in all valleys. In most examples, the limits of this expansion, which is dependent on the availability of irrigation water, have not yet been reached. On the local scale, intensified irrigation with new water channels has led to an increase of hygrophilous vegetation along the channels and below the cultivated terraces. In other examples, enlargement of settlements and expansion of the road network can be detected. Generally, visual interpretation of bitemporal photographs and contemporary landscape dynamics strongly depends on the integration of additional ground truth analyses, interviews with local people, and reviews of historical literature. If these conditions are fulfilled, matching historical photographs can serve as a valuable basis for landscape monitoring focusing on land use and land cover change.

FIGURE 11 Lower Rupal Valley (visual interpretation of matched pair of photographs)



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