MOUNTAIN RESEARCH AND DEVELOPMENT, VOL. 16, NO. 2, 1996, PP. 117–133

IMPACTS ON MIXED MOUNTAIN AGRICULTURE IN THE RUPAL VALLEY, NANGA PARBAT, NORTHERN PAKISTAN

MARCUS NÜSSER[1] AND JÜRGEN CLEMENS[2]

ABSTRACT In the Hindukush, Karakorum, and northwest Himalaya the struggle for subsistence by mountain farmers is based on agriculture and animal husbandry in the form of mixed mountain agriculture. This study analyses the seasonal pastoral migrations to alpine pastures as a strategy for utilizing the natural resources in the Rupal Valley, south of Nanga Parbat (8,126 m).

Traditionally, this strategy of resource management was sustainable, but increases of population and livestock as well as external innovations are rapidly effecting change throughout the region. However, the results of this development vary according to the potential for off-farm employment and access to modern infrastructure in each valley. In Hunza, approximately 100 km north of Rupal, the utilization of alpine pastures decreased following a significant reduction of the male workforce and, after the introduction of cash crops and fodder cultivation, cropping patterns changed.

Agriculture in the Rupal Valley during the last 20 years is characterized by an increase in animal husbandry and pastoral movements. Although there is also off-farm employment, it is more likely that animal husbandry will remain an important part of the agro-pastoral economy and there is potential for its commercialization.

RÉSUMÉ *Impacts sur l'agriculture mixte de montagne dans la vallée de Rupal, Nanga Parbat, Pakistan du nord.* Dans l'Hindoukush, Karakorum et l'Himalaya du nord-ouest, la lutte pour la subsistance des fermiers de montagne est basée sur l'agriculture et l'élevage, sous la forme d'une agriculture mixte de montagne. Cette étude analyse les migrations pastorales saisonnières en tant que stratégie d'utilisation des ressources naturelles de la vallée de Rupal, au sud du Nanga Parbat (8 126 m).

Cette stratégie de gestion des ressources était viable dans le passé, mais la croissance de la population et du bétail, ainsi que le progrès à l'extérieur, ont entraîné des changements rapides dans la région. Cependant, les résultats de ce développement varient selon le potentiel d'emploi non rural et l'accès à l'infrastructure moderne de chaque vallée. Dans l'Hunza, à environ 100 km au nord de Rupal, l'utilisation des pâturages alpins a diminué par suite d'une réduction importante de la main-d'œuvre mâle, et les modes de culture ont changé après l'introduction de cultures commerciales et de la culture du fourrage.

L'agriculture dans la vallée de Rupal au cours des 20 dernières années est caractérisée par une augmentation de l'élevage des animaux et des déplacements pastoraux. Bien qu'un l'emploi non rural existe, il est probable que l'élevage des animaux continuera à tenir une place importante dans l'économie agro-pastorale et qu'un potentiel existe pour sa commercialisation.

ZUSAMMENFASSUNG *Einflüsse auf die Hochgebirgslandwirtschaft im Rupal-Tal, Nanga Parbat, Nordpakistan.* Autochthone Handlungsstrategien zur Existenzsicherung im Hochgebirgsraum von Hindukusch, Karakorum und Nordwest-Himalaya kombinieren den Bewässerungsfeldbau auf Talniveau mit almwirtschaftlicher Nutzung alpiner Hochweiden. Dieser Beitrag untersucht die Formen der Hochgebirgslandwirtschaft und ihre jüngere Entwicklung im Rupal-Tal, südlich des Nanga Parbat (8126 m).

Die traditionelle Hochgebirgslandwirtschaft hat bislang eine nachhaltige Nutzung der natürlichen Ressourcen gewährleistet. Bevölkerungswachstum und die Zunahme der Viehbestände sind typisch für den gesamten Hochgebirgsraum. Doch in Abhängigkeit von der Möglichkeit zu außeragrarer Erwerbstätigkeit zeigen sich verschiedene Veränderungen. In Hunza (etwa 100 km nördlich von Rupal) erfolgte ein Rückgang der Hochweidenutzung infolge einer Arbeitskraftverknappung sowie veränderter Anbauschwerpunkte durch marktorientierten Anbau und Futterbauwirtschaft.

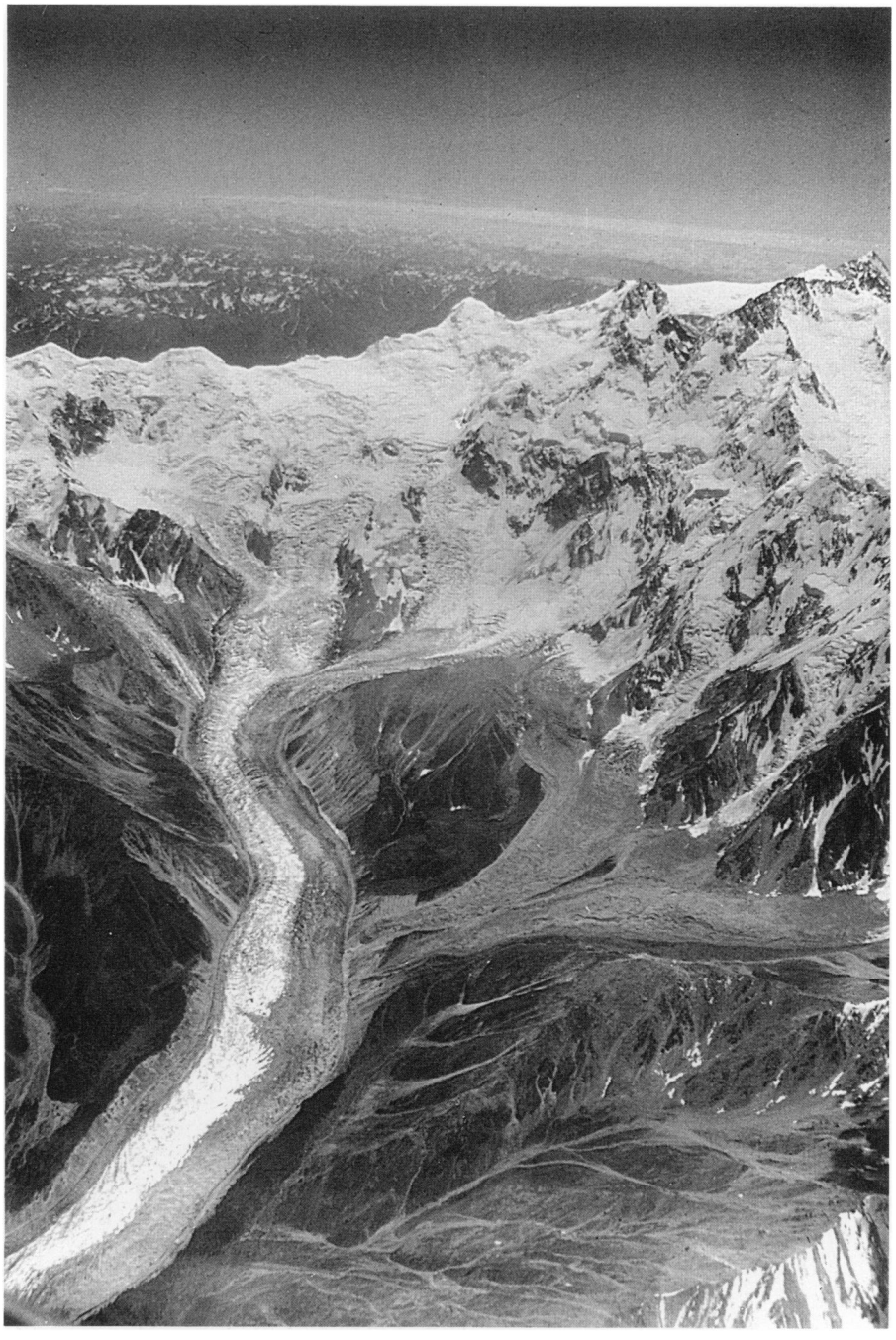
Im Rupal-Tal ist für die vergangenen 20 Jahre jedoch eine zunehmende Bedeutung von Tierhaltung und Almwirtschaft festzustellen. Trotz der einsetzenden außeragraren Einkommensmöglichkeiten wird die Viehwirtschaft hier auch weiterhin eine hohe Bedeutung behalten, zumal noch Potentiale zur marktorientierten Viehhaltung erschlossen werden können.

INTRODUCTION

This study presents a detailed survey of the system of animal husbandry and grazing resources in the Rupal Valley, a side valley of the Astor Valley in the Nanga Parbat area of the northwestern Himalaya (Figure 1). The adaptive strategies of mountain farmers and the carrying capacity of the land are analyzed in terms of the use of alpine pastures. In the Hindukush, Himalaya, and Karakorum the utilization of alpine pastures forms an integral part of high mountain agriculture. The ecological potential and limitations of the summer and transitional pastures, shortages of winter fodder, and socioeconomic impacts are factors that affect land use.

The central concern throughout the Himalaya is the threat to montane forest resources from overexploitation

[1]Department of Geography, The Free University of Berlin, Grunewaldstrasse 35, D-12165 Berlin, Germany.
[2]Department of Geography, University of Bonn, Meckenheimer Allee 166, D-53115 Bonn, Germany.



A general view of the Nanga Parbat region showing the upper Zaikot Valley. All photographs are by M. Nüsser.

and subsequent effects on the neighboring lowlands. This region has been the focus of much environmental discussion and many development projects; however, it has been suggested that frequently studies have been based upon false assumptions and inaccurate estimates due to insufficient knowledge of local conditions (Ives and Messerli, 1989; Kreutzmann, 1993 b: 10–15). However, the ecological aspects of high pastures have received very little attention.

There have been few scientific studies based on synoptic aspects of the Nanga Parbat region. There is a remarkable gap of knowledge in the relationship between human activities and the biosphere. In the 1930s some well-known studies of physical geography were carried out within the framework of mountaineering expeditions to Nanga Parbat. To this day, the 1934 topographic survey by Finsterwalder and Raechl (Finsterwalder *et al.*, 1935 a, b) and the 1937 vegetation survey by Troll (1939), which

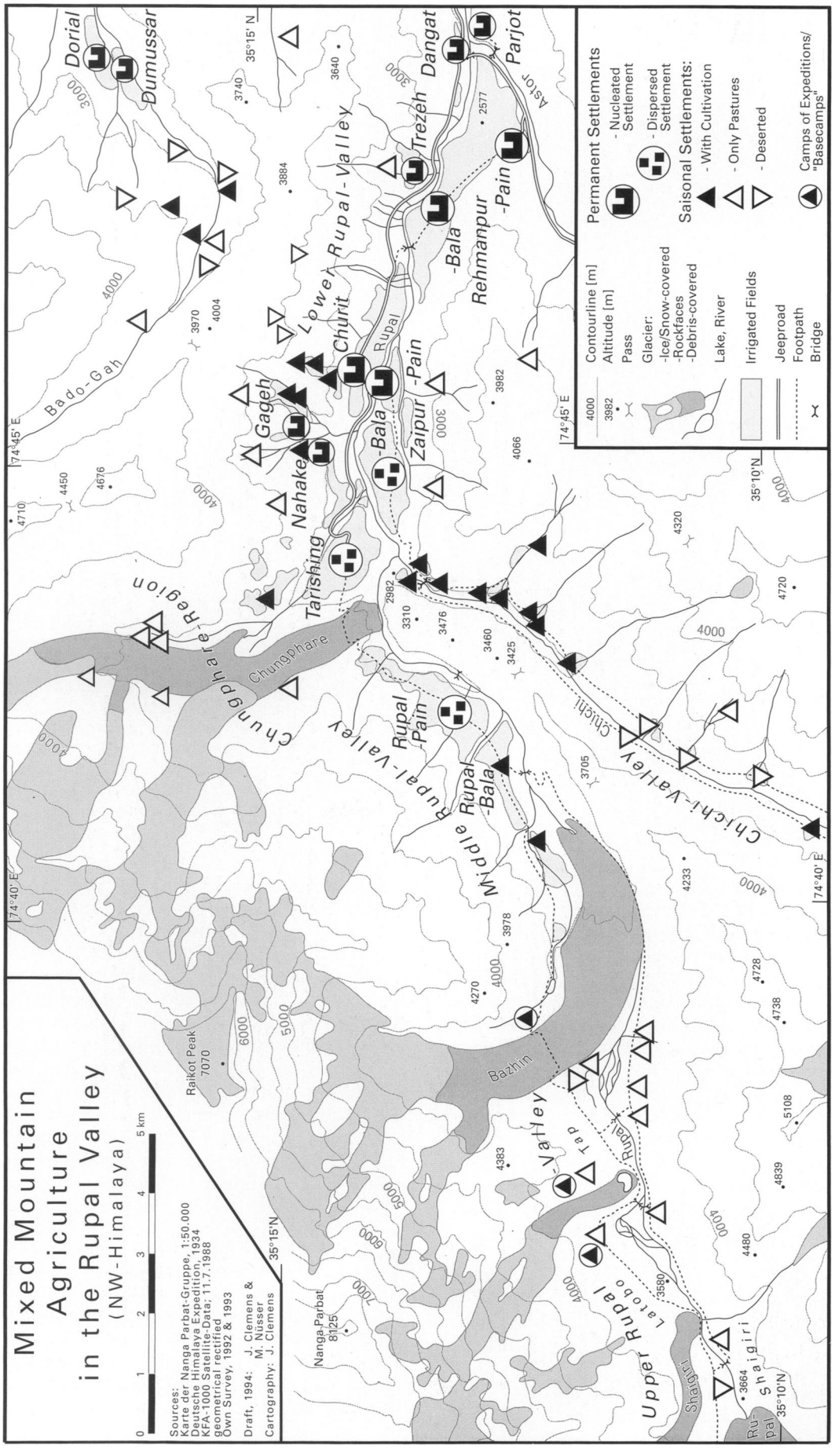


FIGURE 1. The Rupal Valley showing the cultivated (i.e., irrigated) area and the location of seasonal settlements in relation to the permanent villages.

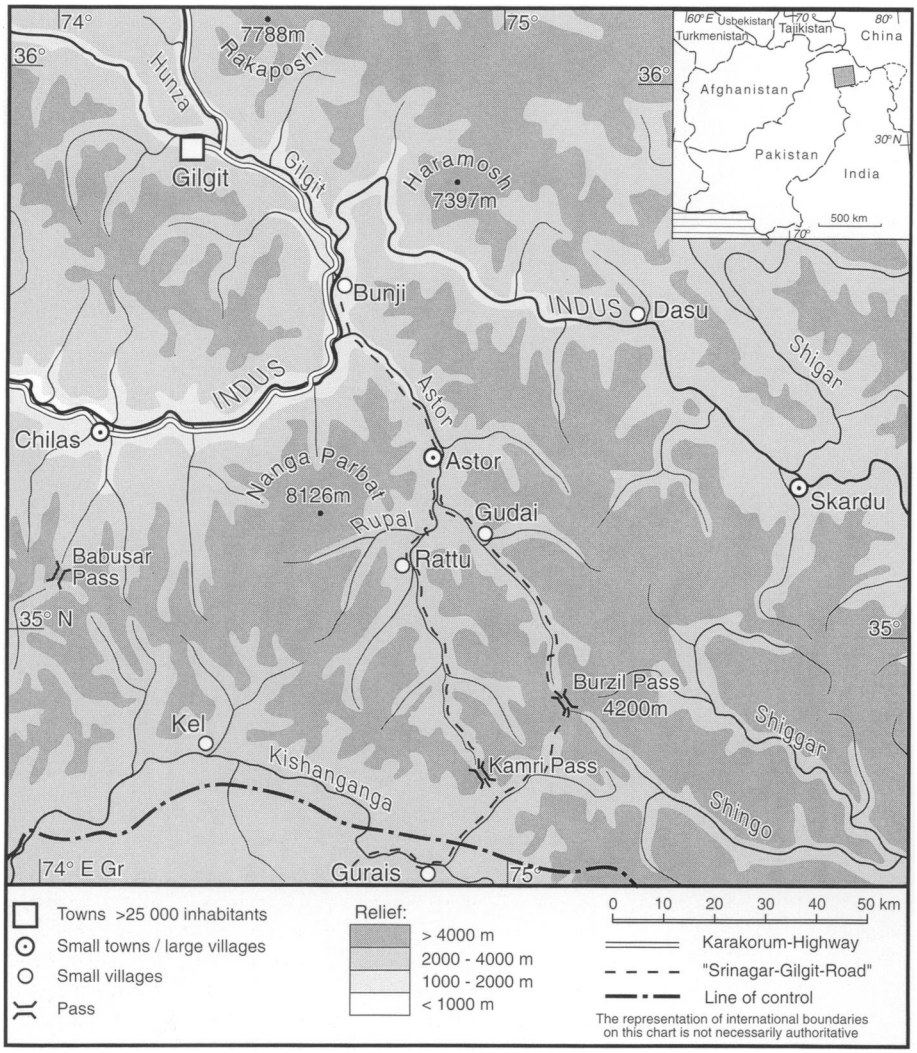


Figure 2. The location of the research area. During the period of British control, the Astor Valley provided a route through the mountains between Srinagar and Gilgit; after partition of the subcontinent in 1947, these traditional communication lines were interrupted; more recently the Nanga Parbat region has become more accessible after the opening of the Karakorum Highway (KKH).

resulted in splendid maps, scale of 1:50,000, have been an important source of valuable information. However, these surveys, and also other available geological, glaciological, and climatological reports, pay little attention to aspects of land use and animal husbandry. Recent work by cultural geographers and anthropologists in adjacent mountain areas of the Karakorum and Hindukush deal with aspects of animal husbandry and offer comparable data for this study (Grötzbach, 1984; Kreutzmann, 1988, 1989, 1993 a; Langendijk, 1991; Butz, 1993; Uhlig, 1995).

In a recent overview of mountain pasturing (*Almwirtschaft*) in the regions of Hindukush, Karakorum, and northwest Himalaya, Snoy (1993) indicates a remarkable decline in animal husbandry, although the population continues to grow. According to his sources, the workforce is no longer large enough to fulfill the demands of alpine pasturing, because of the convenience and economic advantage of non-agrarian income opportunities (Snoy, 1993: 69). Kreutzmann's findings (1989: 139–143; 1993 a: 33) in the Hunza valley provide a good example of this decline in high pasturing where the number of animals increased in proportion to population growth. In summer, however, the lactating animals are stall-fed and no longer left to graze in the high pastures.

According to Grötzbach (1980: 267, 272), the intensity of high-altitude pasturing reflects the economic and demographic factors in the permanent settlements of the lower altitudinal belts. The use of high pastures is an important indicator of the socioeconomic conditions in high mountain regions. As a result of his study in Hunza, Kreutzmann (1989: 143) regards pasture use as an indication of a new evaluation of labor inputs and of changing priorities in production within integrated high-mountain agriculture. In his opinion, changing influences, such as population pressure and external socioeconomic innovations, do not necessarily affect the intensity of animal husbandry. The reasons are more likely to be found within the entire system of mixed mountain agriculture. Whereas Grötzbach (1980) points to a general relationship between population growth and pressure on natural resources, Kreutzmann (1989) emphasizes that, due to new income from off-farm employment and changes in animal husbandry such as increasing fodder cultivation and stall feeding, this relationship is not at all well defined.

Generally, high mountains in developing countries are characterized by rudimentary accessibility and considerable intra-regional developmental disparities, due to lack

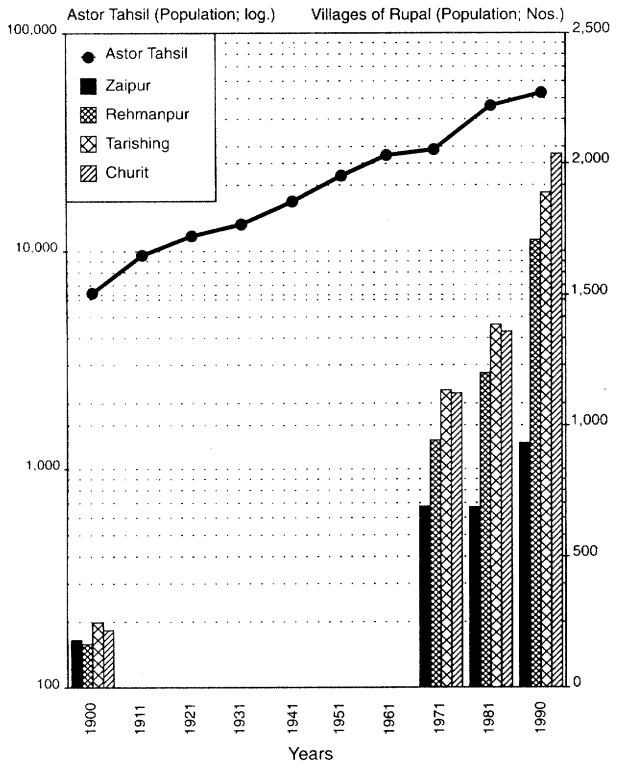


FIGURE 3. Population growth in Astor Tahsil and villages of the Rupal Valley, 1900–1990, indicating the rapid increase after 1941.

Sources: Anon. (1890); Census of India (1912, 1923); Singh (1917); General Staff of India (1928); Ahmad (1952); Census of Azad Kashmir and Northern Areas (1961); Khan (1979); Government of Pakistan (1984); Revenue Office, Astor (1991; 1992a).

of infrastructure and spatial distribution of resources. These factors apply especially to the Northern Areas of Pakistan. The altitudinal zonation and the factor of access are closely related in their impacts on the land-use systems. In his model of accessibility, Allan (1986: 191) puts particular emphasis on the temporal sequence from traditional, subsistence-oriented villages with limited access to neighboring market-oriented agricultural villages. Allan's model is based primarily on the impact of the Karakorum Highway on land use in the mountainous regions of Northern Pakistan. Butz (1993: 468) details that, although the construction of the Karakorum Highway and other roads generally improved the accessibility of all altitudinal belts, the villages and alpine pastures that previously had no road access are now perceived by the population as being more remote than before. In the framework of a study of the Aga Khan Rural Support Programme, a project of rural development in the high mountains of Northern Pakistan, Clemens (1992) noted that intra-regional disparities sometimes increased during project activities; for example, the central areas of Hunza received special development advantage. These findings were confirmed by Langendijk (1991) for Ishkoman where social and economic change also took place, although to a lesser extent. In Ishkoman the use of high pastures has not declined, but shepherds are hired while the local households spend the summer in permanent settlements on the valley floor (Langendijk, 1991: 37–38). Hunza is exceptional within the Northern Areas because the early initiation of socioeconomic change created an advance in development which exceeded that of surrounding regions; but this had negative effects on the intensity of use of high pastures in Hunza.

These intraregional developmental disparities within the high mountains of Northern Pakistan indicate the significance of the historical factors in the Astor and Rupal valleys. Astor belonged to Kashmir as an independent *Tahsil* (district) in *Gilgit Wazarat* until 1947. Due to the Gilgit Road from Srinagar, the capital of Kashmir in the south, and the military outpost in Gilgit and other garrisons, Astor became a transit region in the mountains (Figure 2). The road increased the opportunity for non-agrarian income from transportation and trade. However, Astor lost this key position after the partition of British India in 1947. The line of control dividing the Pakistani and Indian administered parts of Kashmir is situated 40 km south of Rupal near the Kishanganga River and cuts off the Astor Valley from its historical connections with Srinagar. This "peripheralization" of Astor has been gradually broken down with the completion of the Karakorum Highway in 1978 and the opening up of higher valleys for four-wheel drive vehicles (Allan, 1989: 131; Kreutzmann, 1991: 723; 1995: 219–221).

In the Rupal Valley the most significant factors are: the high rate of population growth (sometimes over 4% a year, Figure 3); the improved accessibility to the "modern world" via the Karakorum Highway; the extension of jeep roads up to Tarishing; and the impacts of these developments on the intensity and efficiency of high mountain agriculture, and high pasturing in particular. It has yet to be seen whether or not population pressure will lead to overexploitation of pasture phytomass; whether the indigenous strategies of local farmers are sufficiently flexible; and whether or not the new exogenous influences and sources of income from tourism and labor migration will lead to specific changes of this traditional form of subsistence economy.

MIXED MOUNTAIN AGRICULTURE AS A SYSTEM

Mixed mountain agriculture (Rhoades and Thompson, 1975: 537; Kreutzmann, 1989: 148; 1994: 338; Uhlig, 1995: 201, 203) is practiced in the Rupal Valley. Irrigated cultivation and pastoral activities are interdependently related and extend over the different altitudinal belts. This economic system is also known as "Vertical Control" (Casimir and Rao, 1985: 222). In former times the strategy assured the subsistence of the population; today the

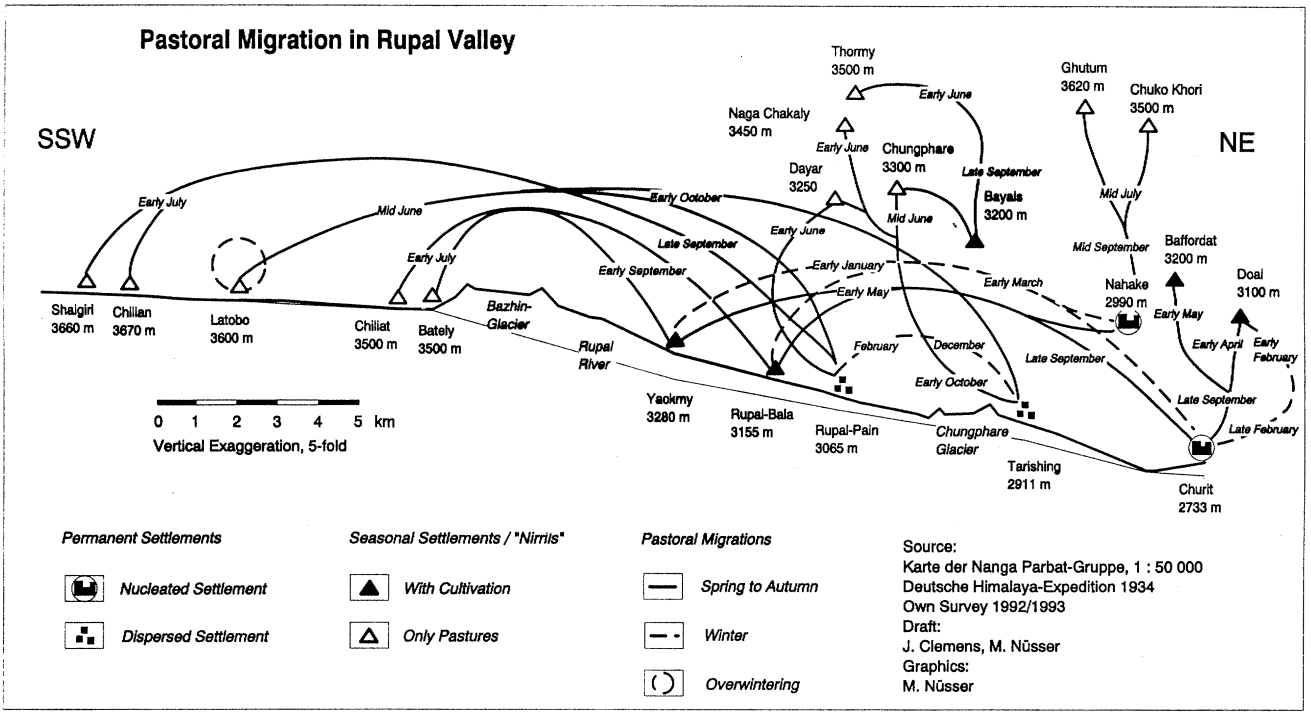


FIGURE 4. The pattern of pastoral migration in the Rupal Valley.

utilization of different altitudinal agro-ecological belts provides a wide spread for agrarian risks. Butz (1993: 463; 1994: 93) points out that indigenous mountain communities gain sustainability from altitudinal diversification by increasing the variety of potential resources and by reducing the risk of failure due to natural hazards. Animal husbandry, therefore, continues to be mobile, so that a variety of different pasture ecotopes can be used throughout the year. The pastoral economy whereby the mountain farmer is able to use different ecotopes on a seasonal basis is described as *Staffelwirtschaft* (altitudinal zonation of land use) or *Almwirtschaft* (high pasture economy) (see Kreutzmann, 1989: 127, and Uhlig, 1976, 1995: 201–202 for detailed discussion of the terminology).

Butz (1993: 462) argues that the difference between the concepts of verticality and *Almwirtschaft* is one of emphasis rather than content. Whereas, on the one hand, the model of verticality emphasizes the strong influence of altitude in determining the production strategies of mountain communities, *Almwirtschaft*, on the other hand, concentrates on the production sector of animal husbandry, using vertical ecological belts. Both concepts provide a framework for understanding how mountain farmers attain a balance between the natural resources and their material requirements.

The Rupal Valley is a high valley to the south of the Nanga Parbat group and it releases its waters into the Astor River, which is a tributary of Indus. The valley floor ranges between about 2,500 and 3,700 m (Figures 1 and 4). The altitudinal belts of all plant formations reach their uppermost limit in this valley due to the extreme uplift of Nanga Parbat's Rupal Face (Troll, 1939: 169). With the permanent settlement of Rupal-Pain (3,065 m) and the cultivation of barley near the summer settlement of Yackmy (up to 3,340 m), altitudinal limits of agriculture extend much higher here than in other valleys of this high mountain group (Troll, 1939: 158).

Due to altitude, the Rupal Valley is a single cropping area with summer grains dominant. The most important crop is wheat, followed by recently introduced maize and potatoes. These have reduced the cultivation of traditional grains such as barley, buckwheat, and millet and caused a change in the crop rotation. According to Pilardeaux (1995: 80–81), the displacement of the traditional grains to higher summer settlements is widespread in northern Pakistan and results from the expansion of wheat and maize cultivation in the permanent settlements. Barley, however, is still the grain that can be grown at the highest altitude due to its short ripening period (Troll, 1973: 46; and author's own observations). Maize is cultivated up to about 2,750 m. Whereas there is large-scale maize cultivation in Churit and Rehmanpur, the cultivated area of Zaipur forms a transitional zone, mainly because of the lack of solar radiation due to the Chugahm ridge to the south and its shadow effect. Tarishing (2,910 m) and Nahake (2,980 m) are above the limit of maize cultivation. In comparison, in central Hunza maize is grown up to about 2,470 m (Kreutzmann, 1989: 101) and in Chitral to 3,000 m (Haserodt, 1989: 118). The cultivation of fruit and nut trees (mostly walnuts) in the Rupal Valley also reaches an altitudinal limit around 2,750 m.

The arable land in the Rupal Valley generally lacks any fixed crop rotation in the sense of a common field sys-

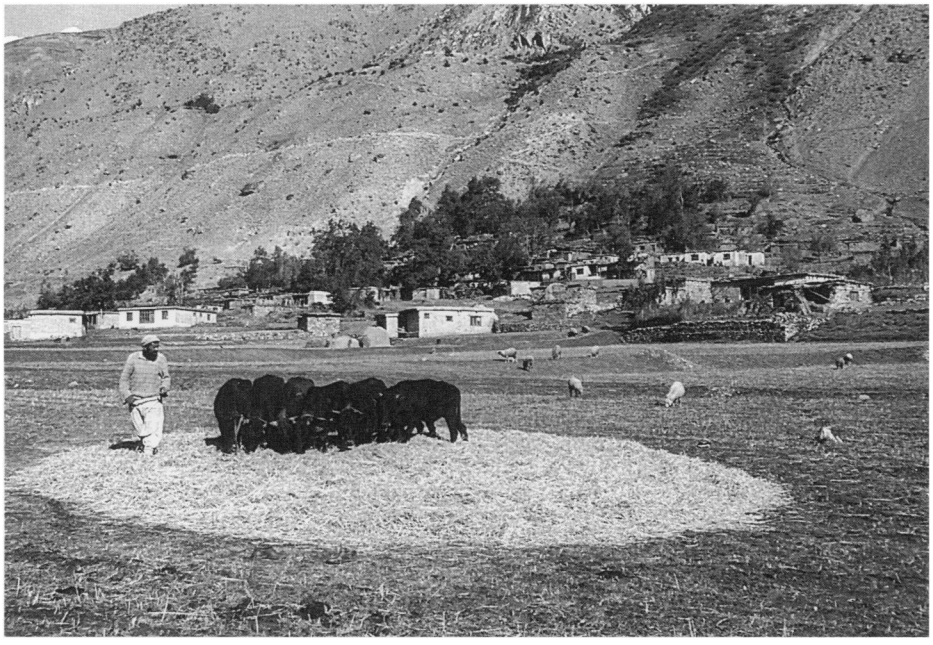


Figure 5. Traditional threshing in early October at Churit (2,730 m). After threshing, straw and crop residues are kept for winter fodder and cattle are allowed to graze freely on the fields. October 1992.

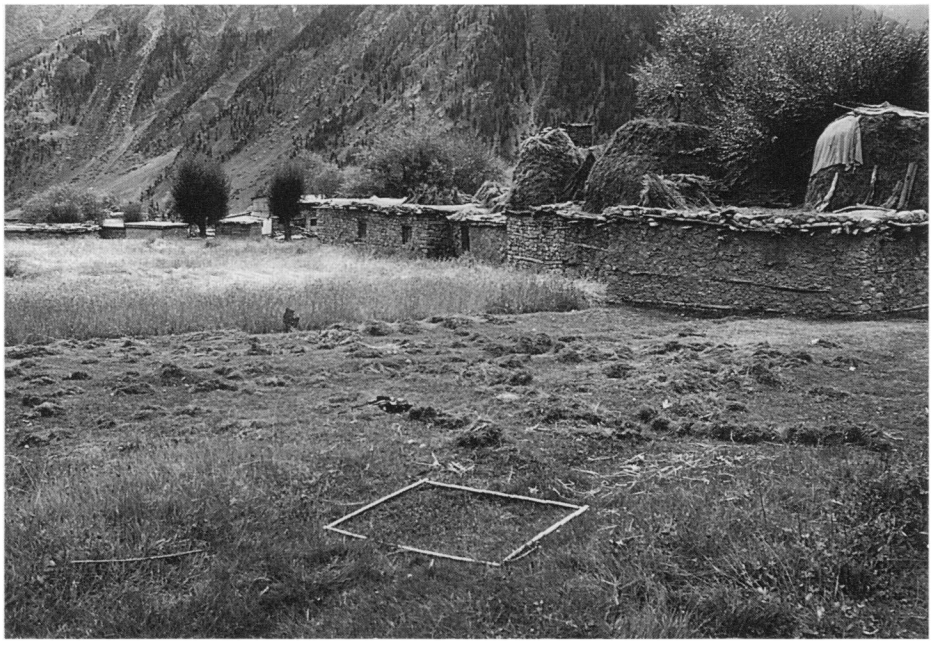


Figure 6. The harvesting of hay in autumn in the village of Tarishing (2,910 m); grass and hay cut in August and September provide essential winter fodder for cattle. September 1993.

tem. The agro-social structure is characterized by individual households and is comparatively homogeneous. Very few farmers own more than one hectare of arable land (Khan, 1979: 28). As a result of the traditional inheritance system, the cultivated land is divided into even smaller units. The rapid population growth in the study area has led to recent village expansions and extensions of irrigation networks.

Throughout the region, areas of single cropping cannot meet the food demands of the inhabitants. Often more than 50 percent of the required grain and flour is brought into the villages at state subsidized rates from down country (Saunders, in Kreutzmann, 1989: 113). From the beginning of this century, supplies for the local population and troops in the garrisons along the Gilgit Road (Figure 2) have been provided by regular deliveries from Kashmir (Singh, 1917: 94). Until the end of the 1970s, twice a year farmers from the Rupal villages would travel with pack animals through the Chichi Valley and over the Shontar Pass at 4,564 m (Barron, 1932: 63) to down country (Kel or Mansehra). They would purchase provisions such as grain, rice, sugar, salt, and tea. Nowadays, these products are easily imported over the Karakorum Highway by tractor or jeep and are obtainable in the local bazaars (for Hunza and Gilgit District, see Kreutzmann, 1995: 221–222).

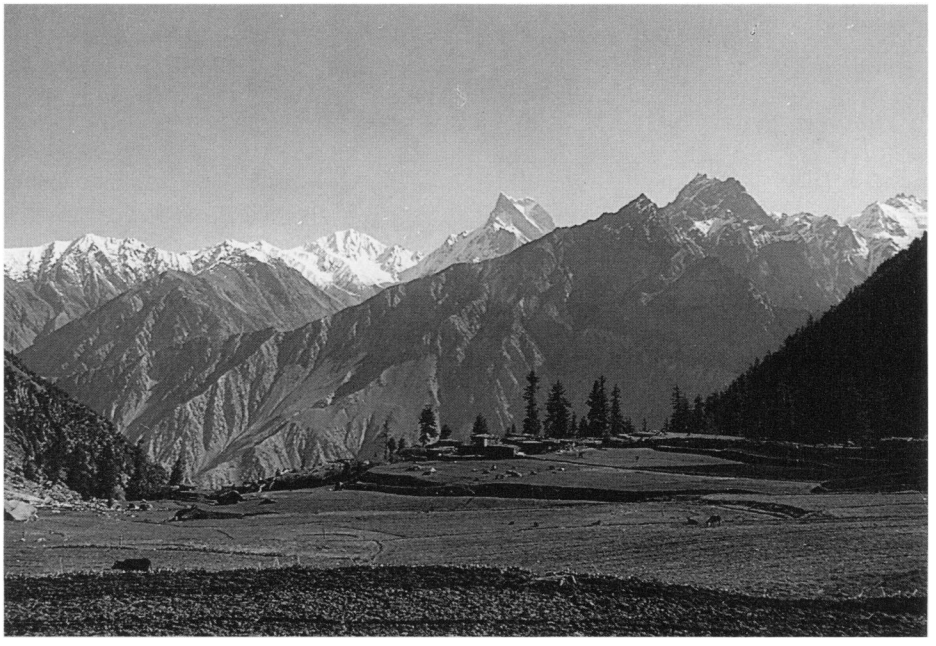


Figure 7. Summer settlement with additional irrigated fields at about 3,080 m; such settlements are usually used twice during the pastoral migration cycle and provide fields, pastures, and fuelwood. May 1994.

Figure 8. Alpine pasture and settlement in the upper Rupal Valley; these are used for eight or nine weeks in summertime; cows and bulls graze freely while the men take sheep and goats to the surrounding hills at about 3,600 m. July 1993.

Within the system of mixed mountain agriculture, high pasturing and crop cultivation are interrelated. Traditionally, plowing and threshing could be done only by use of animals (Figure 5) but within the last ten years, tractors and threshing machines have been introduced. The rough topography, however, prevents them from reaching all the fields of the permanent settlements and also the summer settlements, so that animal labor is still required. Although mineral fertilizer is now readily available, large amounts of animal manure are also needed. In spite of seasonal movements, livestock raising is possible only in combination with cropping, because over-wintering of animals presents the primary limiting factor throughout the mountains of northern Pakistan (Figure 6; Snoy, 1975: 101 ff.; 1993: 52, 65; Grötzbach, 1984: 312). In the study area, no low-lying winter pastures are available and animals must be stall-fed. In contrast to other parts of northern Pakistan and even in Astor (Pilardeaux, 1995: 104), in Rupal agrarian innovations such as mineral fertilizer and mechanization have not reduced the importance of cattle and, to this day, a symbiotic relationship characterizes the link between animal husbandry and crop cultivation (Khan, 1991: 2).

Crop residues, leaves, and hay are stored for winter fodder (Figure 6). Crop selection is determined by animal food requirements. Traditional varieties of wheat are pre-

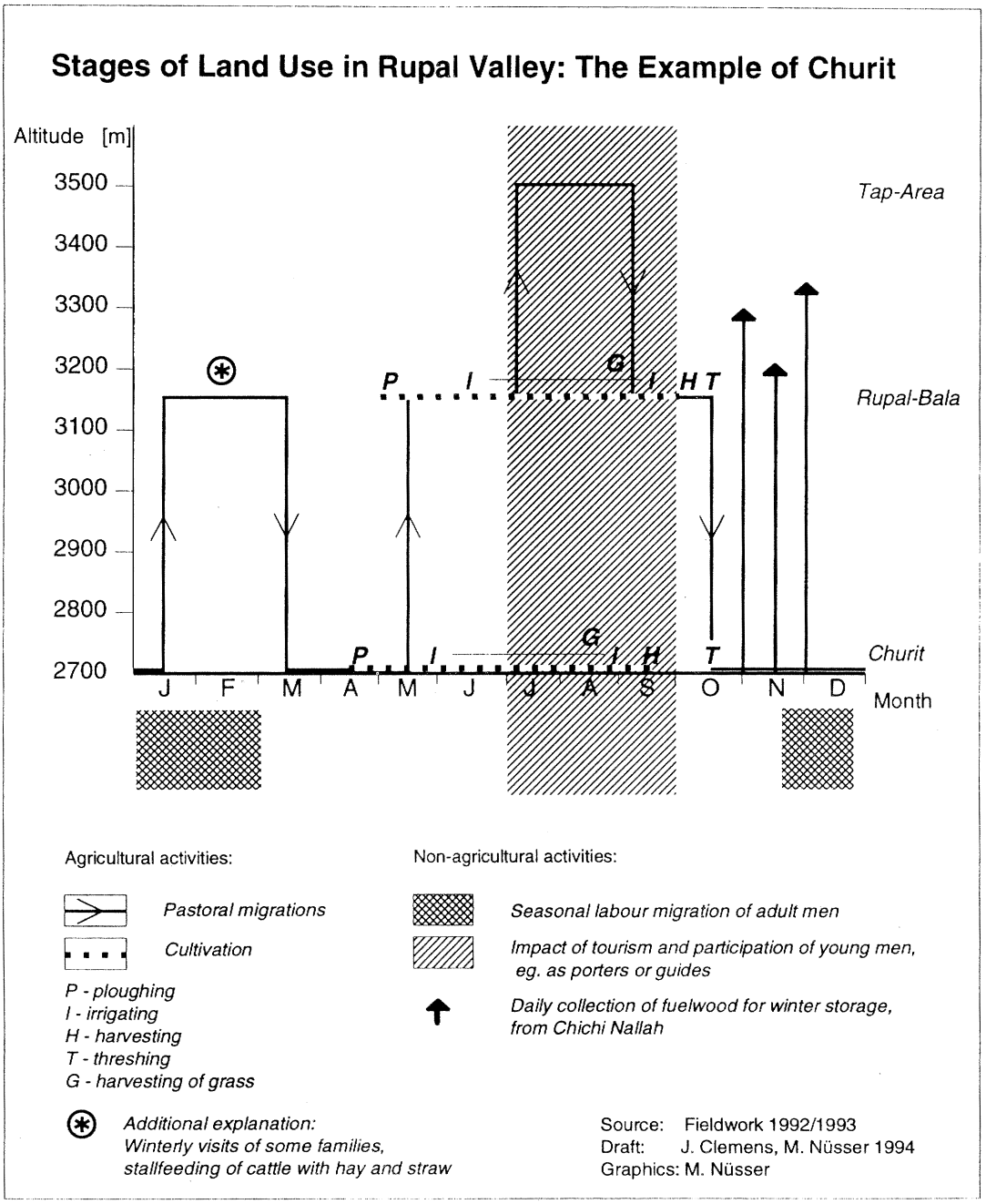


FIGURE 9. Stages of land use at Churit in the Rupal Valley. Mixed mountain agriculture has been influenced recently by non-agricultural factors, especially job opportunities for men.

ferred not only for bread, but also for high yields of straw. Winter slaughtering (*Daikkyo* or *Nasalo*, Shina) is one adaptive strategy to reduce the fodder demand; Nayyar (1986: 10) and Snoy (1993: 66) report this activity in Astor. Within villages, hay and straw are exchanged between households with excess and those with deficits. The allotment of arable land for fodder production was adopted only recently. Lucerne (*Medicago sativa, M. X varia*) is cultivated in only a few isolated patches and, at this altitude, can be harvested up to three times a year. According to Snoy (1993: 66), this is typical for the whole mountainous region.

The pastoral economy, based on the altitudinal zonation of land use, involves seasonal settlements in the upper valley zones (Figures 4, 7, and 8). According to Troll (1939: 157), there are two types of summer settlements: the "summer field settlement" and the "summer pasture settlement" (cf. Uhlig, 1995: 201). The first is characterized by supplementary irrigated agriculture and the latter by pastoral use only. *Nirril* (Shina) is the indigenous term used for all settlements that are occupied only in certain seasons (Troll, 1939: 158). These vertical strategies (*Staffelwirtschaft, Almwirtschaft*) have been developed due to the lack of sufficient pasture resources close to the

permanent settlements. Additionally, traditional rules forbid the keeping and free grazing of animals near the *Heimgut* (households in permanent settlements) during the cropping season. Elected village representatives decide when the herds are to be moved (Figure 9), and neighboring villages must consent to these dates. The upward movement depends upon the available fodder supply (scarcity) in the *Heimgut,* in spring, and on snow conditions in the high pastures. In autumn, the animals can be brought down only after the completion of harvesting.

One characteristic of the region is the importance of cooperative work in agricultural production. Irrigation channels, roads, and bridges are built and regularly maintained by the village community. This is indicated by the efficient utilization of limited resources. Field watchmen (*Rakha,* Urdu, or *Zaituh,* Shina) ensure that the traditional ban of animals is upheld (for Bagrot Valley: Snoy, 1975: 112). During summer all households keep one donkey for transportation, together with one goat or sheep for regular milk supply, close to the *Heimgut.* A traditional communal rotational system (*Ayegon,* Shina), ensures daily grazing on the surrounding slopes. Also on the *Nirrils,* the labor intensive care of sheep and goat herds is commonly shared. Relatives and neighbors provide one male family member to work as a shepherd, according to a rotational plan (*Lachogon,* Shina).

Agricultural labor is generally divided according to gender. Traditionally, men took care of the irrigation and livestock, whilst women were responsible for weeding, cutting hay, harvesting, and milking, including milk processing. Comparable findings are presented by Herbers (1995: 237) for Yasin Valley. The division of labor by gender is similar also in Hopar (Nagyr); however, women do not go to the high pastures and they are excluded from tending sheep and goats (Hewitt, 1989). Also, during the summertime activity at the *Nirrils,* the fields of the permanent settlements still require labor input. For this reason, during summer large families divide their labor force among two or three altitudinal levels, whereas smaller families are forced to change locations frequently or to delegate particular duties to relatives. The village of Churit provides a good example of *Staffelwirtschaft* (Figure 9).

Meanwhile some families spend the summer also in the winter village (*Heimgut*) where there are schools and small bazaars. The men take the opportunity to earn money as high-altitude porters or as mountain guides for tourists and trekking expeditions. In these cases, the men from the winter village manage to irrigate the fields of the summer settlements (e.g., Rupal-Bala) which are nearby. Goat and sheep herds are then brought to the pastures by a relative in exchange for an agreed share of milk products.

AN OVERALL VIEW OF THE PASTORAL USE OF ENVIRONMENTAL RESOURCES

The horizontal and vertical differentiation of the environmental potentials of the Rupal Valley demand very different strategies, expressed by spatial and temporal patterns of pastoral migration between permanent settlements and high pastures (Figures 4 and 9). The general pattern of this *Staffelwirtschaft* is fundamentally influenced by rights for the use of pastures and forest stands in various valley sectors. Usually, these rights are confined to the village boundaries, adjoining slopes, or valley sectors. In some exceptional circumstances, however, villages receive additional forest rights, such as when the forest resources of one village do not provide an adequate wood supply. For example, the villages of Churit, Nahake, and Gageh are allowed access to the forests of the Chichi Valley, although they have no pasture rights there (Clemens and Nüsser, 1995). The schematic profile of the Rupal Valley shows overlapping utilization rights (Figure 4), which are unusual for Astor and are based on factors of settlement history.

For a more detailed understanding of these problems, the following analysis of the environmental potential and utilization strategies in the valley profile is presented. Vegetation cover and land use should be taken into consideration, because they relate the spatial distribution of vegetation to topoclimatic and edaphic site conditions, and also greatly influence the way of life of the people (Schweinfurth, 1983: 537).

The Lower Rupal Valley

In the lower valley sector, recent dissection by fluvial erosion has resulted in isolated plateaus of ground moraine up to 50 m above the river. All cultivated land of the permanent villages between Rehmanpur and Rupal is situated here. Up to 200 m above these plateaus are further glacial terraces on the southerly exposed sunny slopes that are used for agriculture and settlements (Figures 1, 7, and 8). Especially in this part of the valley, hygrophilous bushes including species of *Salix, Hippophae,* and *Populus* are commonly found on wet sites. The dominant species of dwarf shrub on the south slope is *Artemisia brevifolia* and, due to the close proximity of the permanent settlements, *Artemisia* is used for temporary pasturing between winter stall feeding and summer high-altitude grazing. In the context of the rotational herding system (*Ayegon*), it provides a limited fodder supply, sufficient only for small herds. Cuttings from the hygrophilous plant formations are dried and used in times of fodder shortage in winter.

Most pasture settlements are located on the southerly exposed slopes, relatively close to the permanent settlements. The summer field settlements are found up to 3,300 m and are sometimes extensions of cultivated land with separate huts outside the normal village boundary (*Chack,* Shina). The summer settlements of Doai-Bala and Doai-Pain, as well as Baffordat, represent the *Höchststaffeln*

(highest stages of utilization). Formerly some higher pastures and settlements (e.g., Dudeh Haret, Jamay Haret, and Susrat) were occupied for a few weeks each year, but today they are deserted and are used only in the framework of daily grazing from lower settlements (Figure 1). Between 3,800 and 4,000 m *Artemisia brevifolia* gives way to alpine Cyperaceae mats. The vegetation of the alpine belt is dominated by *Kobresia capillifolia.*

Between these *Nirrils,* there are no fixed pasture boundaries or exclusive grazing rights for lineage groups, so that grazing in the alpine belt is freely available to all farmers. Most of the families from Churit and Nahake also own land, and are allowed to use pastures, in the middle and upper sections of the Rupal Valley. Often this leads to a division of livestock: labor-intensive animals (sheep, goats, and lactating cows) stay in the *Nirrils* of the lower valley, whereas oxen and young animals are taken by family members to the upper areas where they graze freely.

On the northern exposed slopes of the lower valley (Chugahm ridge), between about 2,800 and 3,700 m, humid coniferous forests with *Pinus wallichiana, Picea smithiana,* and *Abies pindrow* are found. These forest stands are an important local source of fuelwood and timber. Apart from this, these slopes are used for forest pasturing and are the sites of two small Zaipur *Nirrils.*

In summary, most of the settlements and cultivated land are situated on the valley floor. The vegetation cover and potential land use of the adjoining slopes are primarily determined by the exposure to solar radiation. Whereas the dwarf shrub formation of *Artemisia brevifolia* covers the southerly exposed slopes between the cultivated valley floor and its upper limit at 3,800 m, the slopes exposed to the north are covered by temperate coniferous forests. In one or the other way, all resources are utilized in terms of grazing and fuelwood supply. Due to the proximity of the permanent settlements, the pressure on these natural resources is comparatively stronger than in other valley sectors.

The Chungphare Glacier Region

Near to the Chungphare Glacier are six pastoral settlements which are frequented only by Tarishing and Rupal-Pain farmers. With the exception of Bayals, an adjoining, southerly exposed strip of cultivated land belonging to Tarishing, no field cultivation takes place here. Although there are no altitudinal constraints to cultivation in these *Nirrils,* such as Dayar on the right bank of the Chungphare Glacier, it seems that the intensity and frequency of katabatic winds from the glaciers are limiting factors. Nevertheless, the pastures here are highly valued by the locals and recent field observations indicate no evidence of degradation of pasture vegetation. Especially on the "ice-free islands" (moraines, surrounded by glaciers) of Naga Chakaly and Thormy and on the slopes of Sharsingi (4,676 m), there were mats of Cyperaceae that could be grazed. Only along the main footpaths between the permanent settlements and the *Nirrils,* was there degradation of vegetation cover.

The *Juniperus excelsa* woodlands on the southerly exposed slopes of the Sharsingi are strongly degraded. When they are compared to the vegetation map of Troll (1939) on the west side of the Chungphare Glacier, a distinct reduction in conifers and *Betula utilis* can be observed. As a result of degraded and overexploited forests in the Chungphare region, Tarishing no longer has adequate timber resources.

As previously mentioned, livestock is also divided between the Chungphare pastures (lactating cows, sheep, and goats) and the upper Rupal Valley (oxen, non-lactating animals). All *Nirrils* of this valley section lie close to the permanent settlements and this enables the children to attend school daily and young men to meet tourist groups in Tarishing at short notice.

In summary, the land use around the Chungphare Glacier is characterized by the dominance of animal husbandry because of comparatively easy access to rich pastures. Whereas there is no evidence of severe degradation of the alpine and subalpine mats as the main fodder resource (apart from locations in close proximity to the pasture settlements), there is a remarkable decline in the juniper and birch forests. This causes severe problems for the fuelwood supply of Tarishing.

The Middle Rupal Valley

In this valley section, ground moraine provides good conditions for irrigation. The area can be reached only by crossing the debris-covered Chungphare Glacier. The permanent settlement of Rupal-Pain (at about 3,100 m) was formerly only a summer settlement of Tarishing (Kick 1967: 116). This is evident from the fact that most families own land in both villages and commonly share pasture settlements (Figures 1 and 4).

One characteristic adaptation to scarce fodder supplies in winter in the *Heimgut* is the frequent return to summer settlements between January and March (Figures 4 and 9) where families remain usually for six to eight weeks and feed stocks of hay and straw to their animals. It is considered less problematic to guide the animals over the Chungphare Glacier in winter than to transport large amounts of fodder downstream to the permanent settlements. Recently, fewer families return to these *Nirrils* in winter; they exchange fodder supplies with other families between the villages and the *Nirrils.*

The southerly-facing slopes are covered extensively with *Artemisia brevifolia,* whilst the northern slope of the Rupal ridge is covered with coniferous forests which are used by the inhabitants of Rupal-Pain for fuel and timber, and show clear signs of degradation (especially on the lower slopes). Upstream, the conifers give way to forests and small stands of *Betula utilis* (at approximately 3,950 m) which form the alpine treeline. Birch can be found at 4,150 m and is upwardly replaced by *Salix karelinii* in the form of krummholz (creeping shrub formations).

To summarize, the vegetation pattern of the middle valley sector with the distribution of *Artemisia* dwarf shrubs and coniferous forests, determined by exposure, reflects that of the lower Rupal Valley. Due to altitude (up to 3,350 m), the land use is dominated by summer settlements with cultivation. It is remarkable that the people risk crossing the glacier with their herds in winter to feed them the supplies of hay and straw stored from the last harvest.

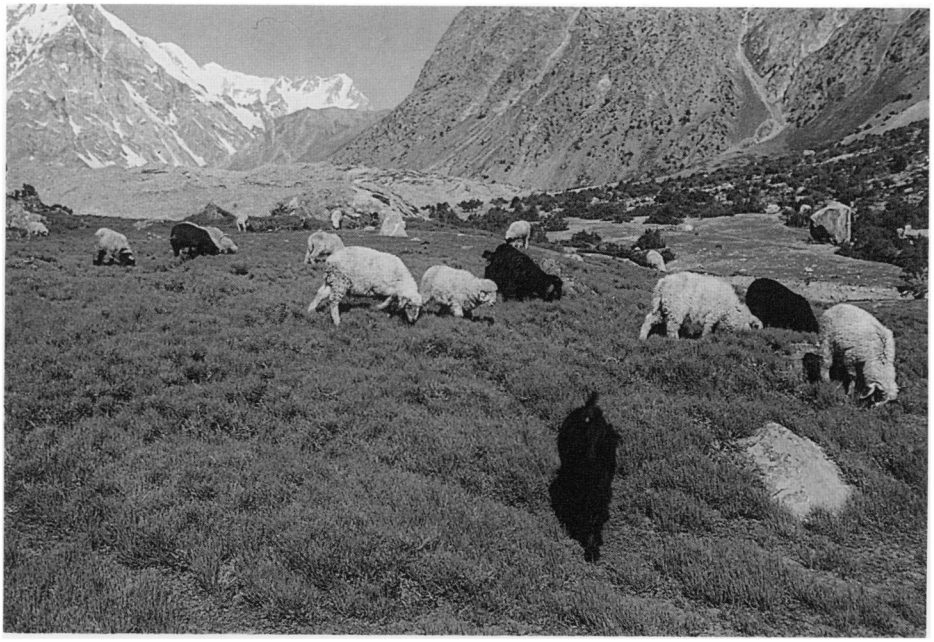


Figure 10. Grazing on alpine pastures of *Ephedra gerardiana* in the upper Rupal Valley at about 3,650 m. July 1994.

The Upper Rupal Valley

Erosional processes are affected by the debris-covered glaciers of Tap, Latobo, and Shaigiri. Wide areas of gravel deposits of recent sediments are formed between these glaciers at elevations between 3,500 and 3,700 m (Finsterwalder, 1936: 333). On these high-valley plains of the upper Rupal Valley, alluvial fans and remnants of isolated rockfalls provide suitable sites and shelter for ten pasture settlements.

In the upper areas, the longitudinal vegetation profile shows pronounced changes in the floristic composition of *Artemisia* stands. The subalpine type of dwarf shrub is characterized by increasing numbers of *Artemisia santolinifolia* and *Ephedra gerardiana*. The lateral glacial moraines provide enough groundwater to support the growth of *Salix* spp. forests, and shrubs. Like the hygrophilous vegetation units of the lower Rupal, these are an important supply of fodder during the meager winter period.

One exception to the pastoral migration pattern is the *Nirril* Latobo (3,600 m) in the upper valley (Figure 8). About ten men from Tarishing and Rupal-Pain shepherd an average of 200 sheep and goats during winter. The number of animals depends on the annual amount of the hay harvest in the *Heimgut*. The use of high pastures throughout the year is an extreme survival strategy to cope with the scarcity of fodder in winter. This is unusual for northern Pakistan, although Kreutzmann (1989: 138) and Butz (1993: 491) have observed this in Shimshal Valley in Hunza. Cattle sheds in Latobo, which house only animals in summer, are shared by the shepherds in winter and the living areas are separated by wooden partitions. Strong glacial winds in winter blow off the snow cover to expose *Artemisia* and to allow grazing along the lateral moraine and the lower slope of the Nanga Parbat south face (also known as the Rupal face, towering more than 4,500 m over the valley floor). This climatic phenomenon is a great advantage to mountain shepherds and reduces the pressure on the fodder supplies in the *Heimgut*.

Other pasture settlements of the upper valley are used for eight or nine weeks in high summer (Figures 4 and 9). Grazing resources here are plentiful for all the livestock from Churit, Nahake, Tarishing, and Rupal-Pain, and indications of local overgrazing are observed only around the *Nirrils*. Mixed herds of sheep and goat graze daily on the surrounding slopes (Figure 10). Cattle graze freely throughout the upper valley, while lactating cows are kept near the summer settlements for regular milking. It is important that the *Nirrils* be situated close to a water source and near the birch forests of the southern slopes of the Rupal ridge. Willow stands on the lateral moraine and by the river should be conveniently close as the wood is used for heating and cooking (Figure 11).

The most important base camps for trekkers and expedition groups are located in upper Rupal (Figure 1). Although tourism offers a welcome extra income for men, base camps situated close to the *Nirrils* can disrupt village life. This causes problems, especially for women, who are forbidden by their religion to have any contact with foreign men (the *Purdah* commandment). Because of this, one particular *Nirril*, which once lay at the foot of the Bazhin Glacier and was frequently visited by tourists, was abandoned. The location of base camps for trekkers in close proximity to pastureland on the valley floor restricts the activities of the pastoral economy.

The uppermost part of the Rupal Valley, including the Mazeno and Toshain areas (west of the map shown in Figure 1, on both sides of the Rupal Glacier), is a subsidiary region for animal husbandry in Rupal. The highly productive vegetation mats around the valley head (between 4,000 and 4,600 m), are grazed only by hardy nonlactating cattle, mostly crossbred with yaks, because lack

FIGURE 11. The Tap Glacier and alpine pastures in the upper Rupal Valley at about 3,600 m. The lateral moraines are vegetated by *Salix* and *Juniperus* forests and *Artemisia* spp. stands which provide rich fodder for cattle from the nearby pasture settlements. July 1993.

of firewood prevents establishment of a pasture settlement.

An overview of the upper Rupal Valley shows that the vegetation is characterized by the transition into subalpine and alpine formations. On the north-facing slopes, conifers are replaced by birch and willow, reaching down to the valley floors at an altitude between 3,500 and 3,700 m. This valley sector is used exclusively for pasturing. The highest grazing areas are in the uppermost part of the Rupal Valley (Mazeno and Toshain areas), reaching altitudes of about 4,600 m at the valley head. These areas of productive alpine mats, however, serve only as subsidiary sites for animal husbandry.

THE CHICHI VALLEY

The basic land use of the Chichi Valley reflects that of the Rupal Valley. Due to the narrow profile of the V-shaped valley, irrigated agriculture is restricted to the alluvial fans of side valleys. At the end of the valley is the summer camp of Bakrwal nomads who migrate annually via the Shantor Pass from the Potowar plateau near Jhelum. Conflicts over grazing grounds are unknown between farmers and nomads. Trading and exchange of animals and food is advantageous for both groups and, for the farmers, the purchase of donkeys is of great importance.

Within the Chichi Valley are the most valuable forest resources of the entire study area. Here, as mentioned earlier, some villages have rights for firewood collection, but no rights for grazing. According to the estimates of local people and the forest department, the natural rate of reproduction cannot keep up with the increasing demand for wood. However, there are no plans for reforestation in this region (Clemens and Nüsser, 1995).

DISCUSSION ON PASTURE CAPACITY

In conclusion, the ecological carrying capacity of the high pastures in Rupal remains unimpaired. This is because no overexploitation takes place although the pastures are used intensively. Moreover, according to the local population and estimates made during this field study, the existing grazing resources of high pastures are adequate to support a slight increase in animal numbers. Case studies of the pastures of Naga Chakaly in the Chungphare region and of Latobo in the upper Rupal Valley (Clemens and Nüsser, 1995) serve as examples to focus on the relationship between pasture ecology and pastoral strategies. The investigations into edible pasture phytomass (in the sense of standing crop, measured by harvesting at the end of the vegetative period) compared with the actual intensity of use (stocking density, fodder needs of grazing animals) show that the yield exceeds the basic fodder requirements. This finding is confirmed by vegetation mapping, as isolated indications of degradation can be identified as sites around the pasture settlements and linear tracks along the main routes of pastoral migration. Klötzli *et al.* (1990: 22), from studies of the ecological conditions of high pastures in Hunza, depict a similar situation. In this context, one has to consider that grazing generally has a strong impact on the vegetation cover, which leads to a distinct botanical change in the balance of palatable and indigestible species. The research area, however, is a cultural landscape that has been developed by the inhabitants over a long period of time.

The actual species composition, as well as the distribution of phytomass, have to be interpreted from a human-ecological viewpoint rather than from a solely botanical perspective. Generally, estimates of the carrying capacity of animal husbandry are inadequate unless the problems of fodder shortage during the long winter season are also taken into account.

DEVELOPMENT OF ANIMAL HUSBANDRY AND PASTURE ECONOMY IN RUPAL

Animal husbandry and pasture economy still occupy a high status in the agrarian system of Rupal. For a quantitative study of the development, a livestock census from 1970/71 is compared with a field survey in 1992 (Figure 12). Within this 20-year period, the influences of modern transport and improved accessibility have to be considered. In every village in the Rupal Valley the number of animals per capita has risen significantly and the total number of livestock has doubled within this period. Langendijk (1991: 44) came to a similar conclusion in Ishkoman and he puts this down to necessity. Even small, divided households need a minimum number of livestock for subsistence farming, that is, for plowing and threshing, whilst a few households increase their livestock numbers, especially sheep and goats, for prestigious reasons.

Despite this increase in livestock, there are still no signs of fodder shortages in the high pastures. Likewise, due to the strategies described earlier, the limitations of winter fodder supplies can be overcome. Furthermore, the increased cultivation of wheat and maize, compared with buckwheat and barley, produces a greater amount of straw for winter fodder. In the last few years, there has also been an extension of the irrigation system around every village, which allows the expansion of arable land and, therefore, an increase in hay and straw production.

The development of animal husbandry in the Rupal Valley is not only an indication of growing population, but also reflects political and socioeconomic changes which partly influence the composition of livestock. The importance of animal husbandry in Astor is recorded in historical documents and travel reports (Drew, 1875; Knight, 1895; Singh, 1917) which mention the keeping of pack animals used along the Gilgit Road. This can be compared with the number of horses noted in the 1970/71 census which, at that time, were the only means of reaching the villages. Nowadays, due to jeep transport, horses are no longer of importance and are regarded mostly as a luxury item. Donkeys, however, are more favored, as they are the only way of transporting firewood to the villages and supplies to the *Nirrils.* Sheep and goats have always been the dominant village animals, and goats tend to be preferred. Since the partition of British India in 1947, the number of cows and bulls has increased. This is due to the fact that the former Hindu rulers of Kashmir forbade beef consumption by both Hindus and Muslims. Cattle rearing still continues to increase (see also Pilardeaux, 1995: 97). Crossbreeds of yaks and cows, *Zoai* and *Zomo,* are typical in the study area and are highly valued for their stamina and high-fat milk. For breeding, selected yak-bulls are commonly reared by groups of farmers and sold in other valleys further north (Yasin, Hunza, Haramosh, and Shigar). For a fee (*Yakluk,* Shina), yak-bulls may also be hired for mating with cows.

When the number of animals (Figure 12) is compared with the numbers given by Kreutzmann (1989: 124) for the Gilgit District, animal husbandry appears to be more dominant in the Rupal Valley and Astor. This phenomenon has already been mentioned in historical documents (Singh, 1917: 94, 100). In Rupal, there are up to ten animals more per household than in Hunza. Thus, the results from Rupal can be compared only to those from upper Hunza. This supports the assumption that animal husbandry and high pasturing in Astor, as a single cropping region, is relatively more important for subsistence farming than in areas where double cropping is feasible (Khan, 1991: 2; Langendijk, 1991: 9; Snoy, 1993: 53).

In Rupal, the livestock overwhelmingly serves the household needs and only occasionally are animals sold, mostly to the army. Additionally, traders from down country bring up water buffaloes for the needs of the garrisons. In the rural economy, animals are kept not only for their meat, but also for the value of milk and wool products (Langendijk, 1991: 28, 31). These are not marketed, however, but stay within the households. The purchase of donkeys and goats from Azad Kashmir or from the Indus valley for breeding is more common than the sale of livestock.

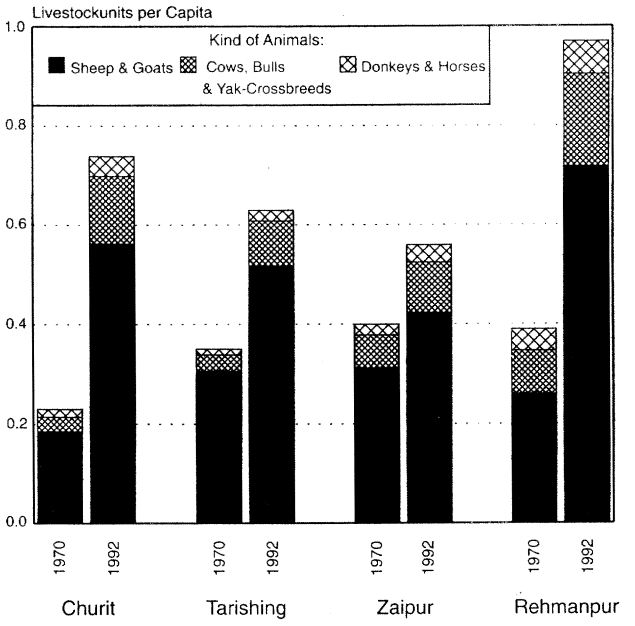


FIGURE 12. Changes in animal husbandry between 1970 and 1992 at four settlements in the Rupal Valley.

Population pressure and significant increases of animal numbers have not led to overexploitation of the high pastures in the Rupal Valley. Nor have the non-agrarian income opportunities reduced the importance of animal husbandry on high pastures as a fundamental component of the indigenous economic system; this is in contrast to the general statement of recent abandonments of marginal pastures in Astor (Pilardeaux, 1995: 97, 103 f). Unlike in Hunza, farmers of the Rupal Valley need not stall feed their lactating animals all year round. A shortage of labor, due to migration and non-agrarian income opportunities, has not yet forced any change in the production systems of animal husbandry and mixed mountain agriculture. Labor intensive activities will continue to be carried out within the community. As in Hunza, women are increasingly taking over more of the activities that were traditionally done by men. In spite of non-agrarian influences, animal husbandry and pastoral migration will continue to have a central function within Rupal's economy. However, the strategies of agriculture and animal husbandry must be improved to more adequately fulfill the economic needs of the rapidly growing population.

The increase in animal husbandry in the Rupal Valley makes the further development of related services necessary. Until now, there have been no veterinary facilities and no promotion of fodder cultivation. Improvements in these sectors are expected to take place through the activities of the Aga Khan Rural Support Programme, a self-help program working successfully in the Northern Areas (Clemens, 1992; Kreutzmann, 1993 b), and since 1993 also in the Astor Valley. It has managed to improve the rural infrastructure (road networks and irrigation systems), introduce a successful immunization campaign for animals, and encourage fodder cultivation. The potential for market-oriented animal husbandry to satisfy the increasing demand for meat in the surrounding towns and garrisons has not yet been exploited.

OUTLOOK

Although *Almwirtschaft* places pressure on the carrying capacity due to the increased number of animals, the ecological balance remains stable in the Rupal Valley. To assess the potentials of intensification of animal husbandry, a more detailed study of present pasture management (especially rotational systems) is required. An analysis of qualitative and quantitative estimates of high-pasture phytomass has already been carried out for parts of Hunza by Klötzli *et al.* (1990). Their contribution highlights the problems of high pasturing in the context of the complex mixed mountain agriculture and rural development in the northwest Himalaya. By discussing the problem from a human-ecological point of view, the present authors attempt to address the request for more interdisciplinary integration within high mountain research (Uhlig, 1980: 304; Winiger, 1992: 406). Aspects of cultural and physical geography, such as natural resource use (pastures and forests) and village-orientated rights of access and utilization, should be analyzed in a broad context of research. In this perspective, changing socioeconomic conditions in the Rupal Valley, including an increasing influence of labor migration, off-farm income, and tourism, need consideration. The impact of these factors and the pressure from increased population on agro-pastoral practices and survival strategies of indigenous mountain communities are still not fully understood.

ACKNOWLEDGEMENTS

This study is part of the "Culture Area Karakorum" research project. The authors are grateful to the German Research Council (Deutsche Forschungsgemeinschaft) for financial support and to the project's scientific coordinators, Prof. I. Stellrecht, Prof. E. Ehlers, and Prof. M. Winiger. Most of the plant names refer to determinations by Dr. W. B. Dickoré in the framework of the "Flora Karakorumensis" Project. Prof. G. Miehe and Dr. S. Miehe provided unpublished proposals for the description of plant formations. G. Laos helped with the translation. Many thanks also go to several host institutions and friends in Pakistan for kindly providing assistance.

REFERENCES

Ahmad, I. (ed.), 1952: *Census of Azad Kashmir 1951.*

Anonymous, 1890: *Gazetteer of Kashmir and Ladakh. Together with routes in the territories of the Maharaja of Jamu and Kashmir.* Superintendent of Government Printing, Calcutta (reprint, Lahore 1991). 871 + 218 pp.

Allan, N. J. R., 1986: Accessibility and altitudinal zonation models of mountains. *Mountain Research and Development,* 6(3): 185–194.

_____, 1989: Kashgar to Islamabad: The impact of the Karakorum Highway on mountain society and habitat. *Scottish Geographical Magazine,* 105(3): 130–141.

Barron, J., 1932: By Shontar Gali to Rama, Astor. *The Himalayan Journal,* 4: 59–66.

Butz, D., 1993: Developing sustainable communities: community development and modernity in Shimshal, Pakistan. Ph.D. Dissertation, McMaster University, Hamilton, Ontario. 709 pp.

_____, 1994: A note on crop distribution and micro-environmental conditions in Holshal and Ghohushal villages, Pakistan. *Mountain Research and Development,* 14(1): 89–97.

Casimir, M. J. and Rao, A., 1985: Vertical control in the western Himalaya: some notes on the pastoral ecology of the nomadic

Bakrwal of Jammu and Kashmir. *Mountain Research and Development,* 5(3): 221–232.

Census of Azad Kashmir and Northern Areas, 1961: Vol. I. Reports and tables. Compiled by M. Bashi Malik. Peshawar.

Census of India, 1912: *Census of India 1911,* vol. XX: Kashmir. Lucknow.

_____, 1923: *Census of India 1921,* vol. XXII: Kashmir. Lucknow.

Clemens, J., 1992: Das Aga Khan Rural Support Programme. Zur regionalen und sektoralen Wirksamkeit von "non-governmental organizations" im Entwicklungsprozeß der Northern Areas von Pakistan. M.Sc.Thesis, Dept. of Geography, Bonn.

Clemens, J. and Nüsser, M., 1995: Resource management in the Rupal Valley, northern Pakistan: The utilization of forests and pastures in the area of Nanga Parbat. *In* Stellrecht, I. (ed.), *Contributions to Comparative High Mountain Research: Pakistan-India-Nepal.* (Culture Area Karakorum, Occasional Papers, 3). Wezler, Reinbeck.

Drew, F., 1875: *The Jummoo and Kashmir Territories. A Geographical Account.* London. 568 pp. (Reprint: Karachi, 1980).

Finsterwalder, R., 1936: Die Formen der Nanga-Parbat-Gruppe. Topographisch-morphologische Begleitworte zu den Karten der Nanga Parbat-Gruppe. *Zeitschrift der Gesellschaft für Erdkunde zu Berlin,* pp. 321–341.

Finsterwalder, R., Raechl, W., and Misch, P., 1935a: The scientific work of the German Himalayan Expedition to Nanga Parbat 1934. *The Himalayan Journal,* 7: 44–52.

Finsterwalder, R., Raechl, W., Misch, P. and Bechtold, F., 1935b: Forschung am Nanga Parbat: Deutsche Himalaya-Expedition 1934. Sonderveröffentlichung der Geograpischen Gesellschaft zu Hannover. Hannover. 143 pp.

General Staff India (ed.), 1928: *Military Report and Gazetteer of the Gilgit Agency.* Simla.

Government of Pakistan, Population Census Organisation, 1984: *District Census Report of Diamir.* Islamabad.

Grötzbach, E., 1980: Die Nutzung der Hochweidestufe als Kriterium einer kulturgeographischen Typisierung von Hochgebirgen. *In* Jentsch, Ch. and Liedtke, H. (eds.), *Höhengrenzen in Hochgebirgen.* (Arbeiten aus dem Geographischen Institut der Universität des Saarlandes, 29). Selbstverlag, Saarbrücken, pp. 265–277.

_____, 1984: Bagrot-Beharrung und Wandel einer peripheren Talschaft im Karakorum. *Die Erde,* 115 (4): 305–321.

Haserodt, K., 1989: Chitral (Pakistanischer Hindukusch). Strukturen und Probleme eines Lebensraumes im Hochgebirge zwischen Gletschern und Wüste. *In* Haserodt, K. (ed.), *Hochgebirgsräume Nordpakistans im Hindukusch, Karakorum und Westhimalaya.* (Beiträge und Materialien zur Regionalen Geographie, H. 2). Berlin, pp. 43–180.

Herbers, H., 1995: Ernährungssicherung in Nord-Pakistan: Der Beitrag der Frauen. *Geographische Rundschau,* 47(4): 234–239.

Hewitt, F., 1989: Woman's work, woman's place: the gendered lifeworld of a high mountain community in northern Pakistan. *Mountain Research and Development,* 9(4): 335–352.

Ives, J. D. and Messerli, B., 1989: *The Himalayan Dilemma. Reconciling Development and Conservation.* Routledge, London-New York. 295 pp.

Khan, A. A., 1979: *Landuse survey of Astor river watershed (Diamer District).* North-West frontier forest record inventory series (13). Aerial forest inventory project, Pakistan Forest Institute. Peshawar. 60 pp.

Khan, F. U., 1991: A report on livestock in the Northern Areas. Gilgit, unpublished report, Aga Khan Rural Support Programme. 37 pp.

Kick, W., 1967: *Schlagintweits Vermessungsarbeiten am Nanga Parbat 1856.* (Reihe C, Dissertationen, 97). Deutsche geodätische Kommission der Bayerischen Akademie der Wissenschaften, München. 141 pp.

Klötzli, F., Schaffner, R., and Bosshard, A., 1990: Pasture development and its implications in the Hunza valley. High pasture mission 1989. Gilgit, unpublished report, Aga Khan Rural Support Programme. 56 pp.

Knight, E. F., 1895: *Where Three Empires Meet. A Narrative of Recent Travels in Kashmir, Western Tibet, Gilgit and the Adjoining Countries.* Longmans, Green, London. 528 pp. (reprints: Lahore 1986 and 1991).

Kreutzmann, H., 1988: Oases of the Karakorum: Evolution of irrigation and social organisation in Hunza, North Pakistan. *In* Allan, N. J. R., Knapp, G. W., and Stadel, C. (eds.), *Human Impact on Mountains.* Rowman & Littlefield, Totowa, N. J., pp. 243–254.

_____, 1989: *Hunza-Ländliche Entwicklung im Karakorum.* Abhandlungen-Anthropogeographie Band 44. Reimer Verlag, Berlin. 272 pp.

_____, 1991: The Karakoram Highway: The impact of road construction on mountain societies. *Modern Asian Studies,* 25(4): 711–736.

_____, 1993a: Challenge and response in the Karakoram: Socioeconomic transformation in Hunza, Northern Areas, Pakistan. *Mountain Research and Development,* 13(1): 19–39.

_____, 1993b: Entwicklungstendenzen in den Hochgebirgsregionen des indischen Subkontinent. *Die Erde,* 124(1): 1–18.

_____, 1994: Habitat conditions and settlement processes in the Hindukush–Karakoram. *Petermanns Geographische Mitteilungen,* 138(4): 337–356.

_____, 1995: Globalization, spatial integration, and sustainable development in northern Pakistan. *Mountain Research and Development,* 15(3): 213–227.

Langendijk, M., 1991: The utilization and management of pasture resources in central Ishkoman. Gilgit unpublished report, Aga Khan Rural Support Programme.

Nayyar, A., 1986: *Astor: Eine Ethnographie.* Beiträge zur Südasienforschung, 88. Steiner, Stuttgart. 120 pp.

Pilardeaux, B., 1995: *Innovation und Entwicklung in Nordpakistan. Über die Rolle von exogenen Agrarinnovationen im Entwicklungsprozeß einer peripheren Hochgebirgsregion.* Freiburger Studien zur Geographischen Entwicklungsforschung Band 7. Verlag für Entwicklungspolitik, Saarbrücken. 308 pp.

Revenue Office, Astor (ed.), 1991: Census of Housing List as of Nov. 1990, Astor Subdivision. Astor, Pakistan unpublished; collected, August 1991.

_____, 1992a: Population Census 1970/71, Astor Subdivision. Astor, Pakistan unpublished; collected, October 1992.

_____, 1992b: Livestock Census Astor, 1970/71. Astor, Pakistan unpublished; collected, October 1992.

Rhoades, R. E. and Thompson, S. E., 1975: Adaptive strategies in alpine environments: beyond ecological particularism. *American Ethnologist,* 2: 535–551.

Schweinfurth, U., 1983: Mensch und Umwelt im Indus-Durchbruch am Nanga Parbat (NW-Himalaya). *In* Snoy, P. (ed.), *Ethnologie und Geschichte. Festschrift für K. Jettmar.* (Beiträge zur Südasienforschung, 86). Steiner, Wiesbaden, pp. 536–559.

Singh, T., 1917: *Assessment Report of the Gilgit Tahsil.* Lahore.

Snoy, P., 1975: *Bagrot: Eine dardische Talschaft im Karakorum.* (Bergvölker im Hindukusch und Karakorum, 2). Akademische Druck- und Verlagsanstalt, Graz. 224 pp.

_____, 1993: Alpwirtschaft im Hindukusch und Karakorum. *In* Schweinfurth, U. (ed.): *Neue Forschungen im Himalaya.* (Erdkundliches Wissen, 112). Steiner, Stuttgart, pp. 49–73.

Troll, C., 1939: *Das Pflanzenkleid des Nanga Parbat. Begleitworte zur Vegetationskarte der Nanga Parbat-Gruppe (Nordwest-Himalaja) 1:50.000.* (Wissenschaftliche Veröffentlichungen des Deutschen Museums für Länderkunde zu Leipzig, N. F., 7). Leipzig, pp. 149–193.

_____, 1973: Die Höhenstaffelung des Bauern- und Wanderhirtentums im Nanga Parbat-Gebiet (Indus-Himalaya). *In* Rath-

jens, C., Troll, C., and Uhlig, H. (eds.), *Vergleichende Kulturgeographie der Hochgebirge des südlichen Asien.* (Erdwissenschaftliche Forschung, 5). Steiner, Wiesbaden, pp. 43–48.

Uhlig, H., 1976: *Bergbauern und Hirten im Himalaya. Höhenschichtung und Staffelsysteme–ein Beitrag zur vergleichenden Kulturgeographie der Hochgebirge.* (Tagungsbericht und wissenschaftliche Abhandlungen, 40. Deutscher Geographentag Innsbruck). Steiner, Wiesbaden, pp. 549–586.

———, 1980: Der Anbau an den Höhengrenzen der Gebirge Süd- und Südostasiens. *In* Jentsch, Ch. and Liedtke H. (eds.), *Höhengrenzen in Hochgebirgen.* (Arbeiten aus dem Geographischen Institut der Universität des Saarlandes, 29). Selbstverlag, Saarbrücken, pp. 279–310.

Uhlig, H., edited by Kreutzmann, H., 1995: Persistence and change in high mountain agricultural systems. *Mountain Research and Development,* 15(3): 199–212.

Winiger, M., 1992: Gebirge und Hochgebirge. Forschungsentwicklung und -perspektiven. *Geographische Rundschau,* 44(7/8): 400–409.

Arid mountain slopes seen from the Karakorum Highway below Khunjerab Pass, Northern Pakistan. The highway, the modern expression of ancient trade routes between South and Central Asia, was motivated also by political considerations. The major German–Pakistan research program, Culture Area Karakorum, is assessing the impacts of the highway on the well-being of the local mountain people and their environment.