From Water Towers of Mankind to Livelihood Strategies of Mountain Dwellers: Approaches and Perspectives for High Mountain Research (Von den "Wassertürmen der Menschheit" zu bergbäuerlichen Überlebensstrategien: Ansätze und Perspektiven für die Hochgebirgsforschung)
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FROM WATER TOWERS OF MANKIND TO LIVELIHOOD STRATEGIES OF MOUNTAIN DWELLERS: APPROACHES AND PERSPECTIVES FOR HIGH MOUNTAIN RESEARCH[1)]

With 4 figures and 3 tables

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Zusammenfassung: Von den „Wassertürmen der Menschheit" zu bergbäuerlichen Überlebensstrategien: Ansätze und Perspektiven für die Hochgebirgsforschung

Die disziplingeschichtliche Entwicklung der Hochgebirgsforschung spiegelt sich in den Ansätzen empirischer Untersuchungen und in regionaler Schwerpunktsetzung wider. Drängende Forschungsfragen der Gegenwart erfordern vermehrt eine fächerübergreifende Zusammenarbeit vor allem dann, wenn die Überlebensbedingungen der Hochgebirgsbevölkerung in einer risikoreichen Umwelt bei knapper werdenden Ressourcen thematisiert werden. Unterschiedliche methodische Herangehensweisen einzelner Teildisziplinen stellen ein prinzipielles Problem natur- und sozialwissenschaftlicher Kooperation dar. Trotz dieser strukturellen Unterschiedlichkeit und inkongruenter theoretischer Vorgehensweise bieten sich in Schlüsselfragen der Mensch-Umwelt-Beziehungen thematische Überschneidungsbereiche an. Bestimmte Problemfelder lassen sich ohne fächerübergreifende Kooperation nicht mehr hinreichend bearbeiten. Aus dieser Gemeinsamkeit lassen sich Forschungsfelder extrahieren, in denen Entwicklungsprobleme in Hochgebirgsräumen der Dritten Welt thematisiert werden. Unter Berücksichtigung international angewandter Indikatoren zur Abschätzung des Entwicklungsstandes kristallisieren sich Schlüsselgrößen heraus, die eine zweifache Relevanz besitzen: Sie stellen ein mögliches Instrumentarium zur Messung regionaler Disparitäten bereit und geben eine zukünftige Orientierung von Problemstellungen vor. Dabei können in verschiedenen Sektoren Entwicklungsdefizite und Verteilungsungleichheiten in peripheren Regionen festgemacht werden. Unter Berücksichtigung einer derartigen Projektion auf Hochgebirgsgesellschaften wird Handlungsbedarf in den folgenden fächerübergreifend zu bearbeitenden Teilbereichen ausgemacht: Siedlungsterritorien und Bevölkerung, Wirtschaft und Ernährung, Ressourcenmanagement und Energieversorgung. Die dafür nötigen methodischen Instrumente zur Identifizierung von Entwicklungsproblemen liegen vor und bieten bei angemessener Anwendung die Chance zum überregionalen Vergleich. Am Beispiel der Wassernutzung in ariden Hochgebirgsräumen wird der Ansatz exemplifiziert.

Summary: The history of the discipline of high mountain research is reflected in the approaches of empirical investigations and by focussing on regions. The pressing research questions of our time increasingly require multi- or interdisciplinary co-operation, especially in situations where the theme is one of the deteriorating living conditions of the high mountain population with fewer resources in an environment fraught with risks. Different methods of approach of particular subdisciplines present a fundamental problem of co-operation among the natural and the social sciences. In spite of these structural differences and incongruent theoretical approaches, common thematic areas occur in key questions concerning relations between man and his environment. Some problem areas can no longer be adequately tackled without interdisciplinary co-operation. This common purpose permits the identification of research areas which take development problems in high mountain areas of the Third World as their theme. Taking into account internationally applied indicators for the appraisal of the level of development, key parameters emerge which prove to be of two-fold relevance: they provide a potential set of instruments for the assessment of regional disparities, as well as a future orientation for the approach to the problems. This allows development deficits and distributional inequalities in peripheral regions to be established for several sectors. Working with this kind of projection onto high mountain societies, a need for interdisciplinary action is identified in the following branches: settlement area and population, economy and nutrition, resource management and energy supply. The necessary methodological instruments for the identification of development problems are available, and with appropriate application they offer the opportunity of supra-regional comparison. The example of water utilization in arid high mountain regions serves to demonstrate the approach.

1 Introduction

A growing dissatisfaction with inadequate scientific tools for describing and analyzing development problems in high mountain regions has characterized the scholarly debate of recent years. A number of efforts have been undertaken in order to find new solutions. Stimulated by growing demands from local communities, policy makers and development planners multi- and/or interdisciplinary approaches for addressing prevalent research deficits have been the focus of combined efforts. Crossing traditional thresholds of scientific disciplines is aggravated by declining commonalities in methodological understanding and the application of certain research methods. This principal

[1)] This contribution is dedicated to ECKART EHLERS in commemoration of his 60th birthday.

feature carries especially weight when complex problems need a multi-facetted approach for their solution. Projected from a general level on to the field of high mountain research, this dilemma appears when deteriorating living conditions of mountain farmers are in focus. The interrelationship of all involved factors cannot be neglected when a complex system made up of natural and human system properties is to be understood. To combine the knowledge about the environmental framework conditions – symbolized in the water towers of mankind – with the social sphere of survival strategies of individuals and local communities for a better and sustainable future, presents a challenge for all involved in the process of research, policy making and development practice.

In this contribution an assessment of the tradition of high mountain research is attempted as a starting point for some considerations about new directions for analyzing the conditions under which mountain farmers live.

1.1 State of the art in multi-disciplinary high mountain research

Initially Carl Troll has given the directions more than half a century ago (TROLL 1941, 1959, 1962). His systematic approach towards geoecology – nonetheless heavily influenced by his botanical background – led to a dual conceptual research strategy: "comparative high mountain geography" and the "three-dimensional classification" of high mountain regions (TROLL 1972, 1975). These pioneering contributions were backed by substantial fieldwork experience in the alpine belt and selected comparisons with tropical mountain ranges. Thus the alpine mountain habitat was taken as a field laboratory for perceiving geo-ecological systems and their linkages. Most existing models, classification systems and nomenclatures in high mountain research have been formulated in the alpine context and have subsequently been transferred to other mountain areas and continents. Generations of mountain researchers have been inspired by this school and an exemplary impression of its impact is to be found in the presentations made during the biannual meeting of German-speaking geographers in Innsbruck in 1975 (UHLIG a. EHLERS 1976).

In the process of time emphasis in geo-ecological research was predominantly placed on the interrelationship of vegetation cover and climatic conditions (GERHARD 1990, HOLTMEIER 1981, MIEHE 1995, MIEHE et al. 1996, RICHTER 1996). Nevertheless, two other groups of research efforts have simultaneously gained in importance: first, a better understanding of complex systems was pursued by defining the mountain environment and classifying certain aspects such as morphological processes (PILLEWIZER 1976 and recently RIES 1994), the differentiation of landscape units (HAFFNER 1982, RATHJENS 1972, 1982a), altitudinal variations (HÖLLERMANN 1976), altitude belts and the upper limits of certain phenomena (JENTSCH a. LIEDTKE 1980). Secondly, with a considerable time gap cultural geographers developed their own classifications for enabling comparative research outside the alpine regions to be undertaken. Key words in this debate have been terms and phrases such as demographic pressure (DE PLANHOL 1968, SKELDON 1985), the utilization of high-altitude pastures (EHLERS 1973, 1976, 1980; GRÖTZBACH 1980), high mountains as human habitat (BLACHE 1950, BRUSH 1976, GUILLET 1983, GRÖTZBACH 1982, PEATTIE 1936, RHOADES a. THOMPSON 1976, UHLIG 1984) leading to considerations about a comparative cultural geography of montane regions (GRÖTZBACH 1976, JENTSCH 1977, RATHJENS 1968, 1981, 1982b, RATHJENS, TROLL a. UHLIG 1973, SCHWEIZER 1984, VEYRET a. VEYRET 1962) and/or to aspects of "Human Impact on Mountains" (ALLAN, KNAPP a. STADEL 1988, PRICE 1981, SOFFER 1982). In the Alps an economic transformation was proved by assessing the decreasing importance of agriculture and the increasing dominance of the services sector (LICHTENBERGER 1979) as well as studying demographic trends in the context of urbanisation (BÄTZING, PERLIK a. DEKLEVA 1996). In the early eighties the complex system of ecology and economy, as well as the antagonism of self-reliance and dependency in mountain regions, was highlighted and led to a number of studies. National research efforts, such as the report on "the transformation of Swiss mountain regions" (BRUGGER et al. 1984) and the supra-national UNESCO programme "Man and Biosphere", furthered the knowledge of environmental, economic and cultural processes in the Alpine belt and initiated intensified scientific activities in this field (MESSERLI, B. 1979, MESSERLI, P. 1979, 1989, PATZELT 1987). An overview of the results of comparative high mountain research was presented by UHLIG and HAFFNER (1984). Voices could be heard demanding more integrated research efforts (CHAUBE 1985, LAUER 1984, 1987, SINGH a. KAUR 1985), as well as expecting an increased attention towards changing traffic infrastructures, accessibility (ALLAN 1986) and the integration of mountain regions in the global economy (KREUTZMANN 1993, 1995a). An IGU Commission was established for "High-Altitude Geoecology", later re-named into "Mountain Geoecology and Sustainable Development" (cf. STADELBAUER 1992) as well as the "International Centre for Integrated Mountain Development" (ICIMOD) in Kathmandu (1983). Since

1981 the journal "Mountain Research and Development" has played a prominent role in disseminating knowledge about certain mountain regions and linking individuals and groups for a more systematic approach in international high mountain research. The attempt to broaden the view for a holistic approach led to greater emphasis on defining common research topics. The perceived need for multidisciplinary perspectives was augmented by the attempt to view mountain regions as part of a highland-lowland exchange system incorporating the dimension of a world economy in which mountain communities participate on different levels. This was acknowledged in respect of mountaineering, trekking and recreation tourism, less obvious in studies focussing on nature conservation. The protection of endangered ecological niches and ecotopes, as well as the provisional function for natural resources, has been highlighted in recent years. Demands for multidisciplinary approaches in this field have been put forward in cooperation with the "International Union for the Conservation of Nature" (IUCN) (HAMILTON, BAUER a. TAKEUCHI 1993). In an exemplary manner research deficits were exposed by questioning the validity of the so-called "Theory of Himalayan Environmental Degradation" (IVES 1987) and realizing the "uncertainty on a Himalayan scale" (THOMPSON, WARBURTON a. HATLEY 1986). Methodological shortcomings, particularistic approaches and isolated monodisciplinary studies resulted in the equivocal statement of the "Himalayan Dilemma" (IVES a. MESSERLI 1989), which revealed as many significant research deficits and a multitude of development problems in a particular mountain belt. This timely publication prior to the "United Nations Conference on Environment and Development" (UNCED) in Rio de Janeiro 1992, initiated combined efforts in mountain research and effected the presentation of an "Appeal for the Mountains" as well as a compendium on the "State of the World's mountains" (STONE 1992) at the international meeting mentioned above. Here academics demanded political solutions for a perceived development problem. Besides several regional issues of "Mountain Research and Development", tomes giving a regional overview for certain mountain regions have recently been presented for Africa (MESSERLI a. HURNI 1990) and Europe (PRICE 1995), comparative perspectives are attempted in other contributions (KREUTZMANN 1993, UHLIG 1995, WINIGER 1992). Presently mountain research is directed toward a continuation along this path of homogenization of methods and problem-targetted studies with a regional focus (MITCHELL a. GUILLET 1993). Nevertheless, the integration of local scholars, activists and professionals remains to be a desideratum not only in defining research topics but as well in cooperative research programmes. As a contribution towards the "Rio+5 Conference" in New York in 1997 a further combined effort resulted in the publication of "Mountains of the World. A global priority" (MESSERLI a. IVES 1997) in which efforts for sustainable development embodied in local communities are advocated.

1.2 Problems and prospects

Looking back towards the geoecological research tradition the problems of reaching this end are ubiquitous. All hopes for solving the "Himalayan Dilemma" were projected on to the mountain farmers, although – and that is the surprising fact – comparatively little attention was given to the complex living conditions of the people. The problem of neglect was symbolized in the personification of the mountain farmer and in addressing "his" needs as being somehow representative. The perception of common practices and problems among mountain dwellers in developing countries lacked at least sufficient imagination of the high degree of variation between regions, groups and households and their members. As there seems to be no single person representing the average European alpine farmer or the nomads of the world, there is definitely no such a person in existence who resembles the Third World mountain inhabitant. Living conditions vary along the N-S range of the Cordillera de los Andes as much as within them, and they are quite different from the Hindukush-Karakoram-Himalayan arc or the Ethiopian highlands and Papua New Guinea's mountain ranges. In all the regions identified, living conditions vary between social strata and households. The common form of generalisation disguises one of the most obvious facts to be found in mountain societies, i.e. extreme forms of socio-economic and politico-cultural heterogenity. On the other hand it shows the research deficit towards an understanding of the complexities of human activities and economic penetration within a given mountain habitat. Territorial usurpation and the exploitation of natural resources are underestimated as the driving forces of a habitat system in high mountain regions, as well as the contribution of socio-economic exchange relations between highlands and lowlands.

One could argue that the common inadequate approach might be the end result of a classical regional geography which lacks stamina when it comes to covering the human sphere. But there seems to exist a more general difficulty separating a natural science approach from social theories and related models. This gap is well known to all participants of multidisci-

Table 1: Baseline data for the composition of HDI, CPM and HPI for selected developing countries incorporating major high mountain regions

Eckdaten für die Berechnung von HDI, CPM und HPI dargestellt für ausgewählte Staaten mit bedeutenden Hochgebirgsregionen

Region	Country	Area	Population million inhabitants	PPP $	Life expectancy index	Education index	GDP-related index	HDI	GDI	Births without trained health personnel	Underweight children under age five	Female illiteracy	CPM	Economic deprivation	HPI
		10^3 km^2	(1994)	(1993)				(1993)	(1994)	(%)	(%)	(%)	(1994)	(%)	(1994)
AFRICA	Ethiopia	1097	54.9	420	0.38	0.28	0.05	0.237	0.233	86	48	76.5	70.1	59	56.2
	Uganda	236	18.6	1410	0.33	0.51	0.14	0.326	0.318	62	23	52.3	45.9	45	41.3
	Kenya	580	26.0	1400	0.51	0.69	0.22	0.473	0.458	46	22	33.2	33.8	31	26.1
	Rwanda	26	7.8	1710	0.37	0.52	0.11	0.332	n.d.	54	20	78.5	51.5	28	37.9
SOUTH and SOUTH-EAST ASIA	Papua New Guinea	463	4.2	2530	0.52	0.59	0.41	0.504	0.508	80	30	39.4	49.8	37	32.0
	Burma/Myanmar	677	45.6	650	0.55	0.71	0.09	0.451	0.469	43	37	23.4	34.4	41	31.2
	Bhutan	47	0.67	790	0.43	0.37	0.12	0.307	n.d.	93	38	73.8	68.2	38	46.3
	Nepal	141	20.9	1000	0.48	0.37	0.15	0.332	0.321	94	51	87.0	77.3	n.d.	n.d.
	India	3288	913.6	1240	0.60	0.52	0.19	0.436	0.419	67	53	64.0	61.5	29	36.7
	Pakistan	796	126.3	2160	0.61	0.37	0.35	0.442	0.392	65	40	77.0	60.8	36	46.8
CENTRAL ASIA	Afghanistan	653	20.0	819	0.31	0.26	0.12	0.229	n.d.	91	40	86.5	72.5	n.d.	n.d.
	Kyrgyzstan	198	4.5	1730	0.74	0.88	0.37	0.663	0.628	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
	Tadjikistan	143	5.8	970	0.76	0.88	0.22	0.616	0.575	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
LATIN AMERICA	Guatemala	109	10.3	3400	0.67	0.52	0.56	0.580	0.510	49	34	52.4	45.0	35	35.5
	Columbia	1139	36.3	5790	0.74	0.83	0.95	0.840	0.811	19	12	9.4	13.4	14	10.7
	Ecuador	284	11.2	4400	0.73	0.83	0.72	0.764	0.675	16	17	12.5	15.0	20	15.2
	Peru	1285	23.2	3320	0.69	0.85	0.54	0.694	0.656	48	11	18.4	25.7	32	22.8
	Bolivia	1099	7.2	2510	0.58	0.77	0.41	0.584	0.557	53	16	26.1	31.6	28	22.5

HDI = Human Development Index; GDI = Gender Development Index; CPM = Capability Poverty Measure; HPI = Human Poverty Index (precise definitions are given in the quoted sources)

Sources: UNDP 1996, 1997; World Bank 1996

plinary research programmes. Natural scientists try to understand each other by defining standards for measurement and by incorporating their results into a prevalent model which could be the base for a comparative high mountain geography. Lacking a universal theory, on the social science side a standardisation of methods seems to be extremely unpromising. A variety of theories and methods are applied on a meta level in solving particular research problems. The result is here that the question addressed suggests the selection of a theoretical approach which does not necessarily fit into a natural science model. In a pictorial way it could be termed as the difference between the geoecological analysis of more obvious or visible factors in space and time on the one hand, and the analysis of less visible elements in the space created by human action on the other. For representatives of both sides it sometimes becomes extremely complicated to communicate with each other.

1.3 Research directions

Despite all the dichotomies of the methodological foundations, there remain certain topics in the interaction of space, environment and human practice which pose important fields of cooperation, especially for multidisciplinary approaches. Consensus could be reached by identifying the sectors of landuse in a wide sense, forest exploitation and utilization of natural grazing grounds. The Unesco-sponsored Man and Biosphere projects (MAB-6) adopted such an approach. This threefold set might be augmented by identifying other fields such as the construction and protection of settlements and traffic infrastructure. Furthermore, multidisciplinary cooperation is required when the environment is at risk to such a degree that human activities and habitations are endangered. Investigations into settlement processes and natural hazards have become well established sections in cross-disciplinary research efforts (cf. HEWITT 1997, KREUTZMANN 1994, MESSERLI a. IVES 1997) and are instrumental for comprehension of survival conditions in high mountain regions. The challenge for mountain researchers has been formulated in Chapter 13 of Agenda 21 (SÈNE a. MCGUIRE 1997) and the scientific community is expected to provide adequate responses. In this context one of the most important fields of research are development processes in Third World mountain environments where ecological, socio-political and economic pressures are pushed forward to a substantially higher degree than anywhere else. Here the survival conditions of mountain dwellers are at stake and the understanding of livelihood strategies becomes of overall importance.

2 Suggested approximations for high mountain studies in the context of developing countries

Approaching the pressing problems from the perspective of development research, some support for a general and comparative view on mountain regions might be supported and at the same time a demand for the disaggregation of indicators and their down-scaling from the global level towards the household level is put forward. Both aspects need further discussion. The application of development indicators on peripheral areas, such as high mountain regions, might shed some light on the pressing development problems reflected in regional disparities, infrastructural deficits and unequal access to socio-economic resources. Three indicators are introduced which have been applied by the United Nations Development Programme (UNDP) in order to give a comprehensive picture about the state of development.

(i) *Human Development Index.*[2] The HDI is configurated by three equal components incorporating the per capita-income (in – Purchasing Power Parity – PPP $), the standard of education and the quality of living conditions. For our discussion these aspects are of paramount importance when projected on to high mountain regions. Generally only data at a country level are provided (Tab. 1). This statistical aggregation gives an insight in the level of development in nation states which contain mountainous regions. In a few rare cases data for certain mountain regions/provinces are available at present. In the case of Nepal (Tab. 2) such disaggregated data on a district level in all respects show an extreme difference between central places, such as the Kathmandu basin and a remote high mountain district such as Mugu. While Kathmandu ranks first in the Nepal list, Mugu district occupies the last position. Separating all districts by regional order, the Middle Mountains of Nepal including the Kathmandu Basin fare best with an HDI of 0.421,

[2] All development indicators discussed here have been introduced by UNDP. The definitions and the parameters upon which they are calculated are given in the annual publications on human development. The HDI has been modified several times. For the present discussion the latest version which has been in use since 1996 is introduced. For a regular update version of all mentioned indicators see the technical instructions in the Human Development Reports (UNDP 1990–1997) and/or the homepage for analytical tools >www.undp.org/undp/hdro/anatools.htm<.

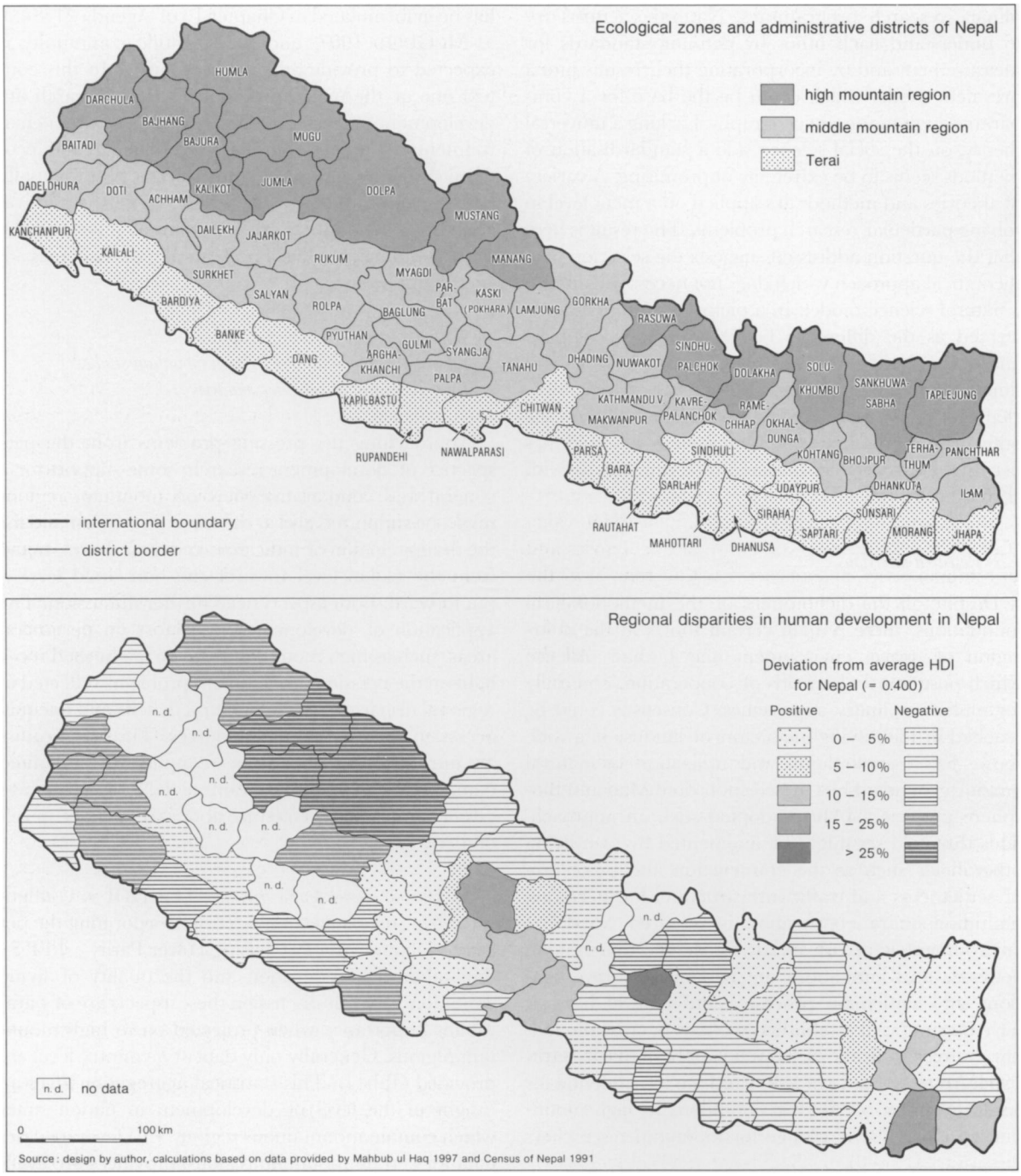

Fig. 1: Disaggregated human development indices on district level for Nepal
Differenzierte Darstellung des HDI für Nepal, aufgeschlüsselt nach Verwaltungsdistrikten

followed by the Terai lowlands (HDI 0.389), while the high mountain region as the northern belt remains on the lowest level with an HDI of 0.365. On a district level the regional inequalities between different ecological zones, as well as between individual administrative units, can be identified (Fig. 1). The capital region commands more facilities and infrastructural assets than any other while the remote high mountain districts of the western development zone remain on the lowest level. There is a significant east-west and

Table 2: Comparison of selected development indicators for Nepal, early-1990

Vergleich ausgewählter Entwicklungsindikatoren für Nepal zu Beginn der 90er Jahre

Indicator	Kathmandu valley	Kathmandu city	high mountain region (12 districts)	Mugu District
population 1991 (in 10^3 persons)	1,105	675	1,086	36
life expectancy (years)	71	74	59	37
adult literacy (% > 15 years)	68	71	37	23
HDI value	0.534	0.560	0.365	0.194

Source: own calculations based upon Census of Nepal 1991 (= Path 1993), Thapa 1995, Mahbub ul Haq 1997, World Bank 1993

lowland-highland decrease in human development while the urban centres of the capital region, Pokhara and Morang in the Terai pose exceptions.

On the contrary the Indian Himalayan province of Himachal Pradesh very much resembles the country's average, which is indicated in a similar HDI value (Tab. 3) far above Nepal's average. Both countries and all mountain regions concerned within remain in the category of "low human development" (HDI < 0.500). The lack of more disaggregated data of this kind for identifying regions and problems is obvious. All the same, the general discussion of the HDI opens important venues for future research:

– Knowledge of monetary incomes on a regional, local, and household level is an important parameter for assessing the availability of cash and market participation of mountain dwellers. The consumptive and productive patterns are linked to entrepreneurial behaviour and external marketing.

– The share of mountain communities in formal education indicates their participation in a "modern" social infrastructure. In peripheral regions this aspect of integration will have crucial importance for the future development of livelihood strategies.

– Demographic variables, such as life expectancy, are indirect indications for the supply of basic infrastructure to remote regions of difficult access. It is of less interest to search for the valley of the centennarians than to look into the accessibility of hospitals, dispensaries and the availability of medical services.

Highlighting gender-related inequalities, a Gender Development Index (GDI) has been constructed in order to show the deprivation and exclusion of women from access to basic resources and infrastructure. The difference between HDI and GDI is a measure for this gap (Tab. 1). The HDI is an appropriate measurement for the disclosure of societal deficits and indicates scope for improving equitability but does not provide any information on the groups and communities involved.

(ii) *Capability Poverty Measure.* The CPM is focussing mainly on deprived and marginalized groups within given societies which are excluded from certain services and development activities. This aspect is quite important for high mountain regions. By omitting the income-related variable, a higher emphasis is put on subsistence production in developing communities. Three equal components constitute the CPM (cf. Tab. 1):

– The indicator of underweight children under age five (based upon WHO standards) is introduced for measuring the proportion of false and insufficient nutrition prevalent.

– The second indicator of births without trained personnel is based as well on a WHO experience for assessing unhealthy forms of reproduction. Basically the substandard hygiene and medical facilities for mother and child are combined in this variable.

– The third indicator aims again at the importance of formal education. In this case the share of illiterate females in the age group above 15 years is estimated. Based upon international standards for defining the state of literacy, this parameter introduces a gender-

Table 3: Comparison of selected development indicators for India, early-1990s

Vergleich ausgewählter Entwicklungsindikatoren für Indien zu Beginn der 90er Jahre

Indicator	India	Himachal Pradesh
population (in million persons)	846	5
life expectancy (years)	60	64
adult literacy (% > 15 years)	52	51
real GDP per capita (PPP $)	1240	1180
HDI value	0.436	0.447

Source: own calculations based upon Bhandare a. Mukhopadhyay 1996, Mahbub ul Haq 1997, World Bank 1993

related perspective in the field of participation in "modern" infrastructure.

Quantitatively and qualitatively adequate food supply and a healthy and safe environment for human production and reproduction enhanced by basic educational facilities remain the prime and equally important indicators for the capability poverty measure. By its application in high mountain regions the share of people who are excluded from basic social infrastructural assets could be given for a comparative perspective and for identifying development deficits. So far no studies on a disaggregated level have been undertaken by applying this newly-introduced indicator.

(iii) *Human Poverty Index*. The HPI is the latest addition in the set of UNDP indicators and is meant to complement the poverty debate with non-monetary parameters (cf. Tab. 1). Thus it puts emphasis on the aspect that the rise in cash incomes does not necessarily indicate an elimination of poverty. The basic dimensions of poverty and human deprivation are addressed in the HPI:

– Life expectancy is taken again as a measure for the overall living conditions.

– The restricted access to basic educational facilities reflected in the prevalence of illiteracy is covering the education dimension.

– The absence of a minimum standard of living is related to the deprivation from accessible public and private amenities. Here a new indicator occurs which is subdivided into three variables such as access to health services, provision of safe water, and the share of under- or malnourished children below the age of five.

In a similar manner, as in the case of the HDI, the attention is directed to the survival conditions, the improvement of formal education and the quality of life.

By identifying the spectrum of development indicators and by projecting them towards high mountain regions, a wide variety of research topics for these remote and marginalized areas can be identified. All are emphasizing different aspects but are related to the basic development goals; thus on a country level they vary to some extent (Fig. 2). In our discussion they were mainly referred to as a tool for further enquiries on different regional levels. At the same time they display a variety of possible approaches and methods in defining comparable indicators for development.

The mountain periphery is especially characterized by environmental extremes, harsh and risky conditions for production and reproduction as well as participatory remoteness from decision making and centres of power. On the one hand, high mountain regions offer niches without any competition for the collection and production of specialized items, on the other hand they are endangered niches when accounting for demographic and socio-economic destabilization. As they are extremely dependent on external supply their sustainability is at stake, but the factors regulating this development are not at all the ones controlled by the mountain dwellers alone. Here the exchange relations and the overall incorporation of mountain regions into nation states cannot be neglected and has to be investigated further.

Based upon these considerations current fields of research emphasizing the livelihood strategies for survival in high mountain regions could be identified. In a preliminary manner the three following should be included from a cultural-geographic perspective:

(1) Territorial appropriation, settlement strategies and population change: demographic processes in high mountain regions are always related to the vital transition and mobility phenomena. The pioneering extension of settlement niches and utilization of marginal resources at the upper limit of cultivation are linked to migration of individuals and communities: regions of disasters versus regions of refuge versus regions of opportunity (cf. EHLERS 1995, HEWITT 1997, KREUTZMANN 1994, 1995, 1996b, LIBISZEWSKI a. BÄCHLER 1997, SKELDON 1985, SÖKEFELD 1997, UHLIG 1995). Narrowing the room for such manoeuvres brings boundaries and conflicts into the picture. Consequently the aspects of majorities and minorities, of state power versus group interests, and of socio-cultural participation and political marginalization are gaining importance. When certain developments such as the globalization of international trade and the regionalization of economic cooperation are followed by a modified role of the nation state, then socio-political deprivation of peripheral areas becomes of prime interest for a development-related high mountain research.

(2) Entrepreneurship and livelihood strategies: projecting the demand for an overall satisfactory economic provisioning onto agricultural and nutritional sustainability in high mountain regions, general aspects of division and allocation of labour as well as participation in food resources become prominent (cf. from the Hindukush-Karakoram-Himalaya BISHOP 1990, DITTRICH 1995, HERBERS 1998, HERBERS a. STÖBER 1995, NÜSSER a. CLEMENS 1996). Securing adequate means for survival is part of a strategy in which the local agricultural production sector and the gender proportion in domestic tasks are as instrumental as the generation of external monetary and material incomes and their distribution among household members.

(3) Resource management and energy supply: the provision of a permanent supply of energy resources

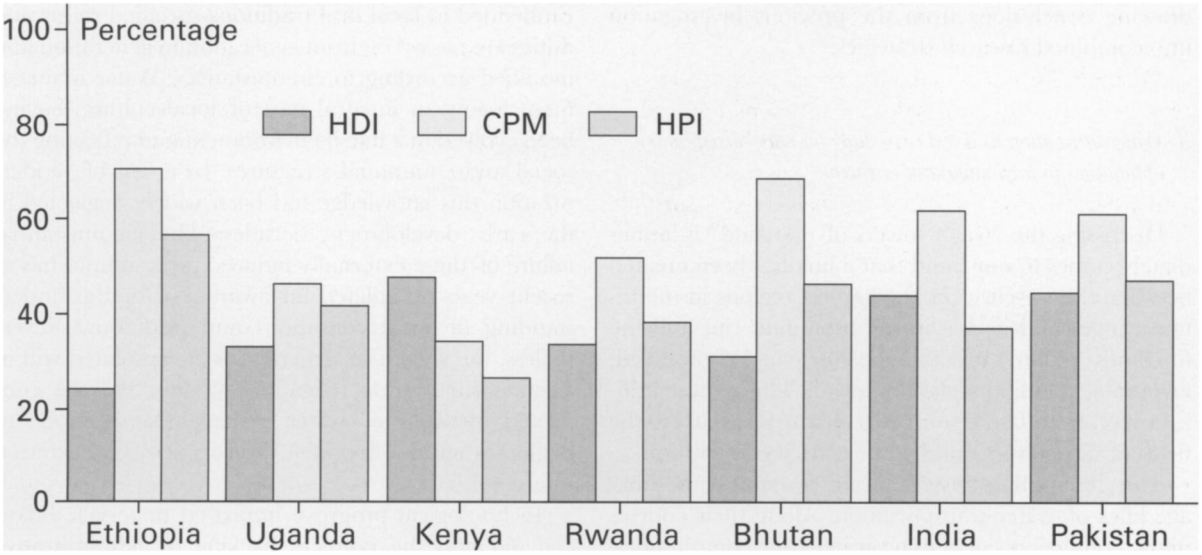

Fig. 2: Comparison of development indices for selected countries*)
Vergleich von Entwicklungsindizes für ausgewählte Staaten

cannot be guaranteed with a growing demand by utilizing traditional sources (cf. SCHICKHOFF 1995). New solutions and the tapping of under-utilized sources are required to sustain the increasing needs in all segments of society either living in the mountains or in the foreland (cf. SCHWEIZER a. PREISER 1997). The availability of natural resources and their distribution among entitled communities and households is a field for substantial conflicts at different scales. Water and timber represent two items which are the target of different groups. Without a substantial state intervention and protective measures marginal groups can easily be sidelined in the competition for dwindling resources.

These three fields have been chosen to illustrate where future research in high mountain regions could be directed. Multi-disciplinary approaches have been introduced lately and are being implemented in a number of international research programmes only to mention the "Dynamics of Landuse/Landcover Change in the Hindukush-Himalaya". In a further step the case of water management is exemplified by

*) Explanation of indicators: All indicators are composed of three equally valued components reaching a combined maximum norm of 100 percent. The lowest possible value is 0.

The Human Development Index (HDI) is constructed of a normed value of standard of living measured in Purchasing Power Parity (PPP $), of a life expectancy (at birth) value, and of an education index (this is created by valuing the alphabetisation of adults double compared to the school attendancy quota). All three componets are embedded in norming formulas to construct a simple and comparable indicator. Countries with low human development are those where the HDI ranges below 50 percent. All countries represented in Fig. 2 belong to that category. Contrary to the HDI which suggests better development standards with high nominal values the other two indexes presented here indicate serious deficiencies while featuring high values.

The Capability Poverty Measure (CPM) estimates the size of groups excluded from social services and development efforts. The CPM adresses three dimensions of neglect for giving the percentage of deprived persons: underweight children below age five, births without trained personnel, lack of formal education (measured in female illiteracy above the age of 15). A low value of CPM indicates smaller groups of deprived persons than in countries with a high value. In Fig. 2 Kenya features the lowest value with one third of the population deprived while in Ethiopia more than two thirds of the population are excluded from basic facilities.

The Human Poverty Index (HPI) measures poverty again in three dimensions. Repeating the importance of life expectancy and a restricted access to basic educational facilities as highlighted before in the HDI and CPM the third dimension of the HPI is emphasizing the absence of a minimum standard of living and constructed of three variables: access to health services, provision of safe water, and the share of under- or malnourished children below the age of five. In a similar manner as in the previous index a high value of the HPI indicates serious poverty problems.

Detailed explanations and mathematical representations are given in the latest issues of the Human Development Reports (UNDP 1996, 1997).

drawing conclusions from the previous investigation into combined research strategies.

3 *Water utilization as a test case study for cross-disciplinary approaches in high mountain research*

Discussing the "water towers of mankind" it immediately comes to our mind that a link has been created between the ice-cover of the highest regions in mountain ranges and its use in the mountain rim and the forelands. Where this relationship can be observed, favourable conditions should prevail. This remote utilization of mountain resources is mainly restricted to the fields of agriculture and hydroelectricity generation.

The "Fremdlingsflüsse" (pirate rivers) are the linkage lines of water transportation. Along their courses many conflicts occur among water-user communities, between different sectoral and regional interests and along the line of water transfer.

Focussing on intra-montane water use, we find decentralized and localized practices of water-management. Across mountain slopes water is diverted from glacier-melt reservoirs towards irrigated terraces. Steep gradients of water flow and limited space for cultivated fields at the upper limit of agricultural feasibility are characteristics of mountain irrigation.

In order to study environmental and societal change in mountain regions the organization of water-user communities, their rules and regulations in a given watershed and conflicts among different groups give an important perspective on these processes. Before entering this field the interrelationship of socio-economic parameters with environmental ones has to be highlighted. Frequently a discussion of hydraulic resources within mountain areas restricts itself to the natural features and its quantitative properties. For an assessment of the development potential within water communities the perspective has to be broadened.

3.1 Observations and sensitizations

The inhabitants of arid and semi-arid mountain regions depend on irrigated agriculture to a substantial degree in order to safeguard their survival within their high-altitude habitat. Different approaches to the utilization of local water resources can be observed in remote regions. Some of the most ingenious and highly sophisticated decentralised irrigation systems form the basis of communal life at the upper limit of human habitations. The expertise concerning the techniques and social frameworks is normally unrecorded and is only common knowledge to the user communities. Embedded in local oral traditions specified rights and duties are passed on from generation to generation and modified according to circumstances. Water management forms an integral part of local culture, having been evolved in a harsh environment and reflecting the social and communal structures. In a feat of modernization this knowledge has been widely neglected in the early development decades. The circumstantial failure of these externally induced programmes has in recent years stimulated an awareness for the understanding of local conditions and traditions. Nevertheless, the wealth of experiences encapsulated within existing small scale irrigation systems and the connected methods of water management is prone to neglect when development projects act as an external force.

Technological progress, improved materials, financial aid and the political backing of administrative bodies pose a strong force to supersede existing user communities or to develop "their" agriculture. The present time is confronted with the competition from different approaches to development. The pace of change seems to be quite fast and research operates between understanding local techniques and social organization on the one hand and the implementation of development programmes and application of blue print approaches on the other. Symptomatic for the scenario in irrigation development seems to be a three-step sequence:

(1) Traditional water management strategies in remote mountain regions have been the result of an adaptation process to environment and societal conditions.

(2) Growing socio-economic pressure on local resources and augmented exchange relations between highlands and lowlands enhance the permeability of local societies and their structural set-ups.

(3) External funding from public and supra-regional resources in a wider community affects the system and enables projects to be implemented which would have been declared unfeasible under local considerations. Failure of these projects results in increased external efforts from NGO and public institutions in planning and development exercises.

Attempts to establish sustainable and equitable development by using appropriate technology go back to fundamental local knowledge. Some materials have been presented in scattered publications (COWARD 1990, 1991, KREUTZMANN 1996a, MITCHELL a. GUILLET 1994), but an overview of the spectrum of autochthonous methods of communal resource management, and their interrelationship with or impact on social organisation, is still lacking.

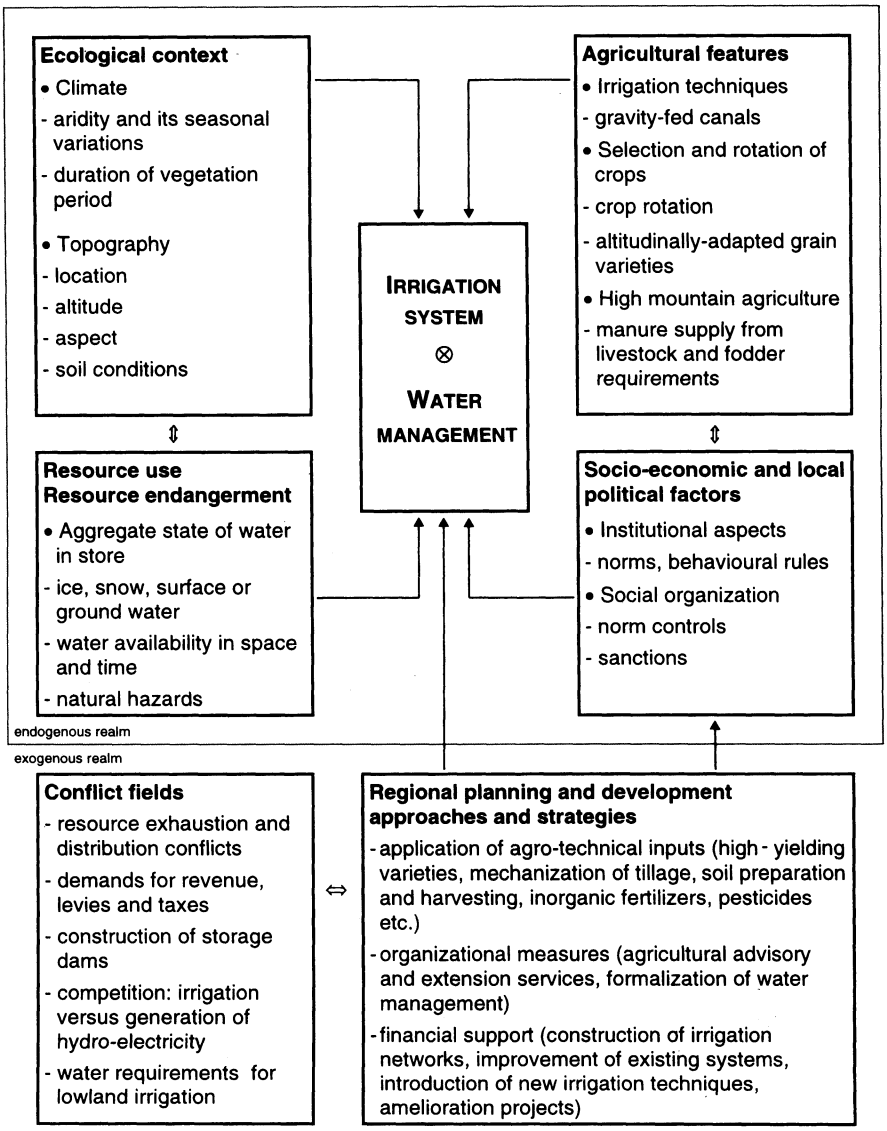

Fig. 3: Water management in high mountain ranges: system elements
Systemelemente der Bewässerung in Hochgebirgen

Suggesting a first step, an analytical framework for the study of irrigation systems is presented which has been applied and tested in High Asia.

3.2 Elements of a conceptual framework for the study of mountain irrigation systems

Water management is concerned with the energy-efficient transportation of hydrologically exploitable resources from the upper zone to thermically favourable areas where irrigation helps to supersede arid conditions for the cultivation of crops and watering of meadows. The task is to tap the water towers of mankind for supporting the livelihood strategies of mountain dwellers. In other words: human intervention sets the stage for the allocation of water from a wider catchment area in a smaller habitat where this resource is deficient.

Six fields have to be identified for the description of relevant parameters influencing an irrigation system (Fig. 3). Four elements belong to the endogenous realm. In the ecological frame, climate and topography are the basic factors in defining aridity and the duration of vegetation periods as well as localized features of

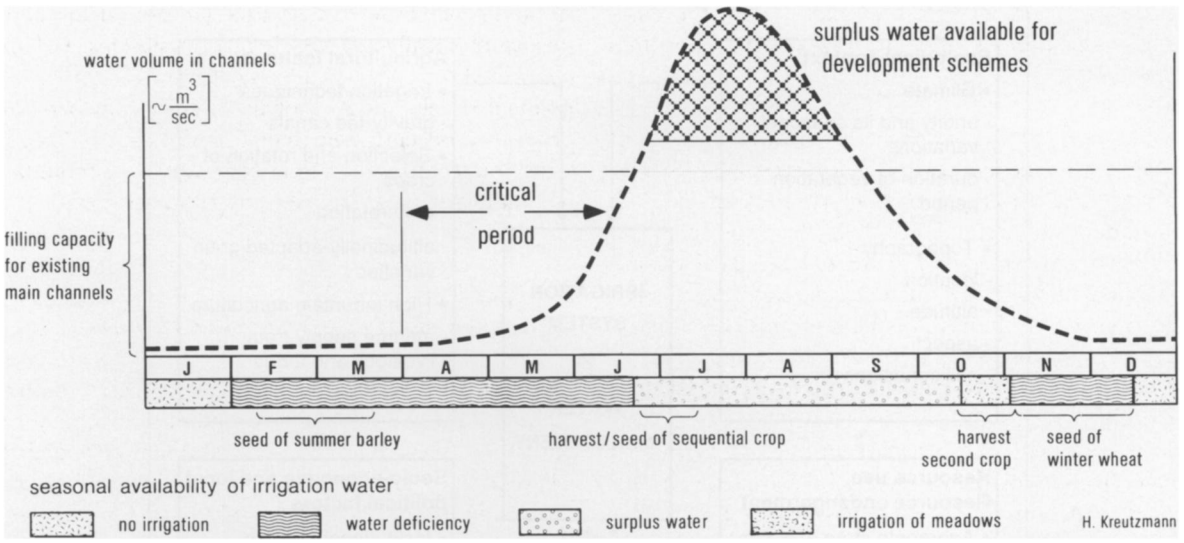

Fig. 4: Seasonality and deficiency of water availability in an arid mountain region
Saisonalität der Wasserbereitstellung und das Auftreten von Mangelsituationen in einer ariden Hochgebirgsregion

water resources and their allocation in the cultivation zone. The resource utilization is driven by use and endangerment, such as the aggregate state of water in store, its spatio-temporal availability and natural hazards.

On the opposite side we are confronted with factors from the agricultural sector. Irrigation techniques and the selection of crops connected with rotation patterns are key elements of mixed mountain farming in arid regions. Hidden behind these more obvious factors of mountain farming are invisible socio-economic properties such as the institutional aspects and local political constellations. They emulate norms, rules and regulations as well as sanctions. These four system components form the inner circle and are augmented by two exogenous boxes basically affecting the social side of water management. External influences appear in the shape of regional planning and development strategies brought into mountain regions through national development funds and aid supply. They are triggering social change in the agricultural sector through agro-technical inputs, organizational intervention and last but not least financial support. These aspects should not be neglected as they compose the enigma of modernization and produce the agents of significant change in high mountain agricultural systems. A second external factor is described as fields of conflict and contains a substantial group of relationships between mountain farmers and the state. Besides taxation and local administration we find here so-called national interests, which are often superseding local interests such as the construction of major water reservoirs and the generation of hydroelectricity for the lowlands.

This systematic approach has been tested in different case studies in the Hindukush-Karakoram and Himalayan ranges and given results which have shown the importance and necessity of interdisciplinary co-operation in studying complex systems. Only a few aspects should be highlighted here. Four examples are selected from predominantly agricultural relevance.

(i) *Crop water requirements*: There remains the popular error that water shortage does not occur for decentralized small-farmer irrigation systems in a mountain environment where only 1% of the available land is cultivated. In that case there should be sufficient resources to irrigate those few terraces properly throughout the year. This assessment holds true especially for the Karakoram where we find the most extensive glaciation outside the polar regions. Nevertheless even here water scarcity is well-known and affects the selection of crops. Traditional crops well-adapted to high mountain conditions have remained barley, wheat, millet and peas. They compose the traditional set, while potatoes, beans and maize have been introduced much later, the latter requiring higher amounts of irrigation.

(ii) *Seasonal water availability*: Even by selecting those low-demanding crops, water deficiency is a well-known feature in the Karakoram. We find an irrigation schedule which is characterized by scarcity and surplus periods. The system of cultivation can only be grasped when taking into consideration the vegetation growth

period governed by climatic factors. Here the combination of ecology and farming practices becomes important.

(iii) *Seasonality and deficiency*: Even when these properties are understood, it is not necessarily obvious what kind of development potential remains (Fig. 4). The amount of water available in the growing season governs the development potential of areal expansion and increase of productivity. Here we find the specific case where the FAO experts promised to build a channel and subsequently double the cultivated land of a village. The only flaw was that there was only surplus water for a very short period as all water was already allocated through traditional water rights (cf. Fig. 4). No single hectare of land was cultivated through this scheme, and thus the permanent basis for crop cultivation could not be increased. This case describes a situation when water towers are visible and promise ample supplies but at the same time invisible rules and regulations create a reality of scarcity.

(iv) *Rules and regulations*: They become extremely important in understanding the tasks and social differentiation of water user groups. They are the most hidden features but obviously very essential. The late ROBERT NETTING (1974) called it "the system nobody knows" in one of his famous contributions to irrigation studies. There is some paradox in his statement. Basically it is a system everybody knows who is concerned with it or is at least a part of it. But the set of rules is nowhere written down, and only because of this researchers and development practitioners run into difficulties because they do not know it. We can find these features of irrigation societies in many mountain irrigation networks and as well in High Asia. The set-up reveals the complexity of a system that seems to be rather easily understood at first sight.

3.3 Conclusions

The existence of locally invented irrigation systems within the harsh mountain environment has been neglected over long periods due to the attribution of backwardness and limited growth orientation towards remote valley societies. Only within the last decade has awareness substantially grown and a deficiency on accessible information about their cultural and socio-economic foundations is ubiquitous. In recent years development agencies implementing integrated rural development programmes have tried to build on local knowledge and to emphasize cooperation with farmers in order to serve their felt needs. In sum, there appears to be an increasing demand to understand the complexity of locally-adapted irrigation systems and the connected societies which could serve as a nucleus for regional development involving a shift from big-scale projects to decentralised activities. One has to keep in mind that complexity and variety within the mountain habitat form one of its principal features.

4 Perspectives: Focus on livelihood strategies in mountain households

The overview of the development of high mountain research and the difficulties of multi-disciplinary cooperation has uncovered shortcomings and deficits when development aspects come into focus. The statement should be taken as an advocacy for increased research activities within the fields identified. The central problems of sustained livelihood strategies in a changing habitat and economic sphere can be measured while applying a set of socio-economic indicators for the development of peripheral high mountain regions. The importance of exchange relations and the degree of external intervention is contained there whilst being projected on the regional situation. The interrelationship of local, regional and supra-regional to global factors continues to form the basis of understanding the survival conditions in remote high mountain regions. The same applies for the development problems of peripheral regions in general.

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