

## **Water towers of humankind research perspectives on hydraulic resources and future development in High Asia**

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### **ABSTRACT**

**The wealth of hydraulic resources stored in glaciated high mountain regions disguises the fact that water management within arid mountain areas can be quite complex and characterized by deficiency symptoms. Scarcity of available water resources could be explained from different systems properties such as ecology, agricultural practices, socio-economic set-up and experiences with resource utilization. External forces and fields of conflict tend to modify the framework. The systematic approach is projected on the conditions in arid high mountain regions and the prevalent forms of agricultural practices there.**

**Keywords:** irrigation, water management, development strategies, High Asia

### **INTRODUCTION**

The "International Year of Freshwater Resources" 2003 was announced by the United Nations following an application and suggestion by the Government of Tajikistan. Although the "projected water scarcity" map (Fig. 1) of the International Water Management Institute (IWMI) in Colombo shows Tajikistan in a position of little or no water scarcity the water issue is a very valid one for Tajikistan. During the Soviet period Tajikistan was identified as a poor republic which could supply only natural hydraulic resources to the economy of the Soviet Union. Large scale projects were laid out and the water of the two major Central Asian rivers, Amu Darya (Pjandsh, Oxus) and Syr Darya (Jaxartes), was directed to the extensive irrigation projects close by the Aral Lake. The second option was generating hydro-electricity through a cascade of nine major dams and lakes of which Nurek dam at the Vansh river was accomplished and Rogun is still under construction. Tajikistan was meant to be a sole supplier of water and related products to neighbouring republics. Irrigation and water management within the Pamir mountain valleys was neglected. Presently Tajikistan has become aware of its valuable hydraulic resources and realizes that domestic water use is an issue of national and regional interest. The "water towers of humankind", i.e. the ice-covered mountain ranges of High Asia, have come into international focus. The IWMI map (cf. Fig. 1) is not reflecting the importance of these mountain regions for the survival of lowland societies as it projects a demand-driven and not a resource-availability-related state of affairs for the future. The connexion of mountain resources with the

demand in lowland subtropical agriculture is significant for the Himalayan forelands of South Asia. The single largest irrigation network of the world is mainly supplied from these resources.

Discussing the "water towers of humankind" 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 (Kreutzmann 2000a, b). Where this relationship can be observed, favourable conditions should prevail. This utilization of mountain resources which are highly esteemed out of the place of their origin is mainly restricted to the fields of agriculture and hydroelectricity generation. A strong dependency on montane water is the result of allocating these fluid resources.

The pirate rivers are the linkage lines of water transportation. They are fed by far away water reservoirs to supply agricultural oases in arid or semi-arid regions. South Asia is one of the prime examples of monsoonal regimes and regions depending on the waters from the High Asian mountain system feeding the rivers providing the life-generating resource to irrigated oases of the lowlands in the Indo-Gangetic plains. Along their courses many conflicts occur among water-user communities, between different sectoral and regional interests and along the line of water transfer. Some of the largest irrigation networks are to be found in the forelands of the Himalayan arc. Generally irrigation is discussed in a context of major grain chambers.

In this contribution attention will be drawn to intra-montane water use where a smaller scale applies. Here we find decentralized and localized practices of water-management. Across mountain



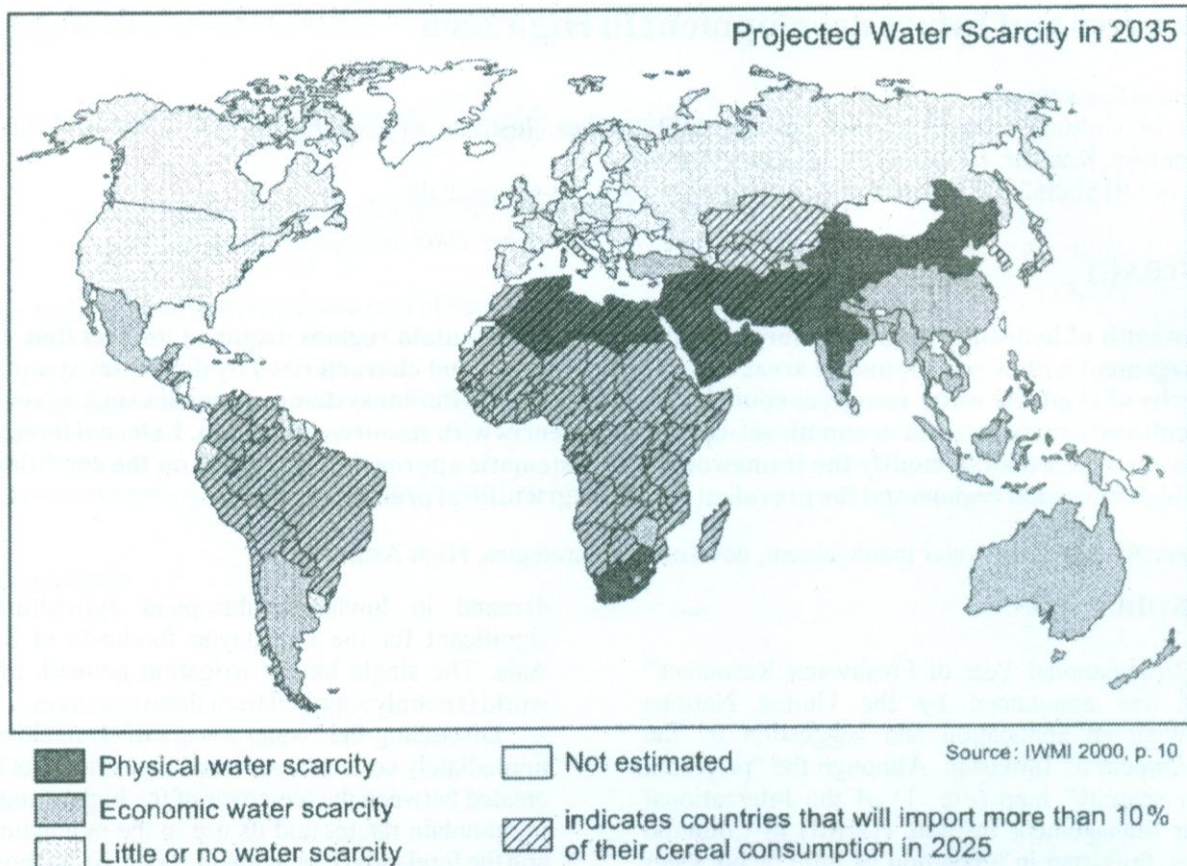


Fig. 1: Projected water scarcity in 2035

slopes water is deviated 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 (cf. Kreutzmann 2000b). 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.

#### 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 (Kreutzmann 1999). The expertise about the techniques and social frameworks is normally unrecorded and only common knowledge to the user communities. Embedded in local oral traditions specified rights and duties are passed over 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 modernisation this knowledge has been widely neglected in the early development decades. The circumstantial failure of these externally induced programmes has stimulated in recent years 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

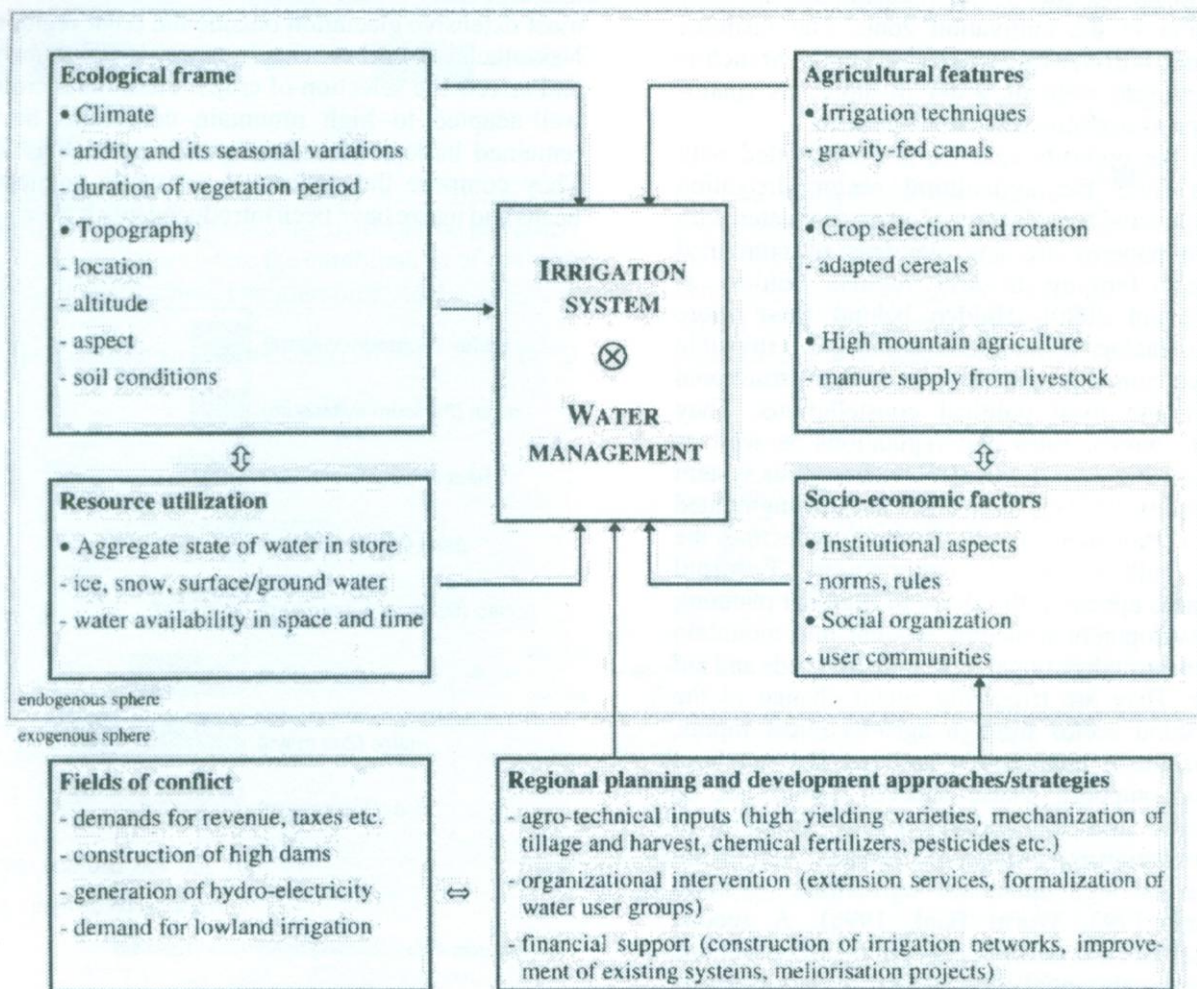


methods of water management is prone for neglect when development projects act as an external force. Technological progress, improved materials, financial aid and the political backing of administrative bodies pose a strong force to supersede existing user communities or to develop "their" agriculture. The present time is confronted with the competition of 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: Traditional water management strategies in remote mountain regions have been the result of an adaptation process to environment and social conditions. Growing socio-economic pressure on local resources and augmented exchange

relations between highlands and lowlands enhance the permeability of local societies and their structural setups. 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, 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.

Suggesting a first step, an analytical framework (Fig. 2) is presented delineated for the study of irrigation



Design: H. Kreutzmann

Fig. 2: Water management in high mountain ranges: system elements



systems which was applied and tested in the Hindukush-Karakoram-Himalaya region.

### 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 climatically favourable areas where irrigation helps to supersede arid conditions for the cultivation of crops and watering of meadows. 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. 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 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 combined mountain farming in arid regions (Ehlers & Kreutzmann 2000). 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 (Coward 1990, 1991). 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 (Vincent 1995, World Bank 1996). 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 Karakoram and Himalayan ranges and given results which have shown the importance and necessity of interdisciplinary cooperation in studying complex systems. Only a few aspects should be highlighted here. For our brief discussion four examples have been selected from predominantly agricultural relevance.

1. *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 (Fig. 3). They compose the traditional set while potatoes, beans and maize have been introduced much later.

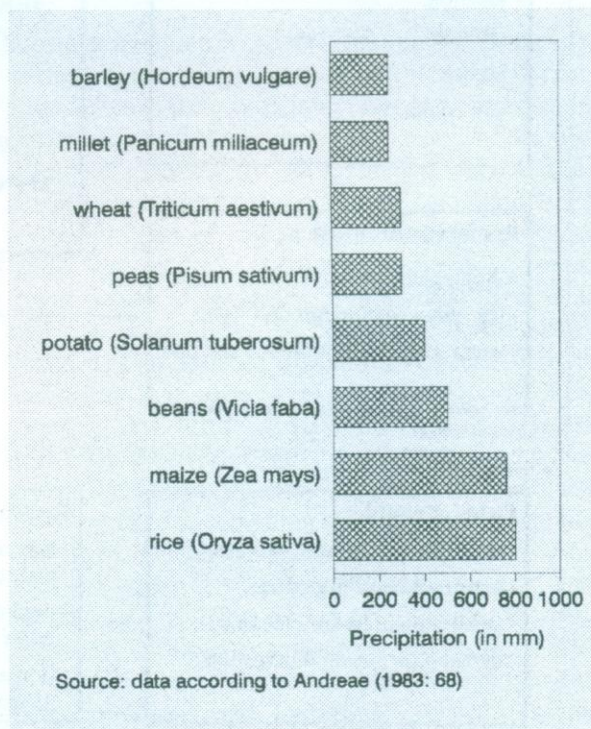


Fig. 3: Crop water requirements



2. *Seasonal water availability:* Even by selecting these 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 (Fig. 4). The system of

properties are understood it is not necessarily obvious what kind of development potential remains (Fig. 5). The amount of water available in the growing season governs the development potential of areal expansion and increase of productivity. Here

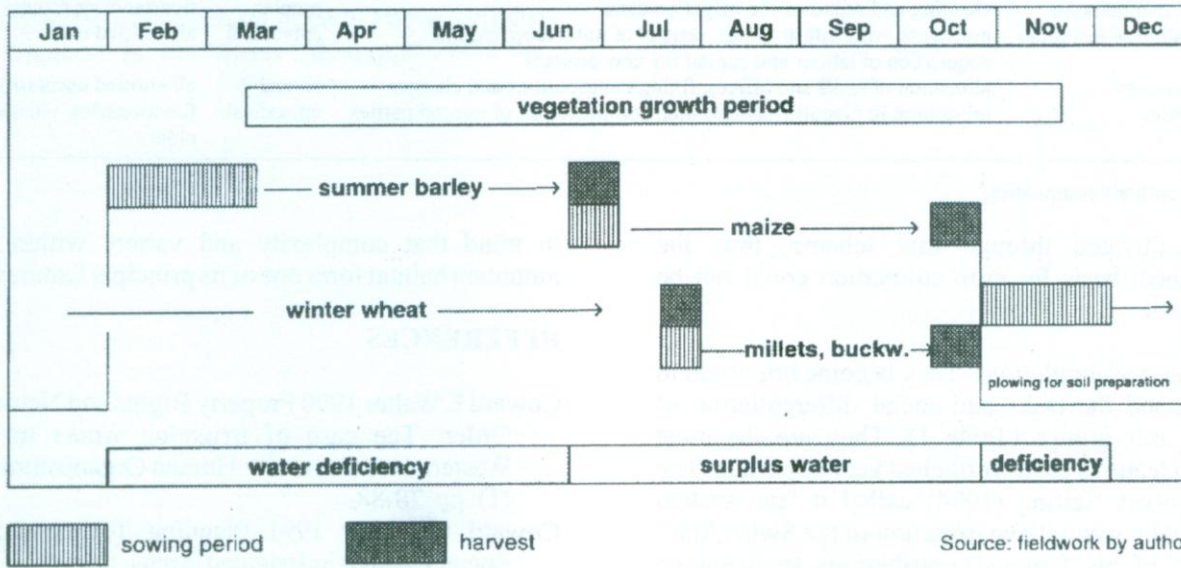


Fig. 4: Irrigation and crop rotation

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.

3. *Seasonality and deficiency:* Even when these

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. No single hectare of land

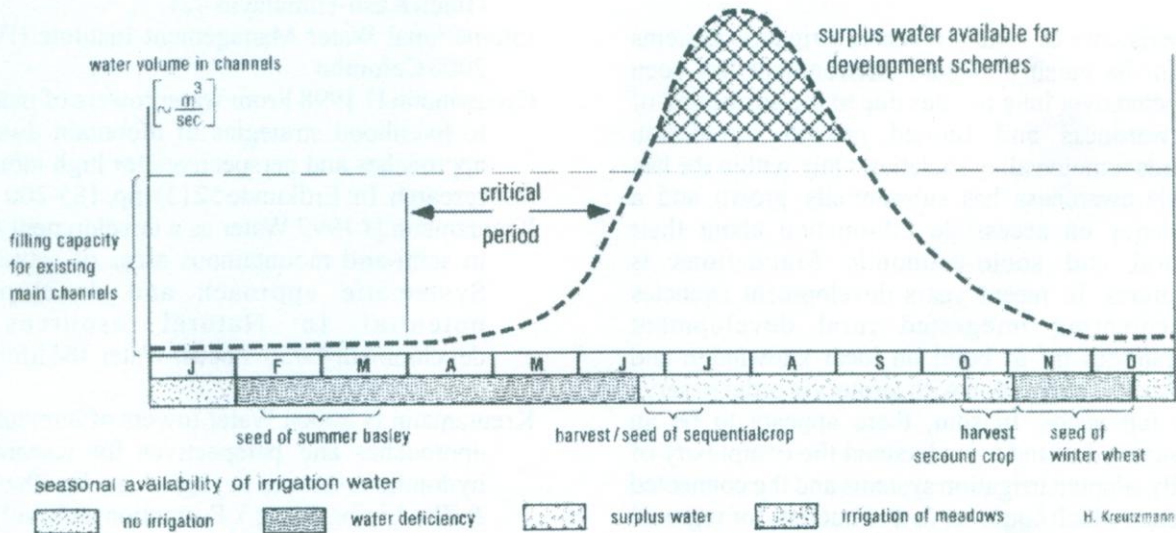


Fig. 5: Seasonality and deficiency



**Table 1. Institutional and organisational aspects of water management**

Institutional and organisational fields	areas of responsibility	Duty schedule	Participants
tapping of water water distribution	construction of new and extension of existing installations distribution of irrigation water according to agreed schemes, observance of the irrigation plan	singular regular	user groups functionaries
care and maintenance mobilisation of resources	cleaning and repair of the irrigation canal assistance with catastrophies, control of unforeseen events, acquisition of labour and capital for new projects	regular episodic	riparian/user groups all entitled users
administration Jurisdiction	allocation of tasks and offices, fixing contributions and charges arbitration in disputes, sanctioning, compensation of injured parties	annual episodic	all entitled users ( <i>jirga</i> ) functionaries, village elders

Source: author's compilation

was cultivated through this scheme, thus the permanent basis for crop cultivation could not be increased.

4. *Rules and regulations*: They become important to understand the tasks and social differentiation of water user groups (Table 1). They are the most hidden features but nevertheless very important. The late Robert Netting (1974) called it "the system nobody knows: village irrigation in the Swiss Alps" in one of his famous contributions to irrigation studies. There is some paradox in his statement, basically it is a system everybody knows but which is nowhere written down and only because of this researchers run into difficulties because they do not know it themselves. 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 on first sight.

#### Conclusions for further research

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 awareness has 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 try to build on local knowledge and 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.

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