The *Culture Area Karakorum Scientific Studies* series presents, in English or German, selected results of research being conducted in the high mountain regions of the Karakorum, Hindukush, and the Himalayas, in Pakistan and in the adjoining countries. The interdisciplinary approach involving cultural and environmental sciences offers the opportunity to arrive at a deeper understanding of the relationship between the high mountain environment, man and culture as well as on the changes occurring in the past and present.
Table 3: Cost/kW and Cost/kWh of Selected Identified Schemes

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Total: 329.5 2,175.33

(Based on Preliminary Estimates)

Hydro-Logic in the Northwest Himalaya: Several Case Studies from Zangskar

Kim Gutschow

1. Introduction

Irrigation systems are ideal examples of what one might call the humanized landscape. Although climate, physical topography, soil type, and other aspects of nature largely determine the amount of water available in a given system, the actual pattern of culverts, sluices, and reservoirs which channel, distribute, and store this water are profoundly human constructions. The resultant pattern of water allocation can be read as a type of 'hydro-logic'. I suggest that a hydro-logic is more than the logical skeleton of the water distribution system, though it is as well. It reflects the most profound sociopolitical relations of a society: the relations of solidarity and the forces of restraint that bind together individuals who share a common resource essential for the survival of one and all. The logic or pattern may not be articulated by those who construct or use the water distribution system. Nonetheless, where water is life, irrigation represents a primary social activity. How a community shares its water tells us a great deal about how it negotiates the common and individual struggle and competition for livelihood. These ancient 'webs of water' can be read as clues to the present social and political networks, as well as to their historical development in the western Himalayan region which is the focus of this study.

These webs of water present an insight into one of the central problematics of anthropological inquiry: distinguishing the particular or ephemeral from the more lasting aspects of a society. Irrigation schemes represent centuries of human labor, political struggles, and socio-cultural adaptation to a changing environment. The physical network of leats and channels which distribute and convey water are an 'artifact' from the past which lives into the present moment. They are like a fifth century house which is still being used. Although the house is being used in ways not intended by its original maker, the renovations, demolitions, and changed floorplans can be clues to the history of those who used it and passed it on. Similarly, irrigation systems in the western Himalaya are a distilled record of over a millenium of
human settlement in this region. Because change is a constant, we must consider settlement as a process, and not a dead moment which we can 'recover' from the past. Unfortunately, the documents available to Tibetologists - fragments of royal chronicles (rgyal rabs), monastic tax records (dgon pa'i khral yig or 'bo yig), household and monastic lineage records (chos byung), and biographies of famous monks and kings (rnam thar) - rarely record the processes of change. Generally, these records present a static or idealized picture of the past. One should not fault the authors who intentionally created such ideal pictures in an era when literature was sacred, not profane, and meant to last forever. We live in a different age and we seek different objects of knowledge. I propose that irrigation systems represent congealed records of the dynamic process of settlement in this region. These systems are not merely technological achievements which should be measured in terms of water flow or salinity rates, but also a profound record of the political manipulations by which power - in the form of water - was distributed over centuries of inhabitation.

2. Irrigation in Zangskar

Irrigation is a strict necessity in Zangskar, a region of some 7,000 km², in the Himalayas of Northwest India. Because Zangskar lies within the rain shadow created by the greater and lesser Himalayan ranges, its climate resembles a high altitude desert. In most of the region, extreme altitudes (3,200-7,000 m) and physical topography (steep slopes of scree or rock outcrops) have restricted the extent of productive surface for cultivation. Zangskari settlements are virtually determined by geomorphology. Only 1% of Zangskar's territory is potentially cultivable, while a bare quarter of a percent is actually cultivated.6

Most Zangskari settlements are confined to the alluvial fans or precepts which lie along the glaciated and non-glaciated sections of the Zangskar, Stod, Lungnag, and Tsarap river valleys. These major rivers flow in gorges cut deep below the valley floor; however, there are no mechanical devices to pump water from these gorges. Most villages take their irrigation water from smaller tributary streams (grog po) which flow from the snow fields and glaciers high at their backs.7 The watershed area of such tributary streams contains one or more settlements which share the water supply that feeds their newly cultivated terraces. The cultivated area of these settlements is defined largely by the water available in the tributary streams.8

The water supply in these tributary streams is limited by a range of factors: the quantity of winter snowfall; the distance from snowfields, glaciers, and other water sources, (i.e., springs); the topography, soil type, and amount of seepage in the streambed; channels, Actual water flow in the streambed varies dramatically by season, month, day, and even hour. Variations in sunshine and temperature are sufficient to turn a calm rivulet in the morning

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1 An oral history of Zangskar recited by the reknown minister (bgon po) of Karsha, Sonam Angebug, mentions that the earliest settlements of Rinam, Rantaksha, and Picha were founded long before the so-called Kanishka stupa in the early centuries A.D. As to the early inhabitation in Zangskar, see Osmaston (1994) as well as Francke's (1926) translation of the "bo yig", a document from Phugtal Monastery in Zangskar.


4 Zangskar is a subdistrict (pop. 10,000) within the Indian State of Jammu and Kashmir, in the northwestern Indian Himalaya. While it is now politically a part of India, it was until the mid-nineteenth century a semi-independent kingdom (like Bhutan) which lay within the wider Tibetan cultural sphere.

5 There is no meteorological measuring station in Zangskar. Osmaston (1994: 42) estimates an annual precipitation rate of 200-250 mm for Zangskar's central valley. This figure lies between that recorded for nearby Leh and Kargil. Hartmann (1983: 136) compiled meteorological statistics over thirty years (1931-1960) to determine average annual precipitation: for Leh, 115 mm/annum and for Kargil, 306 mm/annum.

6 Osmaston (1994), who studied the Zangskari climate and environment for 15 years, estimated Zangskar's cultivated territory using RVB landsat imagery. The 1971 census abstract for Ladakh District mentions only 0.6% of Ladakh's 58,000 km² was inhabited, of which only 30% was actually cultivated. Although the census divides the inhabited area into "irrigated" and "un-irrigated" portions, these terms are misleading. I surmise that "irrigated" refers to actual field space, while "un-irrigated" refers to the lucerne or hay ('dol) which grows between fields and is watered incidentally by runoff from fields or subsidiary channels.

7 There are some exceptions: Zangskari villages which lie directly on the floodplain of the Stod River, such as Yulang, receive most of their irrigation water directly from the riverbed.

8 There have been several analyses of the environmental constraints on Zangskari settlement and irrigation: Osmaston (1994, 1990, 1985) and K. Gutschow (1997).
hours into a raging torrent by late afternoon. Early in the agricultural season (March and April) only a limited supply of water is available, as the nights are still too cold to allow sufficient melting of snow fields. During May and June the water supply is at its peak, yet it begins to decline from July onwards. The streambeds in some Zangskari settlements such as Rinam and Pishu have dried up completely by the harvest in early October.

The size of most Zangskari settlements and their attendant populations is limited by the extremes of geography and water supply. Water is the critical resource which has influenced the available acreage, subsistence, and even population within Zangskari settlements. One might note that between 1971 and 1981 the total "irrigated area" of Zangskar increased from 1,671 ha to 2,049 ha.9 This increase is confusing unless one considers the deceptive nature of the census statistics themselves. The census does not record the 100 or more individual settlements in Zangskar and so one cannot trace growth in separate settlements. Since 1947, the Indian Census only lists 25 'villages' in Zangskar.10 These do not represent actual villages but rather administrative units under a single headman (mgo pa or meg dam) and may include up to ten Zangskari settlements (yul).11 Settlements which were established in recent decades, such as Phyiling thang and Bagartse in upper Zangskar, are not named individually. Instead, they are subsumed under the 25 villages listed in the census records. Therefore, the increase in 'irrigated area' noted above may be due to new settlements being established. In short,

9 See the 1971 District Census Handbook: Ladakh and, also, 1981 District Census Handbook: Kargil (Village and Town Directory). However, the 1971 and 1981 District Handbooks are problematic. Between 1971 and 1981, the census reports that the population of Padum Village declined from 682 to 139 persons, while the population of Karsha Village declined from 609 to 177 persons. As these are the two largest and fastest growing villages according to local accounts, the figures must be mistaken. Perhaps there were typographical errors in the census office.

10 In 1981, the 'inhabited area' of these 25 Zangskari 'villages' ranged between 83 and 341 hectares (ha). Note that the inhabited area, just like the number of houses listed for each 'village', is an agglomeration of statistics from several hamlets and thus appears exaggerated in size. Zangskari villages are far smaller than Ladakhi villages - 80% of which range between 100 and 1,000 ha. In contrast, Leh town has an 'inhabited area' of 5,000 ha. Statistics are from the 1981 District Census Handbook: Kargil and, also, 1981 District Census Handbook: Leh.

11 From a Zangskari perspective, a settlement (yul) has several essential elements: a guardian deity (yal lha), an altar (lha tho) for that deity, and - in many cases - a village temple (lha khang) where the Buddhist protective deities (chos skyong) are worshiped. Essentially each settlement consists of a cluster of houses and fields which belong to or are tilled by the inhabitants of those houses alone.

one should not use census figures, but rather individual studies of settlements in order to understand demographic and territorial expansion in Zangskar.12 Irrigation systems are a key to understanding village society and territory, because they are its most constant agricultural feature. While new houses are easily built and abandoned and new fields sometimes added to the existing pattern of village territory, new irrigation channels are a rare phenomenon.

3. Zangskari Settlements, Resources, and Irrigation

The reader may be wondering how irrigation systems could have been nearly stable for centuries. Irrigation schemes consist of linkages between a water source and fields, which in turn are owned by the households in a given settlement. Most importantly, the number of households has remained fairly constant over centuries and the land owned by these households is virtually inalienable. Land is still not bought or sold in Zangskar, except in its central town, Padum (pop. 1,000), and nearby environs, which have become the locus of government offices and the new cash economy. From a Zangskari perspective, the household is ideally represented by its 'main house' (khang chen or khung pa), an established unit which continues through time.13 This house is somehow eternal: even as one cannot recall its origins, one hopes it will live forever. Traditionally, land was passed down for generations within a single household, which did not divide, sell, or trade its fields. Although sibling rivalries might come and go and household fortunes wax and wane, the main house was a constant. Since fields were firmly attached to the household, human resources were distributed according to need between main and minor houses. The minor houses (khung chung) are clearly subsidiary, temporary, and can be created or abandoned by each given generation, depending on labor, land, and other resources.14 In

12 Crook & Osmaston (1994) present a detailed demographic and population survey for two settlements which uses comparisons across generations to estimate the degree and direction of change in Zangskari society. Alternatively, K. Gutschow & N. Gutschow (forthcoming) discuss how water and field rights have developed over the last century in one Zangskari village.

13 Phylactou (1989), Dollius (1989), Day (1989), and Asboe (1936), among others, discuss the centrality of the household in Ladakhi society, while Crook & Osmaston (1994) note the same for Zangskari society.

14 The minor house serves as an offshoot structure where members of the extended household reside. Aged parents and unmarried siblings would live in the minor house, although they might remain in the main house if there were labor short-
sum, new (minor) houses were built and people shifted between houses, but the land owned by a given household changed little over time.

Recent decades have begun to erode this picture. While Zangskari livelihood remains based heavily on indigenous resources – grain, butter, fodder, fuel – the outside world (Ladakh and India) is accessible and present in terms of the new cash economy. The completion of a jeep track from the neighboring district capital, Kargil, in 1980 constitutes the most dramatic shift in Zangskar's economy of this century. The road brought jobs in the government sector and army, which led to a new cash economy in the food sector. As younger sons, who traditionally had no inheritance rights, have gained jobs in the government sector, there has been a rash of new minor houses (khang chung) in the last decades. However, basic wealth is managed in terms of locally available resources, despite the introduction of food rations. The major crops grown in Zangskar are barley, wheat, peas, and buckwheat (in the higher valleys), as well as mustard seeds in central Zangskar. Besides fields, most households have livestock (yak, cows, mdzo [a crossbreed], sheep, and goats) to meet their dairy and protein needs. Further, each household owns a certain amount of hay or lucerne ('ol) which grows between the fields, an essential crop that provides winter fodder for the livestock. Last but not least, each house has a small garden (tsas) where turnips, radishes, spinach, potatoes, and cabbage are cultivated. In sum, most households are self-sufficient in terms of food, although they buy government rations from salaries available in the new cash economy.

Significantly, Zangskar's three most precious natural resources – water, fodder, and fuel – cannot be bought in the new cash economy, although they remain crucial to household prosperity and survival. One should note how villagers regulate and distribute access to these most critical resources.

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Every Zangskari village has a unique and strictly regulated system of customary foraging rights, for both the fodder (wild grasses and shrubs) and fuel (thorns, shrubs, and dung) found beyond the cultivated field space. Just as these two resources can only be tapped by the inhabitants of the village in question, so too is water only available to the common inhabitants of villages which lie along a certain streambed. These resources can only be owned communally, as is the power to amend or adjudicate breaches in this common 'trust'. In other words, there is no language of individual rights or private ownership when it comes to the most important resources. In theory, if a household or a village lost access to fuel and fodder resources in one area, it could forage in other areas. Far worse, if a household were denied water, it would not be able to obtain water from elsewhere since there is only one stream in most villages. Since water is the most primary communal resource in Zangskar, I consider its distribution as a means of exploring hydro-logic and therefore socio-political logic of Zangskari society.

Every Zangskari village has a unique irrigation system. Nonetheless, all systems share two interrelated factors: (1) the 'water allocation scheme' (chu res) or the manner in which water rights are actually divided up within village society, and (2) a set of 'water-user groups' which are the groups of individuals or houses who share water in a rotational cycle. The water allocation scheme (chu res) distributes irrigation water according to a numbered sequence of units (i.e., houses, households, or lots) for a certain amount of 'water-time'. While some schemes allocate units of water-time by house (in which the main and minor houses receive separate turns of water), other schemes allocate water by household (in which the main and minor houses

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15 Osmaston (1994: 61-71) describes the resources in and around one Zangskari village, Stongde.
16 The example of a village losing its access to shrub or fuel resources outside the village space is not merely hypothetical. In the spring of 1994, I witnessed a dispute between two villages in Zangskar, Sani and Trahan, over the foraging of thorns and shrubs (isher ma, bral ba, sit chu). Sani villagers had trespassed onto a hillside which lay beyond the cultivated area of Trahan Village, but had 'belonged' to Trahan villagers by customary law. Trahan villagers attacked the Sani villagers and stole their pictaxes, while Sani villagers responded by stealing the horse bridles of the offensive party from Trahan. Ultimately, the Trahan villagers did not bring their annual obligatory quota of thorns and brushwood to feed the cooking fires at the festival in Sani where the Tibetan canon is read each spring.
17 The word for time in the Tibetan language is chu tsho, which literally means 'water-measurement'. An amount of water in the Indian water clock, the clepsydra, served as a measurement of time before mechanical clocks were available. See Das 1992: 419.
receive a joint turn of water). In general, these units of water-time are allocated only along the 'main leats', which are the conduits that feed directly from the streambed. The smaller subsidiary channels which link the fields to the leats are not regulated by a formal allocation scheme (chures).

The water-user group forms the social backbone of the distribution system. The members of such a group share the water informally for the time specified in the rotational scheme. All the individuals in a water-user group have the same 'entitlement' to water in theory. In practice, they must negotiate the watering amongst themselves in an ad hoc and egalitarian fashion. This involves an intricate procedure whereby water-users adjust the openings in the leat and channels so as to route a certain percentage of the water to their fields while leaving a significant percentage of the water flowing in the leat for other users. The water-user group serves as the critical index of the degree of tension in the system. When a given water-user group can no longer share the water peacefully, the system is readjusted to a new level of formal sharing and the water-user group is split into smaller subgroups with each having separate rights to water.

Zangskari water distribution systems may be readjusted throughout the season to adapt to the most significant variable: the water available in the streambed. For instance, when the watering season opens in May, there is so much snowmelt that water rationing is usually not necessary. In some years, there may be no need for water rationing at all during the entire growing season, and farmers may water their fields whenever and however they wish. In most years, the snowmelt begins to decline and water supplies decrease by July, when the age-old water distribution schemes are put into effect. The seasonal variation in water supply demands a flexible water distribution scheme, since day by day, hour by hour, there is a different flow of water in the channel. Since water allocation schemes are based on an ideal of equitable water distribution, the members of every household must feel they have received sufficient water to irrigate their fields. Two opposing pressures are balanced: the streambed's variable water supply and an ideal of equitable water for each farmer. We now move to a series of examples, from simple to complex, to illustrate how the water allocation schemes in different villages resolve these pressures.

Case 1: A Small Village System – Rinam

Rinam, a Zangskari village of 48 people living in five extended households, offers a 'simple' rotational scheme. Most significantly, the irrigation scheme reflects the historical circumstances which divide the three original or 'oldtimer' households from the two 'newcomers' who settled in Rinam during this century. Most of the area cultivated by the old-timers is irrigated from a single leat, the 'mother leat' or ma yur. This leat feeds five channels flowing throughout the cultivated area. Three other leats lie below the mother leat on the Rinam streambed. Since these three are 'secondary' (i.e., more recently constructed than the millennium-old mother leat), they do not have the same right to water as the mother leat which is at the top of the system, literally and figuratively. There is no rotational scheme among the four leats. The mother leat takes water every day, while the lower three leats make do with whatever water remains in the streambed. The lower three leats each have a story of their own: the first was built in this century but abandoned due to insufficient water, the second was completed over the last three decades by a unique cooperation between a newcomer and an old-timer who share the water, and the third is a recent communal leat which feeds the government willow plantation.

Ultimately, the mother leat receives water every day which is distributed amongst the houses in a ten-day cycle. The water rotation scheme is pegged to the three old-timer households which are founding members in the village. These three households each receive three days of water, and finally

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20 A unit of 'water-time' may consist of days or easily recognizable portions thereof: dawn to mid-morning meal, mid-morning to early afternoon lunch, early afternoon to dusk.

21 Exactly how much water any user takes depends on how polite, generous, and skilled they are, as well as how many other users are out watering their fields at that given time of day.

22 The variation by month and by hour each day has a significant effect on total water available. Since fallow fields are rare, the amount of irrigated land is nearly constant each season. One finds abandoned fields in many settlements, perhaps due to increasing aridity or decreasing labor resources in this century. Only a detailed, contextual study of fields and irrigation channels within a single village can explain why fields are abandoned or created.

23 Rinam, Pipcha, and Rantagsha appear as the first Zangskari settlements in the bo yig document, translated by Francke (1926). Because this document shifts between legend and history, just as the Karsha minister's oral history does, it is not possible to identify exactly when Rinam was founded.
one newcomer, Lobsang, takes water on the tenth day.24 After the ten-day cycle is complete, it begins again and so repeats itself endlessly. The single leat system is very basic and is not readjusted throughout the season as in our next irrigation case, Karsha.25 While the mother leat is going through the ten-day cycle, the two houses (a newcomer and an old-timer) which built the new leat take alternate water on alternate days. Last but not least, the communal leat is left open every day and water trickles into and around the government willow plantation.

Rinam's hydro-logic exhibits several remarkable features. First of all, the 'original' inhabitants — the three main households which have been in Rinam since it was founded — are granted 'full' rights to water. In contrast, the two newcomers who settled in Rinam during the latter half of this century have only partial shares. The original three households each receive a total of three days water (two for their main house and one for their minor house) in each ten-day cycle.26 A subtle hierarchy is in effect: the original three houses represent a closed caste which admits no new members. There will never be more water in the Rinam streambed, so these original households do not allow anyone to join their ranks with equal status. The mother leat is not integrated into a rotational scheme with the other three leats, but runs on its own schedule without 'regard' for the other leats further down the streambed.

The second noticeable feature of Rinam's hydro-logic is that it is premised upon conflict avoidance. The ten-day rotational scheme is arranged so that a household need not share its water on its allotted day of watering.27 Since there is only one user per day, there is no danger that water will be rerouted or diverted by another upstream user (as is commonly the case in Karsha). The individual household whose turn it is to take water can decide which of its fields to water that day and then rearrange the system by opening or closing the mouths of specific channels so as to route water as it wishes. Most Rinam villagers I interviewed agreed that the simplicity of the system was responsible for the paucity of disputes. In irrigation, as in society more generally, each Rinam household balances independence with integration: its watering decisions are made privately, yet within a communal or public frame of action.

Case 2: A Large Village System — Karsha

I will now describe irrigation in Karsha, one of the largest settlements in central Zangskar. The 'village' of Karsha which appears in the Indian census, actually refers to four settlements (yul or contiguous sets of houses and fields): Karsha, Yulang, Rinam, and Sendo.28 Karsha is farmed by 40 extended families who live in 70 separate houses or residential units.29 The irrigation system of Karsha is fed by a single stream (grog po) which flows through the center of the village dividing its field space into two opposing halves, rather like two wings of a butterfly with the river down the center representing its elongated body. There are nine major irrigation leats which take water from this streambed.30 The system of water distribution in Karsha is arranged by leat or subsection thereof, and fields are given rights to water depending on where they lie within the system.31 The season begins with all fields in Karsha receiving water jointly and no water rationing at all. However, as the season progresses the rights to water are calibrated in increasing detail with fewer fields receiving water jointly. Essentially, the

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24 In the first three-day cycle, each main house (khang chen) receives a day of water turn by turn. The second three-day cycle repeats the first. In the third three-day cycle, all of the minor houses, or subsidiary branches of the main houses, receive water.

25 Rinam's water supply is so low that water distribution remains in effect all season long, once the first watering (sgrol chag) is finished.

26 One of the newcomers, Lobsang, receives the tenth day in the cycle. He gained the right to water tangentially, during a 1954 water dispute which established the present rotational scheme. The other newcomer, Ngosgrub, receives no water at all from the mother leat and must content himself with water received by the new leat he has built.

27 Since one of the Rinam households has two minor houses, they must take water jointly on one day of the cycle; however, they are considered one household.

28 The 1981 District Census Handbook: Kargil notes that Karsha 'village' has an inhabited area of 322.13 ha. Considering the cadastral maps for the four settlements noted above as well as Osmaston's RVB Landsat images (pers. comm.), I estimate the area of Karsha settlement at 220 ha.

29 The houses are called khang chen or khang chung depending on whether they are main or subsidiary houses, and deh ra in the case of a rented room.

30 While most Karsha fields receive water from the nine main leats, several fields receive water from two additional sources: the Langmi leat which comes from a watershed to the southwest, and a leat which comes from the northeast. A reciprocal relation is established between Karsha and Langmi villagers in which the 'gift' of water is repaid by an annual gift of grain. By contrast, the water coming from the northeastern leat is 'free' because the watershed flows through an uninhabited valley.

31 See figure 1 for a schematic map of the Karsha irrigation system and figure 2 for a field lying along a subsidiary channel (running above and below the field in the photo).
water-user groups are subdivided so that less members have to share water simultaneously.

In July when the snowfields have shrunk significantly, the water supply may become so low that Karsha villagers no longer can take water freely. As disputes begin to arise, there is a mechanism by which the villagers can renegotiate their water distribution system. When enough villagers have complained to the Karsha headman (mgo pa), a town meeting is called to which every household must send one member. If a majority of the participants reach a sufficient consensus at the meeting, the age-old system of water allocation goes into effect. After the meeting, a town crier ascends to a ridge top chorten overlooking Karsha Village known as pho tho gangs. As he calls out into the evening darkness, everyone in the village knows that water rationing has begun. From now on, a strict allotment of daytime and nighttime water goes into effect.

At this point the system consists of nine water-user groups which correspond to the nine major leats noted above. Each water-user group consists of those individuals whose fields lie along a major leat (yur ba) which branches off the streambed. Karsha's nine major leats are divided into two groups: (1) those four which receive water in the daytime (nyi mad chu) versus (2) those five which receive water by night (mtshan gyi chu). The leats which receive water by day lie upstream of the leats which receive water by night. The nighttime leats have a reservoir (zing) attached where water can be stored, with the exception of the last or ninth leat, which takes water to the neighboring hamlet of Yulang. The water which is stored during the night will be emptied out by opening a sluice on the following day, sparing the water-user group's members the tiresome chore of nighttime watering. During the day, the mouths of the uppermost four leats are opened and they

take most of the water in the Karsha streambed. The mouths of the lower five leats are blocked off, while the remaining water in the streambed will be diverted for communal purposes to the government willow plantations lying at the bottom of the village. At night, the situation is reversed: the mouths of the four upstream leats are shut so that all the water in the streambed flows down to the five lower leats whose mouths are opened at sunset. Those individuals who comprise the water-user group along a leat are responsible for opening and closing the mouth of the leat each night and morning using rocks, clods of earth or sod, and whatever other materials are handy (old torn bits of cloth, etc.).

When the water supply in the streambed is plentiful, all the villagers within a water-user group along a leat may take water simultaneously without much fuss. However, as the water supply diminishes even further, it becomes increasingly difficult for the members of a water-user group to irrigate their fields at the same time or within the unit of time allotted for that group (i.e., one day). Most commonly, those households whose fields lie at the furthest end of the leat (i.e., farthest from the streambed) can no longer irrigate their fields because of insufficient water supply flowing in the leat so far from its mouth at the streambed. At this time, the members of the water-user group may decide to rearrange their own water distribution scheme.

When their water rationing scheme no longer operates informally, the water-user groups along individual leats meet to refine it. This moment is not village wide, but is an independent decision made by the members of a given water-user group. Other water-user groups and their corresponding leats may reach this point of redefinition at a different moment in the season. At this time, the leat in question is divided into three sections, named according to their proximity to the streambed: upper (stod), middle (dkyil), and lower (sham). According to where along the leat a field takes its water, each field now 'belongs' to a section of the leat in question. The original water-user group along a single leat now splits into three parts, each associated with a given section of the leat. A lottery is held to set the order of three sections for the remainder of the season. After the lottery, a rotation scheme begins in which each section along the leat receives water for one

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32 The head of household is usually male. However, the head can be female if the male head is deceased, living outside of Zangskar, or if the parents only had daughters and no sons.
33 The term refers to the rocky ridge where the chorten is situated: pho means male; tho means cairn, and gangs means glacier or snowfield.
34 The ninth leat was constructed more recently than any of the other leats in Karsha. See figure 3 for an example of a storage reservoir (zing).
35 The reservoir tanks usually do not store more than a single night's water, although in times of severe water shortage the tank only may fill up halfway. In time of such shortage, villagers may water their fields at night, directly from the reservoir. Any water remaining in the reservoir at the end of the night will be let out into the fields on the following morning.
36 Three persons, who each represent one of three sections of the leat (upper, middle, lower), draw straws. The longest straw receives water first, the middle second, and so on.
day. On any given day within the rotational scheme all of the fields which lie on that section of the leat are eligible to receive water.

In an extremely arid summer, even this arrangement will fail as it becomes impossible to water all of the fields within a given section on one day. As fellow members of the water-user group divert water from the leat to their own fields, members at the furthest distance from the leat or the streambed are left high and dry. The water distribution scheme may be refined once again and the water-user group split into even smaller units. As before, each leat section now is subdivided into three parts – lower, middle, and upper.

By taking three sections and dividing each of them into thirds, nine parts are created for a leat. The new order of three parts within each section is adjusted by three new lotteries (one per section) based on the same principles as the first lottery. The rotational timing is readjusted and each part of a leat receives four hours of water. Thus, three parts are accommodated in a single day and the full rotational cycle for a channel remains at three days. This ensures that the spacing between watering does not get excessive. In theory, each field in the three original sections has access to water every three days.

Several basic themes can be discerned within Karsha’s hydro-logic: egalitarianism, flexibility, decentralized power, and consensus. First, the system provides an egalitarian amount of water to all users based on their need – since water is distributed by fields, not household. Secondly, the system is flexible, since it is adjusted using the water flow in the streambed and channels as a base measurement. Thirdly, the flexibility is directly related to the lack of centralized authority. Most strikingly, the system can be renegotiated by the consensus of the users themselves. The power to change or control the system is not concentrated in one office, but is distributed among the water-users themselves. The water-user groups who meet to readjust their system can be arranged in concentric circles. Initially, the group includes all field owners in the entire village, which is subsequently subdivided into field owners along a single leat, and eventually sections and even subsections of that leat. When informal water sharing is no longer feasible at any given level, the users may choose to subdivide their group into smaller sections to ease water sharing. This move operates in a non-confrontational manner.

These nine parts would be called ‘lower low’, ‘middle low’, and ‘upper low’ (sham gyi shan, dkyil gyi shan, stod gyi shan), ‘lower mid’, ‘middle mid’, ‘upper mid’, and so on.
Figure 2: A view of a Karsha field; it shows the characteristic pattern of field subsections (nang) as well as central median channel (star). These patterns are still visible, although it is after the harvest in late October.

Figure 3: A reservoir located in Kazar (near Tetsa); water is stored during the night for those fields which receive 'nighttime' water.

(Photos by M. Khoo, 1995)
Figure 4: An early morning view of the new leat and channels in Rinam which one dynamic newcomer has built in the last two decades. Note that in later October, the channels receive only a trickle of water which freezes overnight

(Photograph by M. Khoo, 1995)

Figure 5: A field in Rinam where the horizontal veins (yi hu), as well as subsidiary channels leading to the field are clearly visible

(Photograph by M. Khoo, 1995)
Case 3: Four Village Systems – Rizhing/Hongshe Watershed

We may now examine the water distribution scheme which encompasses four Zangskar villages along a single watershed to the east of Karsha Village. One sees that water sharing operates on several levels: within a water-user group along a channel, within an entire village, and even among several villages that share a single watershed. The Rizhing/Hongshe watershed (skong shed gyi glog po) is shared by four villages with each having its own internal systems of water allocation, as well as being part of an overarching distribution system. First off, a basic division may be made: the two upstream villages, Rizhing and Hongshe, are allotted water by day, while the two downstream villages, Tetsa and Langmi, receive water at night.

Each of the four villages has no more than 10 major houses (khang pa); thus, their water allocation schemes resemble our first case, Rinam. Water rights in these villages are pegged to the household. Hongshe has nine households (grong pa) which are divided into two water-user groups. Each water-user group consists of four households which receive water for four consecutive days. The ninth house has a separate irrigation leat because its fields lie somewhat removed from the central part of the village. After the two main groups take water for a total of eight days, the ninth house is allotted water for one day. In contrast to Hongshe's scheme, the Rizhing allocation scheme is arranged by leats and house. Depending on the number of fields owned along a leat, the 10 major houses (khang pa) and 5 subsidiary houses (khang chung) are allotted a fixed number of days or hours on each leat. Each of the four main leats in Rizhing has a fixed rotational schedule ranging between 9 and 11 days.

While Hongshe and Rizhing have daytime water rights, Tetsa and Langmi villages store the water they receive at night in reservoirs and let it out into the fields on the following day. Langmi's eight households are divided into two water-user groups: each with four member households. Each group takes water for four days, making a total cycle of eight days. In Tetsa, three water-user groups are formed: two groups each having four main houses and two minor houses, while the third group has four minor houses. Each of these three groups takes water for one day, making a total rotational cycle of three days. In sum, within a single watershed each of the four villages has a unique and independent water allocation scheme. Hongshe's cycle runs for nine days, Langmi's for eight days, Tetsa's for three days, and Rizhing's for 9 to 11 days (depending on the leat in question).

Every 18 days, all of the four villages along the Rizhing/Hongshe watershed interrupt their cycles for a 36 hour period (two nights and one day). During this period, all water in the watershed is routed along a separate leat (via Langmi Village) toward several fields owned by Karsha villages and grassland (lom thang) owned by Karsha Monastery. As the patron monastery for all of the villages along the watershed, Karsha Monastery has the privilege of having its grassland irrigated by water from a neighboring watershed. Karsha Monastery is the only landowner in Zangskar to have formal and separate water rights just for its grassland. The Karsha villagers whose fields receive water from the Rizhing/Hongshe watershed 'repay' the gift of water with an annual tribute to a nearby nunnery.

The organizing principles of this four-village hydro-logic are self-regulation and autonomy. Both Hongshe and Langmi have water-user groups in which four households jointly receive water for several days, rather than each household receiving water for a single day for instance. Because households with different numbers of fields take water jointly, their different water needs are adjusted informally within the four-day period of water

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38 Each Hongshe household includes both main and minor houses (khang chen and khang chung) which are taken together as one unit for irrigation purposes.

39 Leat A might have a rotational schedule as follows: House #A1: 2.5 days; #B1: 2.5 days; #C2 and #F2: 1 shared day; #A1: 2 days; #E2: 1 day; #G1: 2 days; and #G2 and #H2 sharing 1 day. Adding all of the days together, one can observe that the total rotational schedule for leat A is 10 days. After the cycle of 10 days is completed, the cycle starts anew. Each house in Rizhing has a separate water allotment according to the number of fields it owns.

40 The first two days of Tetsa's rotational cycle only see water distributed to Tetsa fields. However, on the third day of the cycle half of the water from Tetsa's reservoir flows down a leat (called rka mo che, i.e., the great female conduit) to the neighboring village of Kazar. On that day, four Kazar houses share the water with four minor houses of Tetsa. Conversely, a Tetsa household (known as mog dam because it was the traditional seat of the village headman) receives water from Kazar. Since my account focuses on the Hongshe watershed, I only mention the water exchange between Tetsa and Kazar briefly.

41 Karsha householders owe a tribute for the water they receive from the neighboring watershed. Karsha villagers whose fields take water from this watershed must bring a donation of grain during the annual reading of the Prajnaparamita texts or Bum at the Dorje Dzong Nunnery, which lies above Rizhing Village. Depending on whether it receives one or two turns in the water cycle, each Karsha household gives either one or four bo of unprocessed barley to the nunnery in the fourth Tibetan month when the Bum is read. A bo is roughly equivalent to 10 kg of dry weight.
allocation. This kind of unsupervised coordination allows each household to receive a 'fair' amount of water according to need, without explicit regulatory measures to ensure that members are not taking more than their share. Although each household or village is an autonomous unit, it must cooperate in an overall distribution scheme. The system is also individualized: each of the four villages has a unique water allocation scheme which is independent of the other schemes in neighboring villages. Ultimately, autonomy is not compromised when the four schemes are integrated into a shared system.

4. Irrigating Zangskari Fields: From 'First' to 'Last' Water

As soon as the snow has melted sometime in the third Tibetan month (April-May), Zangskari farmers plow and sow their fields. For the first month after plowing, the main leats and subsidiary channels are cleared of rocks and debris. The main, communal leats are cleaned out by the water-user group for that leat (i.e., the householders whose fields take water from that leat). Several weeks after plowing, the water-user group chooses a day to clean out its leat. Each household which obtains water from the leat in question must send one of its members to help clean out the leat. If a household has nobody to send due to labor shortages, it must send a fine (a thermos of butter tea and some breads) to the villagers who are working on the leat. If most of the water-user group is present, the entire leat can be cleared out in one day.

One month after the field is plowed, the most important watering, called the first watering (sgrol chu), takes place. This watering should be done so precisely that even the wealthiest families do not entrust it to hired labor, which is brought in for other agricultural tasks. If the first watering is done properly, then subsequent watering for the rest of the season is easy. Conversely, if the first watering is poorly done, the field suffers the entire season. The first watering involves a delicate and intricate flooding of the fields, which guides the water carefully through the entire surface area of the fields along an age-old pattern. The watering pattern used in Karsha is assisted by certain features which have been plowed into the field (see fig. 6). A channel (yur ba) is made along the circumference of the field, a median (star) is dug down the center of the field for carrying off excess water, and smaller veins (yi hu) are dug to carry water throughout the field.

The organizing principle of the first watering in Karsha is that the entire field should be flooded with water (up to 10 cm in some areas), leaving no portion dry but also leaving no portion with excess standing water after the process is complete. The water is let into the fields according to a standard sequence:

1. The furrow or mouth (rka or kha) of the main channel is opened to allow water to flow into one's private channel (yur ba). Opening this furrow (rka) always involves two simultaneous actions. One removes a clod of earth from an earthen dike to form a sluice, at the same time that one uses this clod to block the further flow of water down the channel being worked on.
2. The conduit (rka) of one's own field is opened to allow water to flow along the field's perimeter channels (yur ba).
3. Starting at the bottom (jug) of the field, water is let into the subsidiary veins (yi hu) which divide the field space into separate 'rooms' (nang).
4. Beginning at the lower end of these subsidiary channels and steadily proceeding upward, each subsection (thor mig) of a room is flooded.

44 Das (1992: 72) notes that yur ba'i rka is a "small furrow conveying water from a conduit to trees or plants..." He also comments that rka is synonymous with chu'i rka or chu rka. Although the term might be spelled either kha (which means mouth in Tibetan) or rka, I incline towards the latter due to Zangskari pronunciation. The Zangskari pronunciation of this term is "ha," which can only be spelled rka in Wylie transliteration. Baker (1995) corroborates this theory, for he notes that in Ladakh the term is pronounced "ska" which is spelled rka.

45 A Zangskari informant explained that thor mig refers to the small openings at the top and bottom of each square subsection of a room in the field which is flooded (see fig. 6). More generally, the term also refers to the entire square section which is simultaneously flooded. The etymology of the term is interesting: mig simply means eye; however, thor refers to the patterns created by streams of water which are gathered or released at these openings. Das (1992: 595) defines thor as "anything gathered into a single point; what is in a tangle drawn out fine" and he provides as an example of usage "thor cog or thor tshugs ... a plaited tuft of hair." One might say that the "plaits" of water are gathered into a single point as they exit the subsection, or the "tangle" of water is released and drawn out from the opening of the subsection.
5. When one has completely flooded all the subsections along a certain vein, one moves up the field to the next highest vein (yi hu) and the same process is repeated.

The entire field is flooded in this manner, which varies slightly depending on the size and shape of the field as well as the crop. A basic principle of water flow is maintained throughout. One always proceeds from the bottom to the top of a field or channel; that is to say, one moves against the flow of water. This movement upstream allows the villager to calibrate the water precisely and provides a dry spot of field to stand on.

The Zangskari farmer does not have a fixed schedule of planting although when possible, barley and peas are planted before wheat whose young shoots are most susceptible to cold snaps early in the season. After the first watering is given, watering occurs every 8-15 days, depending on the amount of water available, the farmer's own labor resources, the weather, the soil quality in each particular field, and the growth rate of the shoots. Later in the season, when water rationing is in effect, the time between watering may become more fixed due to the standardized allocation of water. While the first four waterings all have names (sgrol chu, bshags chu, gnon chu, and rgyas chu), the next seven or so waterings do not. The final watering just before harvest is called 'bru chu.' This watering serves to loosen the soil and the roots, making it easier to pull out the entire plant as is customary in Zangskari harvests. The first two waterings are precisely calibrated procedures in which women and men go into the field to adjust the flow of water evenly over the entire surface area of the field. Later watering is an automatic task in which the farmers only open or close the successive doors along the main and subsidiary channels, but do not step into the field space itself nor proceed along the subsidiary veins (yi hu) as earlier. At this time the shoots are somewhat bigger and more able to withstand an irregular flow of water over the surface area of the field.

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The names reflect the poetics of the Zangskari language: sgrol chu is 'first water', bshags chu is 'repentance water' (repenting for having not watered the tiny shoots for a fortnight or so); gnon chu is 'subdual water' (perhaps subduing the last unruly strands which refuse to grow...); while rgyas chu is 'last water' or 'after water'. Finally, bru chu means 'grain water' or the water of the ripened grains, that is just preceding the harvest.

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The organizing principle of water in Karsha: The mouth (rka) of the main channel that originates from the village stream (drog po) is opened to feed the private channels (yar ba). Starting from the bottom (jug) of the entire field, the veins irrigate the subsections (thor mig: a to b) and rooms (nung: 1 to 6), steadily proceeding upward.
5. Hydraulic Solidarity in Zangskar

Each of the case studies presented here was a kind of 'ideal type' of the actual process of watering which occurs in the villages involved. Due to constraints of space, it was not possible to present the disputes, irregularities, and exceptions which are involved within a given watering season. Nonetheless, the examples illustrated the hydro-logic which underlies Zangskari irrigation as well as the socio-politics of Zangskari villages more generally. This hydro-logic was based on varying principles depending on the scale of the village involved. The smallest case study, Rinam, showed us the village as a closed caste system, in which the original inhabitants have full rights and all subsequent newcomers are only granted partial rights. A larger system such as Karsha, is premised less on such hierarchy, but suggests other principles: a modulated, flexible system of water-user groups who are arranged in a pyramid of inclusiveness. A group that includes the entire village at the beginning of the water season moves, as summer progresses, into groups which are divided and subdivided, as fewer and fewer users can share water at the same time. The system is a remarkable solution to a recurrent problem: how to manage the ideal of egalitarian water distribution with the increasing aridity which places 'downstream' users at a disadvantage. Finally, the four-village system suggested that villages can be integrated 'seamlessly' into a more inclusive level of coordination without sacrificing their individual autonomy. Ultimately, water distribution schemes offer an index of social solidarity, tension, and hierarchy in a given community.

In conclusion, these cases give us a clue to the socio-political dynamics of Zangskari society, as much as a more obvious 'political study' might have. The distribution of water creates a corporate reality which might not be otherwise articulated. Irrigation systems mobilize what one might call 'hydraulic solidarity'. In other words, the shared patterns of water are a reflection of the most fundamental political principles that bind a community together. Not only water allocation but also political rights more generally are distrib-

uted in a manner consistent with non-confrontation, consensus-based decision making, egalitarianism, and autonomy. However, a lengthy diachronic study of Zangskari irrigation systems would be necessary before one could draw any conclusions in these areas.

The concentric levels of water-user groups form networks of dependence and solidarity, which are fundamental to the smooth coordination of so many users relying on a single, critical source of livelihood. The basic principle seems: water is distributed according to the need rather than the greed of the user. This customary pattern of water sharing can only operate within a small scale context, where the principle is shared by all users. Furthermore, the irrigation systems do not depend on a more formal political mechanism to negotiate water allocation. Most Zangskari villages do not have a 'hydraulic bureaucracy' which manages or monitors the allocation of water. There is only one Zangskari village which has a chu dpon office: Zangla, which is also the seat of one of the ancient dynasties or royal families of Zangskar. In constrast several larger Ladakhi villages have an office, known as the 'water lord' or (chu dpon), responsible for monitoring water distribution and mediating disputes.

Besides comparing the scale and type of water distribution mechanisms in the neighboring regions of Ladakh and Zangskar, one might look more broadly to societies along the entire Himalayan and Karakorum zone to see how variations in culture, social scale, political bureaucracy, religion, history, kinship, and topography affect water distribution schemes in a high montane region. A good deal of comparative research on irrigation in the Himalayan and Karakorum region remains to be synthesized. Contrasting irrigation systems in areas that share similar topography, aridity, socio-cul-

47 The term was used by Lansing (1991) in his work on Balinese irrigation. Lansing (1987, 1991) examines a hierarchical system of 'water temples' in Bali which integrates water-users throughout the island. His analysis suggests the temples maintain a hydraulic solidarity which coordinate irrigation and rice-planting all over Bali. Lansing (1991: 52) notes, "In the absence of a 'hydraulic bureaucracy' to manage irrigation, the temple system itself must maintain a kind of 'hydraulic solidarity', by persuasively articulating the common interest in watershed management...

48 Zangla's irrigation system is described by Friedl (1983) who notes the presence of a "tsur dpon." This term may refer to Zangla's chu dpon official. As one of the larger villages in Zangskar with two watersheds providing irrigation water for more than 36 households, Zangla's complicated irrigation system requires a chu dpon office.

49 Gutschow (1997) discusses the role of these lords as well as compares Zangskari, Ladakhi, and Tibetan irrigation systems.

50 One might compare irrigation schemes along the Himalayan borders such as in Mustang, Dolpo, and Humla with older descriptions of Tibetan irrigation found in Bell (1928: 36-38), Dargay (1982: 14-15), Aziz (1978: 112-113), and Curran (1959: 8). One could include descriptions of irrigation in parts of the Karakorum, such as found in Kreutzmann (1989), Parkes (1983), and Emerson (1984).
tural norms, or religion could yield interesting results. When Geertz (1972) looked at two societies (Morocco and Bali) at opposite ends of an aridity spectrum he found the key to social integration in these two societies: Bali exhibited a "pluralistic collectivism" while Moroccan society reflected "agonistic individualism." Rather than sum up Zangskari social integration so quickly, I offer only tentative observations at this juncture.

Water in Zangskar is communal property, first and foremost. Water rights cannot be bought, sold, bartered, or inherited as they can in other societies. The socio-political landscape of Zangskar is profoundly shaped by the invisible and communal webs of water-sharing to which individuals must belong and cannot avoid. Participation in a water-user group is not voluntary but a basic means to survival. While participation in a household or clan also is involuntary or prescribed by birth, individuals may switch affiliation. However, it is nearly impossible to switch one's affiliation in a water-user group. Fields cannot be moved at will, and it usually is difficult to reroute water to a specific field by changing the communal structure of irrigation channels. The water-user groups share a solidarity based on their common interest in water and thereby prosperity. This prosperity is communal, because the success of one farmer cannot be separated from that of his fellow water-users. Karma, skill, diligence, and luck play a part in differentiating the successes of various farmers. In the end, each farmer is bound by the same constraint, water, which no amount of money or karma can procure. Zangskari irrigation reflects a historical evolution of a 'watery' power, as conditioned by environmental, social, and individual factors for centuries. Its traces remain etched in this desert land today.

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51 A preliminary study of water rights in Swat, northwest Pakistan, suggested that water allocation in this Pathan, Muslim region is not unlike that described by Geertz (1972) for Morocco. Every field is allocated a set number of water-hours which can be bartered, traded, sold, inherited, or exchanged. A single irrigation system includes 800 houses and 13 major irrigation channels, i.e., tens of thousands of fields. Such remarkably complex and highly integrated systems have many disputes, not surprisingly.

52 Geertz (1972: 37) concludes that "Balinese social integration comes down to a matter of adjusting the relations among a sizeable number of differently based but similarly organized, highly corporate, cross-cutting membership groups — subaks, lineages, hamlets, castes, temple groups; Moroccan integration comes down to mediating relations among a field of competing individuals, each with a somewhat different basis of power and each scrambling to make his way within the general rules of the game by his own wit and resources."

53 A new bride (or a husband who marries matrilocaly) can and does switch family and clan affiliation.


