

Persistence, Transformation and Demise within the Gravity Flow Irrigation Systems (Kuhls) of Kangra Valley, Himachal Pradesh

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Introduction

The inability of centrally organized, large scale irrigation and afforestation programs to efficiently and equitably manage water, forest, and related resources has led government planners, non-government organizations, and researchers to turn to local, community-based resource management alternatives. The advocacy of local, co-operative management of natural resources in recent years has produced India's widely acclaimed programs for Joint Forest Management (JFM), numerous water user's associations responsible for the management and distribution of water at the delivery end of large irrigation projects, and other local management initiatives such as pani panchayats and the revitalization of irrigation tanks. The devolution of management authority to more local arenas is aimed at promoting equitable resource management and investment in natural resource systems, reducing inefficient resource use and conflict between state and local entities, and satisfying local natural resource needs. However, the failure of centrally organized resource management programs does not imply the success of local, community-based resource management efforts. Key questions remain unanswered concerning the equity effects of local resource management, the conditions under which meaningful participation is more or less likely, the nature of state-local relations and their effects on resource management and use, the role of possible interdependent or exchange relations between different "local" systems of resource use, and the patterns of investment and resource extraction associated with local resource management.

By analyzing contemporary transformations in the farmer-managed gravity flow irrigation systems of Himachal Pradesh, known as kuhls, I hope to shed light on three issues pertinent to this workshop. The first concerns participation - what it is and when it occurs. I investigate the conditions under which local participation in water management is more or less likely, the factors which influence effective participation, and local responses to the problems and conflicts associated with declining participation. The second concerns state-local relations, by which I mean the relationships between local resource managers and users, and government agencies and the civil administration. The kuhl irrigation systems reflect a wide variety of different state roles in local irrigation management. I will discuss both the nature and effects of these different state roles, the influence of the bureaucratic state on kuhl organization and the effects of that organization on local power relations. Thirdly, I address the possible adaptive functions of inter-kuhl linkages. I show that many kuhls irrigate multiple villages and many villages are engaged with multiple kuhls. I suggest that the resulting networks of interdependent kuhls can facilitate the persistence of individual irrigation systems. This may be analogous to tank irrigation systems which, when viewed at a higher scale of analysis, become parts of larger basin-wide or regional water management systems.

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The Setting

The broad, gently sloping alluvial fans which spread southwards from the base of the Dhaula Dhar range of mountains comprise Kangra Valley and create opportunities for irrigated agriculture at a scale unusual in the Himalaya. Each alluvial fan in the valley is bisected longitudinally by a stream or river originating in the Dhaula Dhar. From where these mountain torrents emerge from their narrow headwater canyons, to just before they disappear into the erosive canyons of the Sivalik Hills 10 to 15 km to the south, they each supply water to as many as 40 or 50 different gravity flow irrigation systems. These irrigation systems consist of a diversion structure, a main channel ranging in length from less than 1 to more than 40 km, numerous tertiary channels and hundreds of named distribution points. According to the *Riwaj-i-Abpashi* (Book of Irrigation Customs), compiled as part of the 1915 settlement of District Kangra, approximately 715 kuhls irrigate multiple villages and more than 2500 kuhls irrigate single villages. More than 30,000 hectares in the valley are kuhl-irrigated.

The initial construction of the longest and most complex kuhls was occasionally sponsored by members of the pre-colonial ruling Katoch lineage during the late 17th, 18th and early 19th centuries (Baker 1994:159). However the majority of the kuhls in Kangra Valley were constructed without state patronage either by local elites or collectivities of farmers. At least by the beginning of British colonial rule in Kangra in 1850, responsibility for managing and repairing each kuhl rested with the cultivators of the land the kuhl irrigated (Coward 1990:81-82).

All kuhls require annual maintenance and repair. For most kuhls this is accomplished with communal work parties organized and supervised by the *kohli* (watermaster). Each kuhl's channel(s) must be cleared of debris, vegetation and the sediment deposited by the previous year's flow. Weak channel sections must be shored up. Additionally each kuhl's diversion structure or headworks must be rebuilt at least once a year, and often several times during the monsoon if annual streams do not alleviate irrigators' dependence on perennial streams for irrigation water. In addition to mobilizing the communal work parties necessary for maintaining and repairing the kuhl, the *kohli* is also responsible for performing the religious ceremonies associated with kuhl management, for supervising the transport and distribution of water in the kuhl, and for resolving conflicts between farmers regarding water use.

The 39 kuhls which divert water from the Neugal River irrigate approximately 5,000 hectares distributed across more than 240 hamlets located within the 85 square kilometer Neugal basin. Kuhls vary dramatically in terms of the productivity of the land they irrigate, the availability of alternative post-monsoon sources of water, the scale and scope of coordination required for managing the kuhl, and the degree of social and economic inequality among the kuhl's irrigators. Some kuhls irrigate highly productive rice and wheat growing fields located along the banks of the Neugal River (locally referred to as 'har' areas). Other kuhls, after traversing the fertile riverine terraces, transport water several km. to irrigate less fertile agricultural areas on the ridges and plateau tops above the Neugal River (locally referred to as *larh* areas). In some hamlets annual streams flow after the onset of the monsoon. They reduce irrigators' reliance on water transported from the more distant perennial rivers during the rainy season. Some kuhls irrigate only a portion of one hamlet's cultivated area, other kuhls irrigate land distributed across multiple hamlets. The irrigators of some kuhls are relatively homogeneous in terms of caste and wealth distribution. The irrigators of other kuhls are characterized by relatively unequal land distribution patterns which often follow caste lines. These inequalities are exacerbated when upper caste farmers cultivate the headend areas of a kuhl's command area and lower caste farmers cultivate tailend areas.

Grain production in Kangra depends on irrigation water. The two most important cropping systems in the area are paddy-wheat and maize-wheat. Together, they account for 90% of the total cropped area in

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Kangra District. Both cropping systems are subsistence oriented. Rainfall and evaporation data collected by the Himachal Pradesh Agricultural University in Palampur for the period 1971-1991 show two water deficit periods, from April to June, and from October to November (Singh and Amgires 1992). Evaporation exceeds rainfall by as much as 100 and 50 mm in the former and latter periods respectively. These periods correspond to the sowing seasons for *kharif* (summer) and *rabi* (winter) crops in Kangra Valley, and they constitute the periods of peak dependence on kuhl irrigation water.

Land ownership in Kangra is characterized by a large number of relatively small landholdings. In 1985 the average landholding was 1.1 ha. (GOHP 1990:75). In 1976, subsequent to land reform legislation in the state, 82% of holdings were 2 ha. or less, 11% were between 2 and 4 ha., and 7% were greater than 4 ha. (Agricultural Census Report, 1976-1977). One of the goals of land reform was to provide enough land to each household to meet their subsistence needs. While the historical, and particularly post land reform, patterns of land ownership suggest that access to land is distributed less unequally than elsewhere in India, inequalities do still exist. The relative degree of inequality of land distribution among households in Kangra influences both farmers' incentives to seek out nonfarm employment, as well as the tensions within kuhl management resulting from nonfarm employment.

The current magnitude of the male work force currently engaged in non-agricultural wage labor either locally or outside the district, although consistent with historical trends, far exceeds prior levels. For example, in the Neugal River basin between 1961 and 1991 the numbers of males engaged in full-time nonfarm employment more than tripled, from 2,095 to 7,012, while those engaged in full-time agricultural work remained about the same. During this same period the population of the basin doubled, from approximately 30,000 to 60,000, and the cultivated area within the watershed declined by 12% from 6,250 to 5,450 hectares. Rates of nonfarm employment among 34 of the kuhl's in the Neugal basin vary between 30 and 64% of the male workforce within the kuhl's command area. The average rate of nonfarm employment is 46%.

Demographic pressures, in combination with the financial security and stability a steady salary provides, have fueled the recent and dramatic increase in nonfarm employment. Socially, nonfarm employment is considered to have much higher status than agricultural work. For example, whether or not a prospective groom has a permanent salaried position greatly influences his marriage prospects. The decline in the cultivated area of the Neugal basin, despite population increases, suggests that social fallow is occurring - a phenomena associated with household labor scarcity which has been documented in other areas of the state in conjunction with increasing nonfarm employment (Negi 1993:15).

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The Effects of Kuhl Irrigation Systems of Increasing Nonfarm Employment

Increased nonfarm employment has affected kuhl regimes in four primary ways. It has resulted in decreased participation in kuhl maintenance work parties, increased inequality and conflict between headend and tailend farmers in terms of water consumption and contributions for system repair and maintenance, declines in the authority of the kohli and his ability to enforce customary rules, and changing cropping patterns. Declining rates of participation in communal kuhl maintenance and repair activities are a pervasive effect of increasing nonfarm employment. Without exception kohlis cited nonfarm employment (*nowkri*) as the primary reason why mobilizing farmers for communal kuhl maintenance was their most difficult problem. In 1991, due to high rates of absenteeism on the appointed work days, Shri Laxman Das, the kohli for Kathul Kuhl, was unable to complete the annual cleaning of the kuhl nor was there adequate labor to reconstruct the kuhl's headworks. That year no irrigation was possible prior to the monsoon. Similarly, in 1988 so few farmers turned out to clean and repair Raniya Kuhl that the kohli, Shri Kishori Lai, dismissed the work party and instead collected money from the irrigators to pay migrant laborers from Rajasthan to do the work. Attendance registers for Pathan Kuhl also indicate that the number of farmers participating in kuhl maintenance has declined in recent years, but not to the same extent as for Kathul or Raniya Kuhls.

Participation in Raniya, Pathan and Kathul Kuhls has declined. Yet the reasons for the decline vary among the three kuhls. Kathul Kuhl irrigates less fertile ridge and plateau areas,¹ annual streams provide post-monsoon sources of irrigation water, and the two villages the kuhl passes through no longer depend on the kuhl's water for domestic water or to provide hydropower for milling grain. As the opportunity cost of labor rose due to increasing nonfarm employment, farmers withdrew their labor contributions for maintaining this kuhl because of their relatively low degree of reliance on it. Unlike Kathul Kuhl, Raniya Kuhl delivers water to high value crops for which alternative water sources are unavailable. However its irrigators are characterized by relatively high degrees of caste and land based inequality and conflict. Low caste small landholders able to participate in the nonfarm employment sector have little incentive to contribute to the maintenance of Raniya Kuhl because of the high levels of conflict and lack of symmetry between labor contributions and water use. Even though Pathan Kuhl is the only source of irrigation water for productive grain producing areas, and the irrigators of this kuhl are not divided by caste or class conflict, participation rates have declined for this kuhl because the pull of nonfarm employment has reduced the available pool of labor. Declining participation, while a common phenomenon, has different causes and effects.¹ The dynamics these three kuhl regimes highlight, e.g. declining dependence combined with low reliance on kuhl water, the push of inequality, and the pull of nonfarm employment, probably exist in most kuhl regimes but to different degrees. The different meanings of declining participation among kuhls results from the relative salience of these elements.

Locationally derived inequalities between head and tail portions of a kuhl's command area which intersect with caste inequalities amplify the effects of increasing nonfarm employment. These processes are evident in Buhli Kuhl which irrigates seventeen hamlets. High caste Rajput hamlets are located at the headend of the kuhl and low caste households are at the tailend. Prior to the increased availability of alternative economic opportunities, common dependence on kuhl irrigation water muted potential inequalities deriving from caste and locational asymmetries and provided the kohli necessary leverage to enforce rules for allocating responsibility for kuhl maintenance and repair between head- and tailenders. However in recent years cooperation between head and tailend farmers has declined because of the increase in nonfarm employment among Rajput households. Consequently, despite the kohli's attempts to coerce upstream hamlets to contribute labor, Rajput contributions for kuhl maintenance and repair declined. The resulting inequalities increased to the extent that nearly the full burden of maintaining and repairing the

kuhl fell on downstream households while upstream households, through whose land the kuhl flowed, continued to divert water for irrigation. In protest, in 1985, downstream households withdrew from the kuhl. These households now divert water for irrigation from small nearby annual streams which flow only after the onset of the monsoon. With no pre-monsoon water supply for irrigation, residents of the downstream hamlets now sow paddy using the less productive dry seed broadcast method (*battar*) and rely on monsoon rains to replenish the nearby annual streams. While downstream households freed themselves from the increasingly onerous burden of maintaining and repairing Buhli Kuhl, they did so at the cost of reduced rice and wheat harvests, and increased risk of crop failure from drought.

The inability of the kohli of Buhli Kuhl to enforce rules for distributing the burden of kuhl maintenance and repair between head and tailenders reflects the general erosion of the kohli's authority. Previously the position of watermaster carried respect and prestige. When water was scarce and demand greatest, the watermaster would walk the kuhl supervising water distribution and resolving water-related altercations between farmers. His turban and cane symbolized his authority. His knowledge, and the basis of his authority, extended to supernatural realms. He was (and still is) the officiant in the puja to the kuhl's devi, and to *QuajaPir*, the saint propitiated to calm the destructive force of the river in its flooded state. Local stories recount how watermasters provided water for their kuhl during droughts and averted pest attacks on crops by supplicating the kuhl's devi. Often, the prerogative to be watermaster was a highly valued inheritable right similar to that pertaining to property in land or a family's claim to hold a village office.

However, the authority and respect accorded to the watermaster have declined substantially. The non caste-specific hereditary right to be watermaster, in some cases, is now a liability rather than a privilege. This is partly because participation in wider economic systems, when it reduces dependence on local resource systems, weakens forms of authority that evolved within a context of mutual dependence on local natural resource endowments. The fragmentation of this dependence, although moderated by ideologies of reciprocity and hierarchical relations, nevertheless weakens the legitimacy of rules and the ability of village based authorities, such as the watermaster, to enforce them.

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Kuhl Regime Responses to the Effects of Increasing Nonfarm Employment

The diverse responses among the 39 kuhl regimes in the study watershed to declining participation, increased inequality, and declining kohli authority reflect each regime's particular set of social and ecological characteristics rather than a common response to shared tensions and conflicts. Some kuhl regimes persist unchanged, others transformed their organizational structure to reduce the tensions and associated conflict, and a few kuhls collapsed. Ten kuhl regimes persist relatively unchanged and are informally managed without a kohli. Twenty kuhl regimes modified their organizational structure by establishing elected kuhl committees, all since 1950. The day to day management of these kuhl regimes is the responsibility of generally one, but in a few cases, two or more hereditary or elected kohlis. The remaining nine kuhls collapsed in the late 1960s and early 1970s and are now managed by the Himachal Pradesh Irrigation and Public Health Department (IPH).

The ten kuhls which have persisted relatively unchanged and are informally managed have been least affected by the stresses associated with increasing nonfarm employment. Participation levels within these kuhls have not declined, nor have the farmers of these kuhls had to formalize their irrigation management organization. A combination of social and ecological factors account for the sustained participation, lack of conflict, and the continued informal functioning of these kuhls. These factors can be distilled to high water value and low conflict potential. The value of the water these kuhls bring is relatively high because they irrigate the fertile lower fields adjacent to the river in areas where there are no alternative post-monsoon annual streams from which to divert water. The potential for conflict is low among these kuhls for two reasons: 1) they tend to be shorter and hence their labor requirements for maintenance and repair are relatively low, and 2) the irrigators of these smaller kuhls generally come from single caste hamlets with relatively low levels of inequality between households, and households are embedded in extensive kin and other local exchange networks.

The twenty kuhl regimes which have continued functioning but whose farmers have transformed their organizational structure through the creation of kuhl committees and the formalization of rules governing irrigation management are characterized by high water values but also high potential for conflict among irrigators. As with the first category of kuhls, these kuhls also irrigate the most fertile lower fields for which alternative post-monsoon water sources do not exist, however the social and economic differentiation among the farmers of these kuhls diversifies their discount rates for labor and time; those with access to nonfarm employment opportunities will be less willing to contribute towards the provision of the collective good. These asymmetrical relations governing inputs and access to water may be tolerated to the extent that the unequal status of the resource users is considered legitimate (O'Neil 1987:172-174). However, when access to nonfarm employment opportunities constitutes an increasingly available and attractive exit option (Hirschman 1970), the willingness to tolerate inequality may decline (Bardhan 1993 a: 91) as it did in Raniya Kuhl. The conflicts which result from differential discount rates and decreasing tolerance for unequal distributions of entitlements and responsibilities, when combined with the high coordination and resource mobilization requirements associated with these larger scale systems, generates the problems of declining participation, declining authority of the watermaster and increased inequality discussed above.

The nine kuhls which collapsed in the 1970s are all ones whose water values were least and whose potential for conflict was greatest. These kuhls irrigated primarily the higher elevation, less fertile fields, in many cases alternative post-monsoon sources of water were available for irrigation purposes and their long length and multi-village command area presented formidable organizational and collective action challenges that could not withstand the stresses associated with increasing nonfarm employment.

Therefore, the *panchayats* of the areas these defunct kuhls irrigated negotiated with the IPH Department to assume responsibility for kuhl management under the Himachal Pradesh Minor Canals Act. The IPH Department currently is responsible for the management of all nine of these kuhls. Their management of these kuhls constitutes a direct and total subsidy because it has yet to assess or collect any water tax from the farmers whose land the kuhls irrigate.

These brief examples illustrate that the degree of irrigators' reliance on kuhl water and the extent of social/economic differentiation among them can be used to differentiate kuhl regimes by the effects on them of increasing nonfarm employment and by their expected responses to those effects. Reliance on kuhl water and the social/economic differentiation of a kuhl regime's irrigators mediate the effects of nonfarm employment. As the opportunity cost of labor increases due to increasing nonfarm employment, the relative degree of reliance on kuhl water and the social and economic differentiation of irrigators will influence the willingness of irrigators to continue to contribute labor and/or money for kuhl maintenance and repair. When reliance is high and differentiation is low, increasing nonfarm employment will minimally affect the kuhl regime. Under these conditions the low coordination requirements of the regime, the relatively equal distribution of incentive to contribute towards maintaining and repairing the kuhl, the high productivity of the land the kuhl irrigates, and the lack of alternative water sources minimize potential conflict among resource users. When reliance and differentiation are both high, increasing nonfarm employment will lead to conflicts within the kuhl regime even though it irrigates productive and fertile areas and post-monsoon alternative water sources are not available. Social and/or economic differentiation among irrigators creates the preconditions for conflicts which challenge the ability of these kuhl regimes to maintain their integrity. When reliance is low and differentiation is high, the difficulties associated with mobilizing adequate labor for maintaining and repairing the kuhl and managing conflict will be greatest because the benefits are least and the difficulties greatest. The benefits of maintaining the kuhl are low because of the low productivity of the land the kuhl irrigates and/or availability of alternative post-monsoon water sources. The difficulties of maintaining the regime's integrity derive from the socially and economically differentiated resource user group which leads to greater conflict, and the high coordination costs of managing a regime which involves multiple villages and irrigates relatively large command areas. For these kuhl regimes internal stress will be highest and the incentives to remain within the regime will be lowest.

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The Bureaucratization of Kuhl Irrigation Systems

Most kuhl regimes which experienced declining participation, declining watermaster authority, and increasing inequality changed their operating rules and formalized the kuhl's governance structure through the creation of kuhl committees. The first two committees in the Neugal basin were organized by officers of the Punjab State Government in the early 1950s as part of a more general effort to form Agricultural Cooperative Societies to disseminate green revolution technology, subsidize agricultural inputs and improve access to rural credit. When these two committees were created and registered under the 1860 Cooperative Societies Registration Act, they were given a set of by-laws specifying the purpose of the committee, membership criteria, the committee's officers and their duties, the records it should maintain, and its general functions. These earliest committees constituted the blueprint for the kuhl committees which farmers subsequently formed in the Neugal basin. This section of the paper examines the form and function of kuhl committees and shows how this bureaucratic organizational model came about as a result of increased interaction between irrigators and state authorities.

Farmers formed kuhl committees in the Neugal basin for three reasons. The most common reason was to strengthen the declining authority of the watermaster and to bolster the decreasing effectiveness of rules governing labor contributions for kuhl maintenance and repair. In this regard kuhl committees, a) bolster the watermaster's waning authority by providing an arena for resolving conflicts among farmers and between farmers and the watermaster, especially under conditions of water scarcity, and b) create and enforce rules and impose fines for the infraction of rules governing labor contributions.

Committees also defend against external threats to the kuhl's water supply, usually posed by an upstream claimant. This may be an upstream village through whose land the kuhl flows, or it may be an upstream state-managed kuhl whose diversions threaten the water flows of its downstream neighbors.

Lastly, committees play important roles in facilitating acquisition of government grants for kuhl maintenance and repair, especially following destructive monsoon floods. A kuhl regime with a committee can more easily request government money for system maintenance and/or repair than one without a committee. The committee's ability to acquire government funds derives from its accountability to government agencies and the ability of its officers to approach government officials. A block development officer or sub-district magistrate is more likely to authorize funds for kuhl repair if written requests are channeled through an organized committee, stamped with the committee's stamp and signed by the committee president, than if the request is made by an individual watermaster who is less accountable to the civil administration. Additionally, a watermaster may not have received higher secondary education, nor be skilled in the bargaining and negotiation that inevitably accompanies local level government funding opportunities. In most cases the officers of a kuhl committee will have those skills and therefore will be able to acquire grants more successfully than the watermaster.

The reliance of committees on the local civil administration for occasional financial support helps to explain their striking structural similarity. The rational, bureaucratic organization of the kuhl committees, as well as their formal rules of operation, reflect the imperatives of conforming to an organizational template recognized and legitimized by the civil administration. The form of the committee certainly does not spring from local idioms of social organization. Instead it reflects the hegemonic imprint of the modern, bureaucratic nation state on local resource management organizations.

The structural similarity of formalized kuhl committees is consistent with theories associated with "new institutionalism" within political science and sociology. Zucker (1991) argues that the institutional

environment affects organizational structure primarily by legitimating a "new procedure, position, or element of structure," especially when hierarchically higher elements of the environment, i.e. regulatory agencies or institutions with the power to provide financial or technical support, establish implicit or explicit requirements that the organization must satisfy before support will be given. Zucker's analysis explains the relatively rapid diffusion of kuhl committees as a key organizational response to a hierarchical institutional environment, the rational bureaucratic nation state, which legitimizes certain organizational forms. In order to successfully negotiate and interact with the civil administration, irrigators are subtly compelled to organize themselves in a manner consistent with the organizational norms of the institutional environment in which they find themselves.

However, the structural uniformity of bureaucratized kuhl management organizations belies the diversity of functions and roles that different committees perform. Committees function quite differently according to the social composition of and the nature and degree of conflict within a kuhl. For example the committee for Pangwan Kuhl, whose irrigators are mostly all Rajput farmers with relatively similar landholdings, levies and collects a fine, and gives a receipt, for every six or seven days of absence. On the other hand, due to the high levels of conflict within Raniya Kuhl which is riven by caste and wealth inequalities and whose kuhl committee is controlled by a few large landowning families, the watermaster does not maintain attendance records and has given up trying to collect fines. In Samruhl Kuhl a fine system initiated in the mid-1980s led to women from de facto women-headed households (resulting from male out-migration) having to participate in communal work parties. This contravened the proscription against female participation in any communal aspect of kuhl management. In response, the kuhl committee and irrigators of this kuhl resolved the issue by substituting a monetary fee based on the area a household cultivates in lieu of labor contributions.

The specific configuration of social relations among the irrigators of a kuhl shapes the meaning and effectiveness of structurally similar changes. The kuhl committee for Raniya Kuhl was a means (albeit not terribly successful) for local elites to maintain their threatened hierarchical authority, the structurally identical kuhl committee of Samruhl Kuhl was the vehicle for shifting from labor to monetary contributions for kuhl maintenance and repair, and the fine system of the Pangwan Kuhl Committee effectively mitigates against the pull of nonfarm employment.

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Shifting Power and Authority Resulting from Bureaucratization

To varying degrees the bureaucratization of kuhl management has changed the basis of authority for kuhl management from charisma, personality and local knowledge to literacy, wealth and demonstrated ability to negotiate with government bureaucracies. This has shifted authority for water management away from the hereditary position of watermaster towards the elected members of the committee. Bureaucratization has thus contributed to the general erosion of the watermaster's authority.

Committees, structured in the image of rational bureaucracy, legitimize forms of authority which differ significantly from those of the watermaster. Committees validate forms of authority based on social and economic status and the ability to interact with and skillfully negotiate grants from civil administrative officers and local political representatives. Individuals who possess these characteristics are generally the more politically and economically influential members of the community, the local elite. These are the individuals who are most frequently elected to be the officers of a kuhl's committee. The committee officers make decisions regarding water management, water distribution and conflict resolution which the watermaster previously made. In many cases the watermaster, rather than the autonomous authority regarding water management he previously was, now implements the decisions the committee makes. The committee's authority fills the vacuum left by the declining watermaster's authority. It also contributes to the decline of his authority. Whereas previously the watermaster was a hereditary position, now the committee itself appoints an individual to be watermaster. Such individuals are no longer perceived by others as having the same authority as the prior hereditary watermasters. Instead they are viewed more as semi-skilled laborers unable to find outside employment and for whom this is a way to increase their household's meagre income.

The degree of inequality and latent conflict among a kuhl's irrigators influences the extent to which bureaucratization of kuhl management consolidates elite authority. Where inequality in terms of landholding size and wealth is relatively high, bureaucratization further consolidates the authority of the local elite, as occurred in Raniya Kuhl. The committee for Raniya Kuhl, dominated by large landowning and high caste farmers, opposes rules governing labor contributions based on landownership and has blocked moves by the watermaster and other farmers to petition the Irrigation and Public Health Department to take over management of the kuhl for fear that a tax based on landholding size would be assessed. Large landowners within this kuhl receive a disproportionate share of water relative to their labor contributions. Also, the watermaster for Raniya Kuhl, a low-caste stonemason, does not receive the committee's support for collecting fines from households which do not contribute labor for kuhl maintenance and repair. Consequently, free riding has increased. In situations of relatively unequal wealth distribution and manifest or latent conflict among irrigators, kuhl committees' consolidation of authority deepens preexisting fault lines of conflict. In such cases the watermaster's authority will be further undermined and the power of local elites strengthened.

On the other hand, the committees of kuhls whose irrigators are more homogenous in terms of caste and wealth inequalities are an effective vehicle for formalizing water management rules and for negotiating with the district civil administration for small grants for kuhl repair and maintenance. However, even under these conditions bureaucratization shifts authority away from the watermaster to the committee because of the different basis of authority of the realms in which committee members operate.

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Irrigation networks, Inter-Kuhl Exchange and Kuhl Persistence

This section of the paper examines the possible role of interdependent exchange relations between kuhls in promoting kuhl persistence despite recurring shocks. Floods caused by intense periods of monsoon rainfall are the most common environmental shock. They are particularly destructive when a temporary landslide dam blocks the river until the rising water eventually breaches the mud dam and floods the downstream areas. Depending on the severity of damage, kuhls destroyed by flooding may be repaired within several weeks, months or years. Sometimes a severely damaged kuhl is never repaired. Although less frequent, earthquakes can also inflict substantial damage on kuhls. The high degree of risk and uncertainty associated with periodic environmental shocks represents a considerable challenge to farmers seeking assured and predictable supplies of irrigation water. Water sharing arrangements and other coordinated water management strategies which emerge between interlinked kuhls help reduce the risks associated with environmental shocks such as floods, earthquakes and drought.

The elevational differences between the agricultural fields within most villages create the topographic conditions which make possible networks of overlapping kuhls and exchange between adjacent kuhls. Most farmers cultivate both fertile rice and wheat growing fields just above the riverine cliffs and less fertile maize growing fields on top of the sloping alluvial plateaux. Due to the elevational differences between upper and lower fields, the kuhls that irrigate upper fields must begin ten to fifteen kilometers upstream of those that irrigate the lower fields. Often a kuhl that irrigates upper areas in village (B) will irrigate the lower areas of an upstream village (A), while another kuhl which irrigates the lower areas in village (B) will also irrigate the upper area of a downstream village (C), and so on. This creates a situation in which the upper fields of a farmer in village (B) may be at the tail end of a kuhl originating in village (A) while his lower fields may be at the head end of a kuhl which also irrigates the upper fields of village (C). At the basin level, the pattern of multi-village kuhls and multi-kuhl villages creates a network of interconnected irrigation channels which links upstream and downstream water users. Figure 1 shows the overlapping kuhl networks in the Neugal River watershed.

I observed four kinds of interdependent relations between kuhls: 1) sharing the same diversion structure, 2) having a joint watermaster for both kuhls, 3) joint water guarding, and 4) water sharing. Water sharing arrangements between kuhls were the most common kind of interdependent relation. During the period of field research three clusters of from two to seven kuhls were sharing water and one pair of kuhls had recently shared water. Water sharing arrangements between kuhls typically involve temporary water transfers from an upstream kuhl to a flood damaged downstream kuhl for the duration of the repair work.

Interkuhl water sharing arrangements occasionally also emerge during drought or during the hot and dry, pre-monsoon season. Shri Ranvir Singh, a former watermaster of Pangwan Kuhl who is now President of the Pangwan Kuhl Committee, recounted that during his tenure as watermaster a severe water shortage combined with upstream diversions left no water in the Neugal River. In order to receive the minimum water necessary for pre-monsoon field preparation, Ranvir Singh was able to negotiate with the watermasters of the next five upstream kuhls to not divert water for a twenty-four period. On the designated day all five kuhls were shut down, water flowed downstream to Pangwan Kuhl where the readied diversion structure diverted it to the fields for a single flood irrigation.

The second kind of interdependent relation is the sharing of the same diversion structure, generally between two adjacent kuhls. If reconstructing a destroyed diversion structure and upper channel section is difficult or impossible, then a permanent water sharing arrangement between two previously independently managed kuhls often emerges. The irrigators from both kuhls will coordinate for the repair

and maintenance of a shared diversion structure below which the single common channel splits back into the two original channels. Similar examples of inter-kuhl relations include kuhl clusters which share the same watermaster, or engage in joint water guarding.

Cooperative relations for sharing between kuhls are directly related to the extent to which kuhls are interlinked. More highly interlinked regimes developed cooperative exchange relations to a greater extent than less interlinked regimes. The effect of these exchanges on regime persistence is somewhat unclear, but they certainly facilitate kuhl persistence under environmental conditions such as floods and extreme drought.

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Conclusion

What sorts of conclusions can be drawn from this overview of the kuhl irrigation systems of Himachal Pradesh? One general conclusion which emerges is the need to understand the dynamic context within which community water resource management occurs. The kuhl irrigation systems have long been subjected to environmental perturbations in the form of floods and earthquakes. More recent challenges to the integrity of kuhls come from transformations in the local economy and particularly, increasing rates of nonfarm employment. The ability of different kuhl systems to respond and generally adapt to these changes in a manner which reflects the particular social, economic and ecological characteristics of the kuhl regime has been key to their persistence. Even within a geographically circumscribed region, the flexibility of community institutions to adapt to particular circumstances and change is important for their longterm persistence.

I think we can also make conclusions relating to participation, state-local relations and inter-kuhl relations. Concerning participation we have seen that it varies from kuhl to kuhl and that the effectiveness of local solutions for declining participation seem to vary by the cause of the decline. Viewed from the perspective of the opportunity cost of labor, farmers are least likely to withdraw their labor from irrigation systems which provide high value water, which have relatively low potentials for conflict, and low probability of elite appropriation of water. Participation declined the most in kuhls which provided low value water and had high potentials for conflict. As nonfarm employment increased the opportunity cost of labor, farmers withdrew their labor from certain kuhls. The irrigators of those kuhls attempted to ensure minimal participation rates by instituting new rules and creating kuhl committees. The efficacy of these rules and committees was greatest when the cause of declining participation was the pull of nonfarm employment and least effective when the cause was the push of inequality between farmers.

The second set of conclusions concerns 1) the importance of flexible government approaches for facilitating local water management and 2) the effects of formalizing local organizations. Regional authorities such as the Irrigation and Public Health Department and the civil administration played different roles in different kuhls. Some kuhls continue to function independent of any direct state involvement in water management, others are completely managed by the IPH Department, and the irrigators of a third category of kuhls broker with the civil administration for grants and other subsidies for kuhl repair and maintenance. This illustrates the importance of flexibility when considering what might be the most effective role of the state in promoting community based water management. Even within one watershed a diverse set of state roles was most appropriate for ensuring the overall viability of the irrigation systems within it. Secondly, the creation of committees to help manage the tensions associated with increasing nonfarm employment and to facilitate more effective relations with state authorities shifted authority for kuhl management away from the watermasters towards other local elites who could more successfully broker grants from government officials. This suggests that the formalization of local organizations for water management may also entail subtle shifts in power and authority from one group to another.

Finally, the discussion of the various types of exchanges and cooperation between interconnected kuhls alerts us to the potential pitfalls of considering community water management systems in isolation from other adjacent local resource management systems. Although inter-kuhl exchanges are rather ephemeral and generally occur only under conditions of stress, this is also precisely why such exchanges facilitate the persistence of kuhls despite recurring environmental shocks. Community water management systems are often embedded in wider networks of exchange and reciprocity which must be taken into consideration if we are to fully understand the factors which promote enduring local management.

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