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Changing Contexts, Steady Flows: Explaining Patterns of Institutional Change within the
Gravity Flow Irrigation Systems (*Kuhls*) of Kangra Valley, Himachal Pradesh, India

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Institutions for common property resource (CPR) management and the resource systems they manage persist to a greater extent and for different reasons than prevailing theories lead us to expect.¹ Current theories of CPR management postulate that the response of a CPR regime to environmental change depends upon the effects of the change on individual choices and the internal regime structures that regulate them.² To account for enduring CPR systems, current approaches explain individual participation in CPR regimes in terms of the costs and benefits of participation, and they explain rules, sanctions and other organizational forms in terms of the efficiency and security of exchange between individuals within the CPR system.³ Although current theories predict that environmental shocks and environmental change stress CPR systems by increasing the cost of and controls upon individual choices, they cannot predict why and how a stressed CPR regime will either persist unchanged, transform in order to endure, or collapse.

In this paper I develop a framework for the analysis of change within CPR regimes in order to explain why and how some regimes persist despite environmental change while others do not. I use this framework to analyze the impacts of the rapidly increasing nonfarm employment sector on the gravity flow irrigation systems (*kuhls*) of Kangra Valley, Himachal Pradesh, India. Based on fieldwork among the 39 *kuhls* which divert water from the Neugal River just west of the town of Palampur in Kangra Valley, I argue that the potential for caste, class or locationally derived conflict among the irrigators of a *kuhl*, and the degree of reliance on the irrigation water a *kuhl* provides, shape the tensions arising from increasing nonfarm employment as well as the means people employ to

¹The many examples of enduring communal management of pasture, forest, fishery and water resources contradict the conventional wisdom that people acting in their own self-interest cause resource degradation and declining collective well-being. Well known examples include communal tenure in the Swiss Alps (Netting 1981), communal forest management in Japan (McKean 1986), China (Menzies 1988), and Nepal (Ghimire 1989), and marine tenure in coastal fisheries (Cordell 1986, Berkes 1987).

² Examples of environmental changes include market penetration, migration, public sector interventions, privatization initiatives, population growth and technological changes. The analytical focus of this paper is restricted to those types of external change which increase the opportunity costs of regime membership.

³I define CPR systems to include both the institution that manages the resource and the natural resource itself. I define CPR regime to mean the institutional arrangements that have evolved to manage the natural resource system.

resolve those tensions. I suggest that the temporal and spatial variation among kuhl regimes in their degree of role specialization and organizational formalization, and the extent of state involvement in kuhl management, reflect the differential responses of kuhl regimes to the stresses arising from increasing nonfarm employment.⁴ Furthermore, I argue that the varied roles the state of Himachal Pradesh plays in the management of different kuhls can be best accounted for as a process of negotiation between various state agents and individuals involved in kuhl management. When it occurs, the basis and content of this negotiation and the outcomes in terms of state involvement in water management, are also shaped by local social and ecological influences rather than by the undifferentiated application of a homogenous state irrigation “policy” across a socially and ecologically differentiated landscape.

Irrigation Organization and Common Property

The plurality of organizational arrangements for irrigation management has provided a fertile field of inquiry for scholars interested in a wide variety of questions ranging from the relationship between irrigation and centralized political authority (Hunt 1988) to the conditions under which self-organizing forms of collective action are likely to emerge and persist (Tang 1992). While all irrigation systems share common tasks associated with water management and the construction, maintenance and operation of the physical structures associated with water use (Uphoff et. al. 1986), the organizational forms that have evolved to accomplish those tasks vary widely. They include systems with little or no organized communal activity (Netting 1974), self-organizing decentralized systems (Martin 1986), self-organizing systems based on hierarchical forms of authority (Lansing 1987, 1993, Spooner 1974), and externally organized systems in which a third party, usually the state, plays a dominant role in irrigation management (Whitcombe 1972, Worster 1985).

⁴The degree of role specialization and formalization ranges from informal kuhl regimes with no specialized roles or formal rules, to highly specialized and formalized kuhl regimes with multiple watermasters, a formal kuhl committee with elected officers, extensive written records and sophisticated methods for measuring water flow. Similarly, the extent of state involvement in kuhl management ranges greatly, from kuhl regimes which operate independently of any state involvement to kuhl regimes which are now entirely managed by the Himachal Pradesh Irrigation and Public Health Department.

Those irrigation systems which are self-organizing possess many of the characteristics associated with successful common property resource management regimes. These include well defined user group and resource boundaries, congruence between rules governing resource appropriation and provision, the ability of resource users to modify rules, the existence of monitoring, sanctioning and conflict resolution mechanisms, the political decision making autonomy necessary for local self-organization, and for larger CPR systems, the organization of management activities into “nested” layers (Ostrom 1990, 1992, Tang 1992). Hardin’s (1968) tragedy of the commons model to the contrary, there are many examples of self-organizing resource management systems which possess these characteristics and have persisted worldwide for centuries.⁵ However, the multiple tensions which accompany large scale demographic, political and economic changes have in many cases eroded the viability of local institutions which manage forest, fishery and range resources held in common. This generally results in resource degradation and a shift in property rights to either privatization or state control of the resource (Polanyi 1944, Jodha 1983, 1985, Feeny et. al. 1990, Ensminger and Ruttan 1991, Ostrom 1990). Self-organization irrigation systems subject to rapid political and economic changes are no exception - many have also deteriorated and/or collapsed (Hardiman 1995, Sengupta 1980, Stewart 1994).

Unlike the defunct small dam irrigation systems of the northern portion of the Western Ghats in present day Maharashtra (Hardiman 1995), and south Bihar (Sengupta 1980), the gravity flow irrigation systems of Kangra Valley have, for the most part, maintained their organizational, physical and technological integrity during the recent unprecedented increases in nonfarm employment. Increasing nonfarm employment has generated tensions within kuhl regimes because it differentially alters the discount rates of labor and time for individuals engaged in the nonfarm market economy. This reduces the dependence on, and hence willingness to contribute towards the provision of, kuhl irrigation water for those who have access to new economic opportunities. Unlike the other

⁵Classic examples of communal irrigation systems include the huertas in southeast Spain (Maass and Anderson 1986), Balinese subaks (Geertz 1980, Lansing 1991), and the zanjeras of Illocos Norte in the Philippines (Lewis 1971, de los Reyes 1980).

farmer managed gravity irrigation systems in the Himalaya,⁶ the kuhls of Kangra are also distinctive in terms of the diversity which characterizes the social relations among irrigators and the productivity and size of the command areas of different kuhls. The social and ecological diversity which characterizes the kuhls of Kangra Valley, in conjunction with marked changes in the regional economy, provide the basis for a longitudinal inquiry which elucidates how local factors influence the effects on a CPR regime of increasing discount rates for some proportion of the regime's members, as well as the nature and efficacy of regime responses to those effects.

The Landscape of Kuhls

The topography of Kangra Valley, a series of gently sloping alluvial fans spreading outwards from the base of the Dhaula Dhar mountains, creates 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 ten to twelve kilometers to the south, they each supply water to as many as forty or fifty different gravity flow irrigation systems.⁷ These irrigation systems consist of a diversion structure, a main channel ranging in length from less than one kilometer to more than 40 kilometers, numerous tertiary channels and hundreds of named distribution points.⁸ Approximately 715 major kuhls and more than 2500 minor kuhls irrigate more than 30,000 hectares in the valley.⁹ In

⁶Gravity flow irrigation systems extend from the Karakoram eastward across the Himalayan range. In Hunza, Pakistan, and in Himachal Pradesh, India, they are known as kuhls. In Uttar Pradesh they are called guhls, and in Nepal kulos.

⁷ Prior to post-Independence rural electrification and the widespread availability of piped water in most villages in the valley, kuhls provided not only water for irrigation but also hydropower for milling grain, and water for all domestic purposes other than drinking. Although the uses of kuhl water have narrowed, kuhls are still the primary source of irrigation water.

⁸ The initial construction of the longest and most complex kuhls was occasionally sponsored by members of the pre-colonial ruling Katoch lineage. 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).

⁹This information comes from the *Riwaj-i-Abpashi* (Book of Irrigation Customs) compiled as part of the 1915 settlement of District Kangra. A major kuhl has a perennial water source and irrigates two or more villages. The Himachal Pradesh Statistical Outline (1990:58) notes that in 1988, of the 32,511 hectares of

the study watershed, that of the Neugal River, thirty-nine kuhls irrigate approximately 5,000 hectares distributed across more than 220 hamlets within the 85 square kilometer watershed. The cultivated area of most hamlets in the watershed includes less fertile ridge and plateau top areas (locally referred to as *larh* areas) as well as fertile riverine terraces (locally referred to as *harh* areas). To irrigate the higher and lower cultivable areas within a hamlet, most hamlets are engaged with multiple kuhls, some to irrigate the lower fields and others to irrigate the higher fields.

Agriculture in Kangra remains oriented to subsistence grain production. The two most important cropping systems in the area are paddy-wheat and maize-wheat. Together, paddy, maize and wheat account for ninety percent of the total cropped area in Kangra District. Precipitation in Kangra Valley varies inversely with distance from the Dhaula Dhar range. The average annual rainfall between 1968 and 1991 recorded at the town of Palampur, at the base of the Dhaula Dhar, was 2,700 mm. This declines rapidly to 1,000 mm per year at Dehra Gopipur less than twenty miles southwest of Palampur. Figure 1 gives both average rainfall and evaporation at Palampur (Singh et. al., 1992). The graph shows two water deficit periods, from April to June, and from October to November. Evaporation exceeds rainfall by as much as 35 and 20 mm in the former and latter periods respectively. These periods correspond to the sowing seasons for kharif and rabi crops in Kangra Valley, and they constitute the periods of peak dependence on kuhl irrigation water.

irrigated land in the district, 30,895 were irrigated by kuhls and lift irrigation systems and 1,616 hectares were irrigated by wells and tube wells.

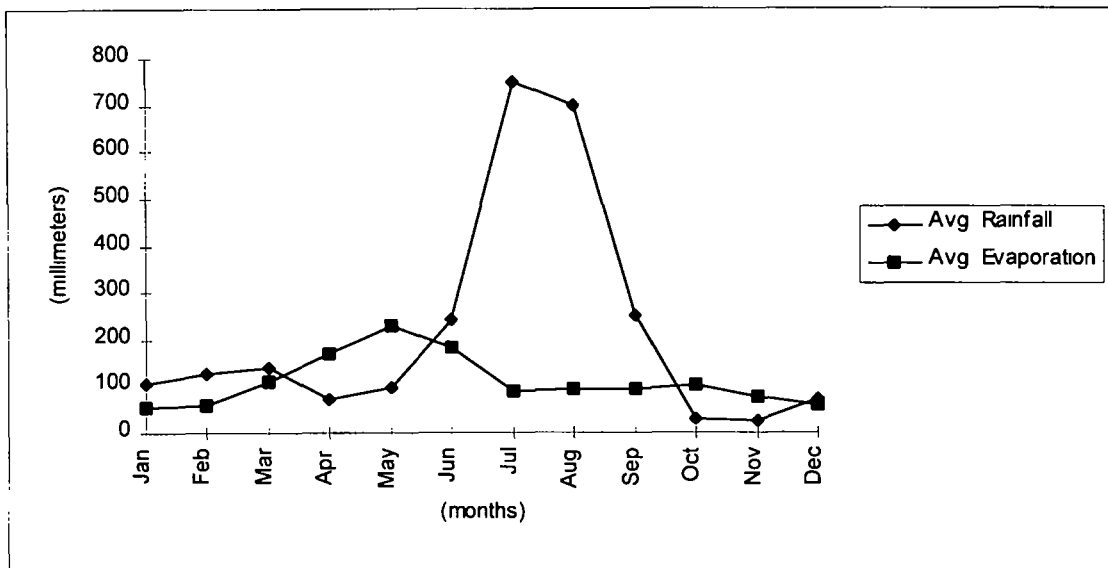


Figure 1 Monthly Rainfall and Evaporation, Palampur, 1975-1991.

In Kangra a rapidly expanding nonfarm employment sector has provided unprecedented opportunities for (mostly male) nonfarm employment.¹⁰ For example, in the watershed of the Neugal River in which the research this paper is based was conducted, between 1961 and 1991 the numbers of males engaged in full-time nonfarm employment increased from 2,095 to 7,012, while those engaged in full-time agricultural work remained about the same.¹¹ During this same period the population of the watershed doubled, from

¹⁰The primarily subsistence agriculture economy of District Kangra has always been supplemented by nonfarm income. As far back as 1874 Lyall remarked that "subdivision has....reached its lowest point; if all these people relied on their land only for a livelihood, numbers would be starved" (1874:85). During pre-British rule, men, especially Rajputs, left their villages to fight as mercenaries in the Mughal, Sikh and local Katoch armies. After the British defeated the Sikhs in 1846, thousands of men who had served in the Sikh army, mainly from Nurpur and Haripur, returned home unemployed. Not only were the families of these men deprived of their earnings used to meet the state revenue demands, but the returned men, trained as soldiers, were poor agriculturists and generally only added to the household burden (Barnes 1855:53). During British control of the district the tradition of out migration for military service continued. A contingent of Dogras, a term applied to Rajputs, Rathis, Thakurs and Brahmins from the hills, raised primarily from Kangra District helped suppress the 1856 'Sepoy Rebellion' in Delhi. Approximately 17,000 men from Kangra District fought in the first world war, and by 1921 more than 40,000 Kangra men were serving in the military (District Kangra Gazetteer 1926:125,465). Tea estates, first introduced in Palampur and Kangra Tehsils in 1849, also provided nonfarm employment. By 1902, 4,600 hectares had been planted to tea. Tea cultivation provided employment to approximately 5,000 persons (District Kangra Gazetteer 1909:123). Lower caste migrants also worked as unskilled and skilled laborers in the plains, and as coolies and rickshaw pullers in Simla (Parry 1976:42). Although consistent with these historical trends, the magnitude of the male work force currently engaged in non-agricultural wage labor either locally or outside the district, far exceeds prior levels..

¹¹As the nonfarm employment sector has increased, there has been a corresponding decrease, among some segments of the population, in reliance on agriculture as the primary mode of subsistence. The declining

approximately 30,000 to 60,000 and the cultivated area within the watershed declined by 12% from 6,250 to 5,450 hectares.¹²

The nature of nonfarm employment varies greatly, often by an individual's educational status. Private sector jobs in transport, commerce, and small businesses are found in the few regional economic centers within the District. Additionally, private sector jobs in industry and other large businesses are found in the larger economic centers in the neighboring state of Punjab such as Chandigarh and Pathankot, and in India's capital, Delhi. The military is the largest public sector source of employment. Other public sector employers include the Revenue, Forest, Irrigation and Public Health, and Public Works Departments.

Factors Shaping Institutional Change Within CPR Regimes

Studies of common property resource management regimes equate formal organization, e.g. written rules, fines and sanctions, elected positions, and written records, with a CPR regime's ability to mobilize resources, resolve conflict and manage the common resource. Consequently, it is assumed that a regime without these formal organizational characteristics is either less able to resolve conflict and mobilize resources than a more formalized regime, or simply has fewer conflicts to resolve and lower resource mobilization requirements. For example Martin (1986) in his study of farmer managed irrigation systems in Nepal found that the degree of formality of irrigation organizations was directly related to the labor requirements associated with water acquisition and management. While the formality of organizational structure may be associated with resource mobilization requirements, I suggest that when temporal rather than spatial comparisons are made across the same set of irrigation systems, the degree of organizational formality, and the process of regime formalization, may be related to changes in the degree of internal system stress within irrigation systems, rather than to the

dependence on agriculture is tempered by the strong local bias against buying food grains and the high value attached to producing one's own rice and wheat.

¹²These statistics were compiled from the hamlet level information in the District Kangra Village and Township Directory of the decennial census for the years 1961, 1971, 1981 and 1991. Within the Neugal watershed approximately 240 hamlets (tikas) comprise 24 revenue villages (mauzas). For a brief description of local administrative units and settlement patterns see Baker (1994:75-80).

amount of resources that must be mobilized to manage the irrigation system. I argue that in Kangra, the formalization of kuhls is a response to internal stress and increasing conflict resulting at least partially from the differentiation of individual's discount rates as some participate in the nonfarm employment sector and consequently reduce their dependence on local resource systems. Furthermore, I suggest that the specific trajectory of irrigation organization formalization in Kangra can be partially accounted for by the institutionalization of rational Weberian bureaucratic organization within the colonial and post-independence Indian state. As the frequency of interaction between individual irrigation systems and various state agencies and departments increases, the organizational structure of the irrigation system more closely approximates a rational bureaucratic form.

I suggest that the impacts of increasing nonfarm employment on common property resource management regimes are shaped by those factors which influence the degree of reliance among the appropriators on the common resource, and the potential for conflict among the group of resource appropriators. These factors include the degree of substitutability of the common resource, the productivity of the resource, the scale and scope of coordination required for managing the resource, and the degree of social complexity and economic inequality within the group of resource users. The degree of substitutability refers to the availability of alternative sources for the benefits the common resource provides.¹³ The productivity of the resource influences its value.¹⁴ Scale and scope of coordination refers to the physical size of the CPR resource and the concomitant organizational requirements for coordinating, monitoring, and sanctioning necessary for regime management.¹⁵ The social complexity of the resource user group refers to the extent of caste, class, clan or ethnic differentiation, factionalism, and locational

¹³For example, in some gravity flow irrigation systems annual streams provide alternative sources of irrigation water after the onset of the rainy season thereby reducing dependence on the main diversion structure and upstream channel. Similarly, within common grazing systems individuals with access to privately owned fodder producing areas will be less dependent on the common grazing areas than those without access to private fodder sources.

¹⁴Examples of variation in productivity include the fertility of the fields irrigation systems irrigate, the quality of fodder from common pastures, and the size of the catch from common fishing grounds.

¹⁵For example irrigation systems which irrigate only one portion of one village's total cultivated area generally have relatively low coordination requirements relative to irrigation systems which irrigate hundreds of hectares distributed across multiple villages.

asymmetries¹⁶ within the CPR system. Inequality refers to the distribution of privately controlled resources, primarily land and/or monetary wealth, among the resource users.¹⁷ While various combinations of these factors have been previously identified as necessary conditions for enduring CPR management (Oakerson 1986, Olson 1965, Tang 1992), they can also be used as a basis for anticipating the effects of an exogenous change on a CPR regime.

These spectra of variation can be distilled into two general indicators of difference among CPR regimes - the degree of reliance on the benefits the CPR regime produces, and the degree of social/economic differentiation within the resource user group. Both indicators range on a scale from high to low. When combined to create a 2x2 table, they can provide the basis for predicting the impacts of expanding nonfarm economic opportunities on CPR regimes with different characteristics, and regime responses to those changes under conditions of increasing access to state assistance and subsidies, and state willingness to assume management of defunct CPR systems.

When the observable characteristics of a CPR regime suggest that “reliance” is high and “differentiation” is low, increasing nonfarm employment will minimally affect the regime. Under these conditions the low coordination requirements of the regime, the relatively equal distribution of incentive to contribute towards the provision of the collective good, and its high value and low substitutability minimize potential conflict among resource users and generally provide adequate incentive for mobilizing the resources required for successful collective action. Given the low levels of internal stress within regimes with these characteristics, resource users will generally not need to formalize their organizational structure and these regimes will function with minimal or no state involvement.

¹⁶Locational asymmetries refer to the relative advantages and disadvantages associated with different structural positions within a CPR; for example in irrigation systems the advantages headenders possess over tailenders. See Ostrom (1993) for a game theoretic bargaining analysis of how individuals with asymmetric relationships to a common property resource can successfully self-organize for its sustained provision and management.

¹⁷ In many instances entitlements to a share of the benefit flows (but not necessarily the distribution of responsibility for required investments) from the commons is based on private ownership and hence reproduces within the commons inequities in privately held resources (McKean 1992:262).

When the characteristics of a CPR regime suggest that “reliance” and “differentiation” are both high, increasing availability of nonfarm employment opportunities will lead to conflicts within the regime despite the high value and low substitutability of the collective good. Social and/or economic differentiation among the resource user group expands the range of discount rates for labor and time among resource users - those with access to nonfarm employment opportunities are likely to have high discount rates relative to those without access to nonfarm employment and hence they will be less willing to contribute towards the provision of the collective good. Asymmetrical relations governing inputs as well as access to the benefits of the commons may be tolerated to the extent that the unequal status of the resource users is considered legitimate (O’Neil 1987). 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). 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 large scale systems, will challenge the regime’s ability to maintain its integrity. In order to persist these regimes will attempt to manage increasing levels of conflict by formalizing their organizational structures and utilizing state assistance such as technical and capital subsidies which substitute for reduced levels of regime member investment in the CPR system.

When “reliance” is low, and “differentiation” is high within a CPR regime, the difficulties associated with sustaining adequate levels of collective action will be greatest because the benefits of doing so are low due to the low value of the common good and its high substitutability, and the costs are high because of the socially and economically differentiated resource user group and the high scale and scope of coordination required for managing the regime. Under these conditions internal stress will be highest and the incentives to remain within the regime will be lowest. Although regime formalization may occur within regimes with these characteristics to manage increasing levels of internal conflict, the effectiveness of formalization as a means to reduce/manage conflict will be compromised by the low degree of reliance on the resource. CPR regimes in this category

will probably eventually collapse and be taken over by the state, or show signs of extreme stress such as resource degradation and the breakdown of monitoring and sanctioning mechanisms.

CPR regimes characterized by low “reliance” and low “differentiation” will have indeterminate outcomes under conditions of increasing nonfarm employment. Low “reliance” suggests that because of the low value of the resource and the availability of substitutes, resource users are not likely to contribute towards the provision of the collective good. However, low “differentiation” suggests that the organizational requirements for managing the resource and the potential for conflict among resource users are minimal. Therefore some members may make adequate investments of labor and other resources necessary for maintaining the regime’s integrity. Under these conditions site specific factors not encompassed with the variables “reliance” and “differentiation” will probably determine the effects of increasing nonfarm employment opportunities on these regimes.

Figure 2 summarizes the effects of different degrees of “differentiation” and “reliance” within a CPR regime on the regime’s response to external change, such as increasing nonfarm employment, which increases the discount rates associated with regime membership. As the figure indicates, I suggest that the degree of regime formalization, the extent of state intervention in regime management, and the likelihood of regime collapse depend on the nature of reliance on the benefits the regime provides for the regime members and the degree of social and economic differentiation of the regime members.

		Differentiation	
		Low	High
Reliance	High	no formalization no state intervention no signs of collapse	high formalization medium state involvement no signs of collapse
	Low	indeterminate outcome	state control of the resource system signs of potential collapse

Figure 2 The differential response of CPR regimes to increasing opportunity costs by regime characteristics.

Irrigation in Kangra: Indicators of “Reliance” and “Differentiation”

The kuhls which divert water from the Neugal River differ significantly in terms “reliance” and “differentiation”. Some kuhls irrigate highly productive rice and wheat growing fields located along the banks of the Neugal River. Other kuhls, after traversing the fertile riverine terraces, transport water several miles to irrigate less fertile agricultural areas on the ridges and plateau tops above the Neugal River. In some hamlets annual streams flow after the onset of the monsoon. They reduce irrigator’s 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.

Figure 3 summarizes the observable indicators of “reliance” and “differentiation” for kuhls. “Reliance” is high when alternative water supplies are unavailable and the kuhl irrigates the fertile and productive fields adjacent to the Neugal River, it is low when the opposite conditions obtain. “Differentiation” is high when a kuhl irrigates more than one village, the irrigators of the kuhl are comprised of multiple castes, and land distribution is relatively unequal, it is low under the reverse conditions. Figure 3 provides the basis for classifying the 39 kuhls within the Neugal basin according to their degree of “reliance” and “differentiation”. The disincentive to contribute labor and/or money for kuhl maintenance and repair as nonfarm employment increases is hypothesized to be greatest when “reliance” is low and “differentiation” is high, least when “reliance” is high and “differentiation” is low, and moderate when “reliance” and “differentiation” are both high.

		Differentiation	
		Low	High
Reliance	High	lower field/upper field ratio=high no seasonal streams irrigates one village or less single caste relatively equal wealth distribution	lower field/upper field ratio=high no seasonal streams irrigates more than one village multi caste relatively unequal wealth distribution
	Low	lower field/upper field ratio=low seasonal streams irrigates one village or less single caste relatively equal wealth distribution	lower field/upper field ratio=low seasonal streams irrigates more than one village multi-caste relatively unequal wealth distribution

Figure 3 Observable Indicators of "Reliance" and "Differentiation" for Kuhls.

The same factors which influence the extent to which disincentives arising from nonfarm employment opportunities create tensions within kuhl regime also shape the responses to those tensions in terms of the degree of regime formalization, if any, and the extent of state intervention in kuhl management. Kuhl regimes which deliver water to high value crops for which alternative water supplies are unavailable and whose irrigators are

not divided by class or caste inequalities are expected to be informally organized with no watermaster and to be managed independently of any state involvement. Kuhls which deliver water to mostly high value crops whose cultivators are characterized by various inequalities are expected to have formalized their management structures by creating kuhl committees and formal management rules, and to receive substantial funds from the government for repair and maintenance. Kuhls which deliver water to low value crops and whose irrigators are divided by class or caste inequalities are expected to show signs of potential collapse or to be managed by the IPH Department. Indicators of potential collapse include shifts in methods of paddy sowing from the water intensive but higher yielding sprouted seed method (*mach*) to the less water intensive and lower yielding dry seed sowing method (*battar*), shifts from paddy to maize in the ridge and plateau top areas,¹⁸ and contractions in the command area of kuhls.

The Effects on Kuhls of Expanding Nonfarm Employment

Increasing nonfarm employment opportunities differentially affect the thirty-nine kuhls in the study watershed. Some kuhl regimes persisted unchanged, others transformed their organizational structure in an attempt reduce the tensions and conflicts resulting from increased nonfarm employment, and a few kuhls ceased to function. This section briefly summarizes the organizational variation in kuhl management structures and the different mixes of local and state authority for kuhl management. The main body of the section presents ethnographic information which demonstrates how the rising opportunity costs of labor and time associated with increasing nonfarm employment affect individual kuhl regimes and how those effects vary from kuhl to kuhl due to micro-level social and environmental factors. By using brief vignettes drawn from particular kuhls I show how

¹⁸During the colonial period the acreage sown to paddy using the sprouted seed or dry seed sowing method was constant enough for Middleton (1919:15) to suggest that the method of paddy seed sowing be used to distinguish between first class cultivated areas with assured water supply and second class areas with uncertain water supply, and to assess revenue accordingly. However, the increasing insecurity of water supply in the less productive and tailend areas due to poor kuhl maintenance and repair, has offset the productivity advantage of sowing sprouted seeds. In some kuhls, areas which used to be sown with the sprouted seed method are now sown using the dry seed method. A second shift in cropping patterns related to changing water availability is to substitute maize for paddy. Maize requires much less water than paddy. The shift from paddy to maize has occurred almost exclusively in the less productive ridgetop and plateau regions of the command area of many kuhls. The shift from paddy to maize in these areas reflects the increasing uncertainty of water supply to low value areas.

increasing nonfarm employment leads to declining participation in kuhl maintenance work parties, shifts in the burden of responsibility for kuhl maintenance from headend to tailend farmers, the declining authority of the watermaster, and changing cropping patterns. Appendices 1a and 1b provide summary characteristics for each of the thirty-nine kuhls in the Neugal watershed.

Ten kuhl regimes in the study watershed have persisted without changing their management structure despite the rising opportunity costs of labor. None of these kuhl regimes have any specialized management positions such as watermaster, nor have any established committees. These kuhls were informally organized prior to the relatively recent expansion of nonfarm employment and they have remained informally managed. They also operate independently of any state involvement, either in terms of monetary grants for kuhl repair, or direct state involvement in kuhl management.

Twenty kuhl regimes in the watershed have established elected kuhl committees, all created since 1950. The day to day management of each of these kuhl regimes is the responsibility of generally one, but in a few cases, two or more hereditary or elected watermasters (*kohli*). Each of these twenty kuhls was managed by kohli(s) prior to the relatively recent creation of committees. These kuhl regimes also receive substantial monetary grants from various state agencies for kuhl repair and construction.

The remaining nine kuhls in the watershed stopped functioning in the late 1960's and early 1970's. The panchayats included within the command area of each of these defunct kuhls negotiated with the Himachal Pradesh Irrigation and Public Health Department (IPH) for the department to assume responsibility for kuhl management under the Himachal Pradesh Minor Canals Act.¹⁹ These kuhls are presently managed by the IPH

¹⁹The Himachal Pradesh Minor Canals Act of 1976 authorizes the Himachal Pradesh Irrigation and Public Health (IPH) Department to "assume the control and/or management of any canal [kuhl] if the owner[s] of the canal consents thereto...". The authority to manage the kuhl can be returned to the owners upon their request at any time. After six years of government management, the owners may request the government to acquire the kuhl under the provisions of the Land Acquisition Act of 1894. Doing so grants the government authority to "exercise all powers of control, management and direction for the efficient maintenance and working of such canal or for the due distribution of the water thereof." It also grants the government authority to levy a tax for the use of kuhl water, "keeping due regard to the maintenance and operation charges for the system and the cost of collection of water rates" (Minor Canals Act 1976:sections 9, 28, 34-36) This water tax is separate from, and in addition to, the land revenue assessed on irrigated land.

Department. The department's management of these nine kuhls constitutes a direct and total subsidy of irrigation water because it has yet to assess or collect any water tax from the farmers whose land the kuhls irrigate.

The willingness of the Irrigation and Public Health Department to fill the management vacuum left when farmers withdrew from these nine kuhls to the extent that the kuhls ceased to function, and of other state agencies and departments to subsidize the repair of non-state managed kuhls, has been instrumental in preserving the overall viability of the kuhl networks within the Neugal watershed. The reasons for the willingness of these state agencies to participate in irrigation management, although varied, are grounded in the ideology of the developmentalist socialist welfare state. More instrumentalist motivations within the IPH Department include increasing the department's power relative to other departments, and justifying an expanding budget. A less direct motivation which informs the giving of subsidies for kuhl repair by the civil administration and on occasion grants brokered by local elected political leaders (e.g. Members of the Legislative Assembly), is the expectation of political support in return for financial subsidies.²⁰

The withdrawal of farmers' labor from communal kuhl maintenance and repair activities is one of the most pervasive effects of the increasing opportunity cost of labor for those engaged in nonfarm employment. The channels of all kuhls must be annually cleared of debris, vegetation and the sediment deposited by last years' flow. Weak channel sections must be shored up. Additionally the diversion structure or headworks of each kuhl must be rebuilt each year at least once, and often several times during the monsoon if annual streams do not alleviate irrigators' dependence on the Neugal River for irrigation water. All of this work is accomplished through communal work parties organized and supervised by the kohli. If this work is not done adequately each year, the kuhl will cease to flow and will soon become defunct. Without exception kohlis cited mobilizing farmers

²⁰ A test of this hypothesis, which I did not conduct, would be to track the numbers of grants given to kuhl committees in relation to election and non-election years. This hypothesized relationship is supported by the fact that large amounts of financial resources have been spent on the kuhls in Sulah, the home constituency of the previous Chief Minister, Shri Shanta Kumar. If a state agency competes with local user groups over resource access and use, rather than benefits from subsidizing local use of the resource, then of course the state/local dynamic will be much different than what obtains within the context of irrigation in Kangra.

for communal kuhl maintenance as their most difficult problem.²¹ In 1991, due to low farmer turn out 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 Lal, dismissed the work party and instead collected money from the irrigators to pay migrant laborers from Rajasthan to do the work.²² 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.²³

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 top areas, local streams provide easily available 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. As the opportunity cost of labor rose, 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.²⁴ Low caste small landholders exiting to escape these inequalities account for

²¹The kohli is responsible for mobilizing the communal work parties necessary for maintaining and repairing the kuhl, 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.

²²Shri Kishori Lal reported that only ten years ago eighty to one hundred men would show up for the four days required to clean and repair Raniya Kuhl. In 1993 only 21 individuals, mostly young boys and elderly men, participated in the maintenance work.

²³Between 1978 and 1991 the maximum number of participating farmers on a given day declined from between 90 and 100 to between 30 and 40. And the total number of persondays contributed per year also declined during this period. The kohli for Pathan Kuhl, Shri Dhyani Singh confirmed this trend by stating that declining farmer participation for kuhl maintenance and repair was his biggest headache.

²⁴In Village Saloh, the primary village irrigated by Raniya Kuhl, caste intersects with landownership - the three or four largest landowning families are Brahmins. These families own most of the fertile land in the village. Their holdings appear to exceed the current ceiling on land ownership size and are leased informally to tenants who give the owner half the production. This share arrangement exceeds the legal share that owners may demand (the 1972 Himachal Pradesh Tenancy and Land Reform Act established that the

declining participation rates in Raniya Kuhl. 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.²⁵

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. Buhli Kuhl exemplifies this point. Seventeen villages have rights to irrigation water from Buhli Kuhl. High caste Rajput hamlets are located at the head end of the kuhl. Hamlets at the tail end are primarily composed of lower caste households. The kohli of Buhli Kuhl, Shri Vichitra Singh, is a Rajput from one of the upstream villages. Prior to the increased availability of alternative economic opportunities, the inequalities deriving from caste and position remained within acceptable bounds. Common dependence on kuhl irrigation water helped provide the kohli the leverage to enforce the customary rules for allocating responsibility for kuhl maintenance and repair between head- and tailenders.²⁶ However, as Vichitra Singh explained, "cooperation disappeared because now people have money". Increasing nonfarm employment enabled

maximum rent payable by the tenant "shall not exceed one-fourth of the crop .or of the value of such produce," (section 20, subsection 1)). The lower caste small landowners I interviewed complained of the discrepancy between landholding size, contributions for kuhl maintenance and repair, and water use. In their view the large landowners contribute less labor relative to the small landowners, yet use more kuhl water. The kuhl committee, although formed in the 1950's, maintains no records, does not support Shri Kishori Lal the lower caste kohli, and appears to represent the interests of the large landowners. The president of the committee is one of the oldest men in Saloh, a Brahmin, and the largest landowner in the village. When asked what the committee does, he said (paraphrasing) that "we formed the committee years ago and we made rules, but because the rules were not obeyed or followed, what is the point of having a committee at all?" at which point he threw his arms up in frustration and resignation. Because of the difficulties in managing the kuhl, Kishori Lal and other village representatives traveled at their own expense to Simla, the state capital, to request the Irrigation and Public Health (IPH) Department to assume responsibility for managing their kuhl. The request was denied, partially because the large landowners of Saloh opposed the proposal due to concern that the government may impose an area-based water tax. In Saloh caste and land based inequalities between landowners and tenants account for declining participation.

²⁵Each kuhl highlights a different process. The dynamics revealed i e. declining dependence, the pull of nonfarm employment, and the push of inequality, probably exist in most kuhl regimes but in different degrees. The different meanings of declining participation between kuhls results from the relative strength of these elements.

²⁶For a discussion of the organization of work and the customary rules governing the distribution of responsibility for kuhl maintenance and repair among irrigators in different parts of a kuhl's command area see Baker (1994:111-123).

the upstream Rajputs to become proportionately less dependent on kuhl water than the downstream lower caste households. The weakened bonds of interdependence between head- and tail-ender households combined with caste antagonisms eliminated the leverage rules previously provided downstream users to influence the contributions of headenders for system maintenance. Consequently Rajput contributions to kuhl maintenance and repair declined.²⁷ The resulting inequalities increased beyond acceptable levels. In response, in 1985, downstream hamlets voiced their “exit” option (Hirschmann 1970) by withdrawing from the kuhl and diverting 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 these hamlets now sow paddy using the less productive dry seed broadcast method and rely on (hopefully) timely rains to replenish the nearby annual streams.²⁸

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. Households that have shifted their economies from subsistence agriculture to nonfarm market based activities are less bound by village rules and norms. Participation in wider economic systems, when it reduces dependence on local systems, weakens forms of authority that evolved within a context of mutual dependence on local natural resource endowments. Rules regulating use of common property resources in Kangra Valley, such as seasonal restrictions on grazing of some forest pastures, or rules governing acceptable methods and quantities of fish harvesting, currently have relatively little impact on individual behavior. The basis for regulating communal activities and the source of legitimacy for rules governing those activities was common dependence on local resource systems. The fragmentation of this dependence, although moderated by ideologically compelling norms of reciprocity and hierarchical relations, nevertheless weakens the legitimacy of rules and the ability of village based authorities to enforce them. The declining authority of the kohli reflects these processes.

²⁷Vichitra Singh Kohli was unable to enforce Rajput labor contributions (when he attempted to, other upstream Rajputs threatened to beat him).

²⁸The kohli prior to Vichitra Singh correctly anticipated this sequence of events. He had predicted that when he was no longer kohli Buhli Kuhl would “go dry”.

Previously the position of kohli carried respect and prestige. When the demand for kuhl water peaked for paddy sowing and water supply was at its annual minimum, the kohli walked his kuhl overseeing water distribution and resolving water conflicts on the spot. His long turban and cane were adequate reminders of his authority and helped ensure that his word held. His knowledge regarding the control, transport and distribution of water extended to supernatural realms. The kohli's role as officiant in the puja to the kuhl's devi, and to *Quaja Pir*, the destructive manifestation of the river in its flooded state, reinforced his authority. Local stories recount how kohlis provided water for their kuhl during droughts by supplicating the kuhl's devi (goddess). Often, the right to be kohli was a *warisi*, an inheritable right similar to that pertaining to property in land or a family's claim to hold a village office.

The authority and respect accorded to the kohli have declined substantially. The hereditary right to be kohli, in some cases, is now a liability rather than a privilege. Fifteen years ago the Brahmin clan which held the hereditary right to the position of upstream kohli for Raniya Kuhl relinquished their claim to that position. The last kohli from this clan stated that he quit because he could no longer resolve conflicts between farmers and mobilize them to maintain and repair the kuhl. In his words, farmers "no longer minded" him. Many current kohlis state that they would prefer their sons to get nonfarm jobs and not assume the responsibilities associated with what they consider to be the relatively thankless, difficult and poorly remunerated responsibilities of the kohli.

Kuhl Regime Responses to Environmental Change

Kuhl regimes have responded to the tensions increasing nonfarm employment created by instituting changes at the operating level and the institutional level (Ciriacy-Wantrup 1969). Responses at the operating level include changes in the remuneration for the kohli, the mobilization of resources for kuhl maintenance and repair, and the formality of kuhl management activities. Responses at the institutional level include the formation of kuhl committees, with their varied structures, functions, and degrees of effectiveness, and increased state involvement in kuhl management. The combination of responses among different kuhl regimes reflects each regime's particular set of social and ecological characteristics rather than a common response to shared tensions and conflicts. For

example, although kuhl committees are structurally similar, some were formed to address increasing internal conflict while others were formed primarily to facilitate negotiations with the state.

In 1993, there were 14 kuhl committees within the Neugal basin. The two most recent committees were formed in 1989. None existed before 1950. Local officers of the Punjab State Government organized two of the earliest kuhl committees in the early 1950's 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.²⁹ These two initial "cooperative irrigation societies", created by state initiative, constituted the blueprint on which subsequent kuhl committees were modeled, though the irrigators themselves rather than government officers created the later committees. This partially accounts for the remarkable similarity in organizational structure among kuhl committees.³⁰ Each kuhl committee consists of a governing head of elected officers which includes a President, sometimes Vice-President, Secretary and Treasurer. Nominations, followed by elections, are usually held once a year. The voting members of the committee sometimes are restricted to landowners within the kuhl's command area, and sometimes include non-landowning cultivators.

Table 1 gives the date formed, and the primary reasons for the formation of each of the fourteen kuhl committees in the Neugal watershed. The more common reason to create a kuhl committee was to strengthen the declining ability of the kohli to enforce rules and

²⁹When 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. Because they are registered, an officer of the Department of Cooperative Societies annually audits their account books. This audit ensures "proper" accounting of money the kuhl committee receives through government grants, membership fees, contributions for puja, and fines. Some farmers feel that a registered kuhl committee has more standing with the district administration than an unregistered committee when applying for grants. However, of the fourteen kuhl committees in the Neugal basin, only these two are registered under the 1860 act.

³⁰The striking similarity in the formal organization of every kuhl committee is partially explained by the institutionalization of this organizational form within India. Since the community development initiatives of the 1950's, the number of village level societies, cooperatives and committees has mushroomed. Government agencies organized many of these. If registered with the Department of Cooperative Societies, the Block Development Officer (BDO) or any other government agency, a committee must conform to the specified organizational structure. This explains the structural similarity between for example, women's village organizations in the Changar and kuhl committees in Kangra Valley.

mobilize labor. In this regard kuhl committees, a) provide an arena above the kohli for resolving conflicts between farmers that the kohli is no longer able to resolve, b) create rules designed to achieve an acceptable distribution of the burden of kuhl maintenance and repair amongst the irrigators of the kuhl, and c) provide the means to monitor and enforce rules and to levy fines against those who violate rules.

Kuhl Name	Bhradi	Bhagotla	Kathul	Sapruhl	Pathan	Makruhl	Samruhl
Year Started	1970	1986	1970	1965	1952	1974	1950's
Why Started	D	L	L G D	L G	L G	L G	L
Kuhl Name	Raniya	Taruhl	Chamruhl	Masanol	Pangwan	Sonia	Gagruhl
Year Started	1952	1989	1989	1974	1954	1950's	1977-78
Why Started	L G	L G	L G	L	L G	L G	L

Table 1 The 14 Kuhls in the Neugal watershed with committees, when and why the committees were established, by kuhl. L = to strengthen declining legitimacy of kohli, G = to facilitate acquisition of government funds for kuhl repair, D = to defend against external threats to a kuhl's water supply.

The second most common reason for establishing a kuhl committee was to facilitate the negotiations with the various agents of the state necessary to acquire monetary support for kuhl system repair and maintenance. A kuhl regime that has a kuhl committee can more easily request government money for system maintenance and/or repair than a kuhl regime without a kuhl committee. The ability of a committee 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 they are channeled through an organized committee that can be held accountable for the money, rather than through an individual kohli. A kohli 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 be more successful than the kohli in acquiring government grants.

The last, and least common, reason for forming a kuhl committee was to defend the kuhl regime members' water claims against an external threat. Only two kuhl committees were formed for this purpose. The threat to a kuhl's water source usually derives from an upstream claimant. In the case of Bhradi Kuhl, the shareholders of the kuhl organized a kuhl committee to protect their water interests threatened by the state-sponsored construction of an adjacent upstream kuhl. The committee mobilized financial resources from its members, and challenged the Department of Irrigation and Public Health in court. In 1988 the District Court decided the case in favor of Bhradi Kuhl, against the state of Himachal Pradesh. Creating a kuhl committee enabled the irrigators of Bhradi Kuhl to mobilize more resources, to be held more accountable for managing those resources, to have more standing in the District Court, and to more effectively represent their interests in the courtroom than if they did not have a committee.

Kuhl committees provide an institutional context within which the rules that govern irrigator's behavior may be formalized or changed. The effectiveness of evolving rules varies among kuhl regimes according to the nature and degree of conflict within the kuhl regime. Three examples of changes in the operating rules of kuhls are the creation of fine systems, the substitution of monetary for direct labor contributions for kuhl maintenance and repair, and increases in the remuneration rates for kohlis.

Every kuhl regime that maintains attendance records also has developed some system for collecting fees from, or imposing fines on, households which do not contribute labor for kuhl maintenance.³¹ 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 kohli, Shri Kishori Lal, neither maintains accurate attendance records nor

³¹The money collected in fines is used to purchase materials and supplies for kuhl repair and maintenance, e.g. shovels and cement.

even attempts to collect fines. In Samruhl Kuhl a fine system initiated in the mid-1980's led to women from de facto women-headed households (a result of male out-migration) having to participate in communal work parties. This contravened the prescription 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. For example 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.

Patterns of Kuhl Regime Response to External Change

To what extent does the observed pattern of response among kuhl regimes conform to the expected pattern as described in Figures 2 and 3? These figures suggest that high "reliance" and low "differentiation" kuhls would be least affected by external change, those with high "reliance" and high "differentiation" would be moderately affected and those with low "reliance" and high "differentiation" would be most affected. Furthermore, they suggest that kuhls least affected by external change would not formalize their organization and would be managed independent of state involvement, those moderately affected would formalize their organization by creating kuhl committees and would have moderate degrees of state involvement, and those most affected would either show signs of potential collapse or have collapsed and be under state management authority.

Figure 4 shows the distribution of kuhl regimes classified by "reliance" and "differentiation". Figure 5 gives the observed extent of state intervention in kuhl management and the observed degree of regime formalization of the same set of kuhls. A comparison of Figures 4 and 5 shows that the observed extent of formalization and state intervention in kuhl management matches the predicted extent for 32 of the 39 kuhls in the Neugal watershed.

		Differentiation			
		Low		High	
Reliance	High	Bhradi Chanogi Bhagotla Majettli Bal Natyrya Karni Boura da Cho	Ghran Masanol Spein Sulah Saldian Macchlana Rein da Cho	Pathan Makruhl Samruhl Pangwan Soniya Gagruhl Ghughrul	Mahang Loharal Taruhl Chamruhl Patnul Menjha
	Low			Kathul Rai Sapruhl Kirpal Chand Sangar Chand Dewan Chand Raniya Mia Fateh	Dai Upperli Buhli

Figure 4 Classification of Kuhls by their indicator characteristics of "Reliance" and "Differentiation" as presented in Figure 3.

		Differentiation			
		Low		High	
Reliance	High	1 Chanogi Majettli Bal Natyrya Boura da Cho Spein Sulah	Saldian Macchlana Rein da Cho Karni	2 Pathan Makruhl Samruhl Pangwan Gagruhl Bhradi Masanol	Taruhl Chamruhl Loharal Soniya Mahang Bhagotla
	Low			3 Kathul, Upperli Sapruhl Kirpal C. Sangar C. Ghughrul Menjha	Dai, Rai Raniya Buhli Mia Fateh Dewan C. Ghran Patnul

Figure 5 Observed Degree of Formalization, State Intervention, and Signs of Potential Collapse, by Kuhl, by Cell as Identified in Figure 2 (Cell #1 kuhls: no formalization, no state involvement, no signs of collapse; Cell #2 kuhls: high formalization, medium state involvement, no signs of collapse; Cell #3 kuhls: total state control of the kuhl or signs of potential collapse. Kuhls in bold face depart from the predicted outcomes given in Figure 2).

As predicted, all low “reliance” and high “differentiation” kuhl regimes are either under IPH management or showing signs of possible system collapse. Three kuhl regimes (Ghran, Patnul and Ghughrul Kuhls) are under IPH management that were not expected to be, and one kuhl (Menjha Kuhl) shows unexpected signs of potential collapse. Ghran Kuhl is managed by the IPH Department because its diversion structure and main channel were subsumed by the large cement structure the IPH Department constructed for the cluster of kuhls it manages which originate at the upstream end of the watershed. Ghughrul Kuhl is managed by the IPH Department because it irrigates land in two villages, Bandla and Ghugar, which have experienced high degrees of land conversion from agriculture to residential and commercial buildings associated with the growth of the nearby town of Palampur as a district commercial center. The intensification and diversification of claims for the water of Ghughrul Kuhl, and associated conflicts over water use exceeded local capacities for water management. Consequently the IPH Department assumed responsibility for the kuhl.

Menjha Kuhl was not expected to show signs of potential collapse, yet it does; the ratio of paddy sown with sprouted to dry seed has decreased in the lower fertile areas, in the higher fields maize has begun to replace paddy, and the command area of the kuhl has contracted towards the headend. This is probably due to a combination of factors including the proximity of Village Menjha to the town of Palampur which may exacerbate the effects of increasing nonfarm employment, the fact that it does have substantial ridge and plateau top areas within its command area, and its relatively large command area (140 ha.) which may approach the maximum effective scale of management for kuhl committee-managed kuhls given the other social and ecological characteristics of this kuhl.

The prediction that high “reliance” and high “differentiation” kuhls would formalize and continue to function without signs of potential collapse was confirmed by the observed outcomes; ten of the thirteen high “reliance” and high “differentiation” kuhls formalized their management structures. The three exceptions are Ghughrul, Menjha and

Patnul Kuhls, all discussed above. In addition three kuhls (Masanol, Bhradi, and Bhagotla Kuhls) which were not expected to form committees did so.

Prior to the early 1970's Masanol Kuhl had neither a kohli nor a kuhl committee. Water was managed on an informal basis by the irrigators themselves. In the early 1970's Phulli Ram returned from Rajasthan where he was a heavy equipment operator on a large government irrigation project. He was asked to be kohli for Masanol Kuhl which a flood had destroyed several years previously and which had not been repaired since. Phulli Ram agreed to be the first kohli for this kuhl. At the same time a kuhl committee was also formed to help the kohli mobilize adequate labor to reconstruct the kuhl. The kuhl committee was able to secure a grant from the Member of the Legislative Assembly (MLA) to purchase materials to repair the kuhl. The need to acquire a government grant to repair the kuhl, and the fact that the kuhl had been defunct for several years, suggests why this kuhl has a kuhl committee despite its low "differentiation".

Bhradi and Bhagotla Kuhls also have committees despite their low "differentiation". As described above, the irrigators of Bhradi Kuhl had organized a committee to facilitate their court case against the IPH Department. The kuhl committee for Bhagotla Kuhl was formed in 1986 at the same time the present kohli was chosen. The previous kohli was from a small (less than ten households) upstream hamlet. Although caste and wealth were not divisive issues, the kuhl committee was formed to bolster the new kohli's authority in anticipation of water conflicts based on the locational asymmetries of the two hamlets.

Figure 1 predicted that high "reliance" and low "differentiation" kuhls would remain informally organized with minimal state intervention. Figure 4 shows that eleven of the fifteen high "reliance" and low "differentiation" kuhl regimes matched this expectation, while four kuhls discussed above (Masanol, Bhradi, Bhagotla and Ghran Kuhls) did not.

Three Classes of Kuhls

Overall, the composite variables "reliance" and "differentiation" captured much of the variation among kuhl regime responses to the stresses resulting from expanding

nonfarm employment opportunities and to the increasingly accessible technocratic state authorities. The seven kuhl regimes that did not respond as predicted indicate a slight trend among kuhls to be more formalized and have greater degrees of state intervention than expected.

Three broad classes of kuhl regimes emerge from this analysis. The kuhl regimes observed in the high “reliance” and low “differentiation” category were informally organized. None have a kohli or a kuhl committee. All continue to be informally organized with few if any rules, sanctions and enforcement mechanisms. With the exception of Rein da cho, none have received any state assistance during the last five years. These kuhl regimes were negligibly affected by the potential stresses resulting from increased nonfarm employment because of the low potential for conflict among the irrigators, their relatively low organizational complexity, and the fact that they irrigate predominantly lower fertile paddy growing fields for which alternative water sources are not available.

The second class of kuhl regimes are those observed in the high “reliance” and high “differentiation” category. All of these kuhl regimes have kohlis, and except for Mahang and Loharal Kuhls, have created committees relatively recently. None of these kuhls exhibits signs of potential collapse such as shifts from paddy to maize in ridge and plateau top areas, and from sprouted to dry seed paddy sowing in lower areas, or command area contractions. Each of these kuhl regimes has received at least Rs. 10,000 during the past five years from the Block Development Officer, District Commissioner, or the Forest Department for kuhl repair work. In these kuhl regimes increasing nonfarm employment lead to the tensions discussed above such as declining participation, shifts in the burden of responsibility for kuhl maintenance and repair, and the declining authority of the kohli. However, the potentially disintegrative effects of these processes were buffered by the fact that these kuhls are the only source of irrigation water for highly productive and highly valued paddy and wheat fields. Regime formalization, e.g. creation of committees, formalizing monitoring and sanctioning rules, and instigating fine systems, enabled these regimes to manage internal stress as well as to broker government grants.

The third class of kuhl regimes are those observed in the low “reliance” and high “differentiation” category. All of these kuhl regimes have either been taken over by the IPH Department or they exhibit the signs of potential collapse mentioned above. The high “differentiation” of these regimes makes them particularly susceptible to increasing levels of conflict resulting from increased nonfarm employment because the irrigators of these kuhls were already riven by pre-existing fault lines of conflict. Additionally their low degree of “reliance” made exercising one’s “exit” option relatively feasible because of the availability of alternative post-monsoon water sources and/or the relatively low productivity of their command areas. The combination of low “reliance” and high “differentiation” within these regimes provided the conditions for high levels of internal stress and few incentives for investing the resources necessary for managing it.

Conclusion

Despite the unprecedented expansion of nonfarm employment and the resulting stresses on kuhl regimes, kuhls continue to transport and deliver irrigation water as they have done for the last several hundred years. However, this constancy of flow has been achieved only through dramatic transformations in the organizational structure of kuhl regimes, and in the mix of local/state authority for kuhl management. Part of this transformation included the collapse of nine previously farmer-managed kuhls and their subsequent takeover by the Himachal Pradesh IPH Department. From one perspective the collapse of these kuhls constitutes a collective action “failure”, another example of the decline of common property resource systems. However these nine kuhls “failed” because irrigators availed themselves of other economic activities which brought them greater return. One elderly farmer who used to help maintain the now IPH-managed Dewan Chand Kuhl succinctly captured the meaning of these broader regional transformations. He first explained how in his youth communal work parties used to spend three weeks for the annual maintenance for the 25 kilometer long main channels of Dewan Chand Kuhl. Each work party carried enough provisions for several days and camped each night along the bank of the kuhl. By the time all the work parties converged at the head of the kuhl to construct the headworks and participate in the annual kuhl rituals they would number more

than 200. Since then cooperation between farmers for maintaining and managing Dewan Chand Kuhl has declined and the kuhl eventually stopped functioning in the late 1970's. He continued his narrative by stating that the decline in farmer cooperation and the collapse of the kuhl was however of very little significance because of the much larger transformations he has seen and benefited from. Most important was the elimination of the threat of famine due to higher crop yields in the prime paddy and wheat growing areas and good transportation networks. Other important quality of life improvements he described included local schools, the hospital in Palampur and local health clinics, and increased access to nonfarm employment. Seen from this perspective, the withdrawal of farmer support for those kuhls such as Dewan Chand Kuhl which required high investments of time and labor to irrigate fields of relatively low productivity seems less a tragedy of the commons than a marker of improvements in the general quality of life in Kangra.

At the basin level increasing nonfarm employment opportunities initiated a sequence of responses that produced new patterns of authority and organization for water management. These differential patterns of change within individual kuhls create a web of multi-jurisdictional, interconnected kuhl networks that would appear highly resilient at the basin level because each kuhl regime is able to find its own equilibrium point of state/local authority and management structure given a particular type and rate of contextual change, and its own configuration of social and ecological characteristics. The existing basin level pattern of authority and organization for water management suggests that while specific organizational forms, operations, and scales of regime management did not persist in the sense of remaining unchanged, the overall pattern of kuhl networks within the basin transformed in order to endure.

The analysis also demonstrates the importance of diachronic analyses of local resource management institutions. Formalization and organizational "robustness" when viewed from a static perspective may be related to the amount of resources that must be mobilized (Martin 1986). However, when viewed diachronically the process of regime formalization signals increasing internal regime stress and conflict and/or increasing interaction with external state authorities. Synchronic analyses of dynamic processes

successfully demonstrate relationships between physical attributes of the CPR system, the social characteristics of the resource user group and the structure of the collective action situation. However they fail to explain why specific institutional arrangements for achieving collective action emerge, and why, when and how they will persist, transform or collapse. Diachronic analysis of CPR regimes provides one way of identifying the regime characteristics which shape the effects of and responses to contextual change. While the specific indicators of “reliance” and “differentiation” will vary from place to place, as summary variables they provide one means of assessing how external change will likely affect a CPR regime.

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