LOCAL APPROACHES FOR A GLOBAL WATER REVOLUTION:

A CASE STUDY OF COMMUNAL WATER MANAGEMENT IN LADAKH, INDIA

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DEDICATION

For my beloved husband and partner in all things, Benjamin,
who has been with me for the entire journey,
and to the people of Ladakh,
from whom I have learned so much

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Please note that any misinformation contained in this document should be attributed to my own misunderstanding, not to any error on the part of those whom I interviewed.

CONTENTS

LIST OF FIGURES

Please note that all photographs were taken by the researcher during the field research period in Ladakh between July and October 2006.

GLOSSARY OF TERMS

Bes = the sharing of labour
Chagzot = manager of the gompa
Chang = local brew made from fermented barley
Chu = water
Chu dzomsa = confluence of two rivers (literally 'water meeting place')
Chumik = water from a spring
Churpun = water manager
Chutso = group of households organized to help manage water in a specific area of a village
Dol chu = first irrigation, given once shoots appear
Goba = traditional village headman
Gompa = monastery
La = pass (mountain)
Lama = Buddhist monk
Lhangsde = system of sharing resources (i.e. farm tools and draft animals)
Katak = white scarf given in ceremonies of homage, appreciation, welcome, departure
Kangri = glacier-covered mountain
Kha = snow
Khachu = water from snowmelt
Khyak chu = frozen water (remainder of winter water in tokpo and zings)
Non chu = third irrigation, given once crops are strong and healthy
Pabchu = system of sharing water between Sakti and Chemray villages (literally 'to bring down water')
Pashpun = cooperative group of households
Phu = alpine pasture
Puja = holy offering to the village oracles
Rares = community turn-taking for animal herding
Ri = mountain
Sha = meat (typically sheep or goat)
Shak chu = second irrigation, given once shoots become dry and yellow in colour
Ska = closure, comprised of boulders and sod, to divert water to a particular yura or field
Spang = marsh
Ston chu = autumn water
Tha chu = pre-ploughing water
Thetse = carved wooden seal (formerly called 'pangya' in Chemray, or 'skargya' in Leh)
Tokpo = principal snow- or glacier-fed stream of a village
Tso = lake, pond
Yura = irrigation channel
Yurgo = head of yura
Zing = man-made water storage reservoir

ABSTRACT

LOCAL APPROACHES FOR A GLOBAL WATER REVOLUTION:

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The mismanagement of water is one of the most pressing development problems of the day. This research argues that, in some circumstances, an often-neglected form of water management, communal property management, can offer a viable solution to this problem. India has a rich history of traditional water management. Within India, the region of Ladakh was examined as an example of successful communal water management. Drawing from the experience of six communities in Ladakh, the case study method was employed to investigate what institutional characteristics have enabled Ladakh's long-enduring success. Factors that challenge Ladakh's continued success, and how these challenges may be overcome, are identified. The Ladakhi experience shows that communal water management is a viable management regime that can provide insights into how to improve the way in which water is currently managed.

April, 2007

It is a fact of the human condition that we can achieve none of our goals without water.
– Chaturvedi, 2006:63

1. WATER IN THE DEVELOPMENT CONTEXT

1.1 The Problem of Water: Scarcity, Consumption and Pollution

Water is vital for life. Next to air, it is the most essential resource for humans. Without it, we die. Approximately every fifteen seconds, someone in the world dies from a water-related illness; ninety percent of these deaths are children under five, and most are in developing countries (World Health Organization, 2004). Unfortunately, over one billion people lack ready access to potable water (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2006). Acknowledging this calamity, United Nations Millennium Development Goal (MDG) number seven pledges to half this figure within this decade. The UN has labelled 2005-2015 the decade of action to achieve 'Water for Life,' noting that accomplishing the MDG of water is vital for achieving a variety of other MDGs (UNESCO, 2006). However, the UN itself admits that the organization has a history of setting ambitious global targets, where "all too frequently, these have not included detailed enough implementation plans or the necessary financial resources ... and were rarely met in full" (UNESCO, 2006:29). Thus far, progress on reaching the MDGs has been patchy and slow, which unfortunately means that achieving MDG number seven by 2015 is less than likely (UNESCO, 2006).

Mahatma Gandhi once said, "[t]he earth has enough for the needs of all, but not for the greed of a few" (Shiva, 2002:xv). It must be kept in mind though, that we live on a planet with finite resources. Of the total volume of water on Earth, most is saltwater and freshwater resources account for only 2.5 percent; most of this 2.5 percent is locked in polar icecaps, permanent snowcover, or deep underground, leaving less than a mere 1 percent of the world's freshwater, or less than 0.01 percent of all water on Earth, easily accessible for human use (Gleick, 1993). However, human use is not uniform across the world. The average British citizen uses approximately 200 litres of water daily and the average American citizen 500 litres. In contrast, the average Mozambican citizen uses 9.3 litres per day, and the average Gambian citizen a mere 4.5 litres (Black, 2004a). Fifty litres has been suggested as the basic water requirement per person per day, and thirty the bare minimum necessary to cover basic needs, with five litres allotted for consumption and the remaining twenty-five litres for hygiene (New Internationalist, 2003). However, as the above figures indicate, many of the world's people go without even the bare minimum, while others consume far beyond their need.

Today, around 1.2 billion people, or almost one-fifth of the world's population, live in areas of physical water scarcity (Food and Agriculture Organization [FAO], 2006). By 2025, an estimated 1.8 billion people will face absolute water scarcity, while two-thirds of the world's population will live in water-stressed areas (FAO, 2006).[1] By 2050, the world population is expected to increase by fifty percent to 9 billion, placing increased demands on existing resources (United Nations Department of Economic and Social Affairs, 2000). However, population growth alone does not explain the problem of water scarcity. "Water use has been growing at more than twice the rate of population increase in the last century" (FAO, 2006:2). In many countries, water demand and profligate use continues to rise, while water levels of lakes, rivers and aquifers continue to fall (De Villiers, 2003).

[1] Absolute water scarcity is defined as less than 1,000 m^3/person/year, while water-stress is defined as 1,000-1,700 m^3/person/year (Falkenmark, 2004).

The problem of water scarcity is further compounded by human pollution. "The industrialized life-style has inflicted on the world's waterways a burden of untreated sewage, pesticides, and industrial waste, endangering both the health of people and the health of the aquatic environment itself" (Black, 2004b:137). As potable water is lost to irreversible contamination, the amount of freshwater available to humans, and other animals, decreases, and the problem of scarcity is exacerbated.

There are countless examples of human overuse of water, in the form of unsustainable consumption and pollution of the resource. Though physical water scarcity does exist in some arid environments with dense human populations, ample evidence suggests that the global "water crisis is primarily a water management crisis" (Figuères, Rockström, & Tortajada, 2003:229). The water management disaster of the Aral Sea represents one of the worst examples of human-caused ecological catastrophe. The Aral Sea used to be the world's fourth largest lake until mismanagement and decades of careless irrigation, by a variety of Central Asian countries, resulted in its demise. As the input waters to the sea were diverted for irrigation,

> [t]he level of the lake fell, salinity rose, and vast expanses of the lake bed were exposed. As a result, the fishing industry collapsed, islands that had served as wildlife refuges became peninsulas, the fish and aquatic birds died, vast clouds of salts and chemical fertilizer residues blew from the lake bed onto neighbouring lands, groundwater salinity rose, and the local climate was altered. The effects on the local human population were catastrophic.
>
> (De Villiers, 2003:46)

Agriculture is the number-one user of freshwater worldwide; approximately 70 percent of all water withdrawn from lakes, rivers, and aquifers is used for irrigation (Brooks, 2003; FAO, 2006). If repeating disasters, like the Aral Sea, is to be avoided, better water management is needed; because agriculture accounts for so much of human water usage, particular attention must be focused on ensuring better water management practices for irrigation.

1.2 The Need for a Water Management Revolution

Prime Minister Gro Harlem Brundtland of Norway helped characterize *sustainable development* as paths of social, economic and political progress that meet "the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987:8). Like Gandhi said, the Earth has enough water for us all, however, how the Earth's water resources are currently being managed, has resulted in the current failure to meet the needs of a large percentage of its citizens, and the diminished likelihood that future generations will be able to meet their needs. In many cases, "such mismanagement has contributed to increasing poverty and a deteriorating quality of life," particularly for the citizens of developing countries (Figuères, Rockström, & Tortajada, 2003:232). Further, it is often "the remote habitats of tribal or aboriginal peoples who have least political and economic clout to defend their interests which are most at risk" (Black, 2004b:133).

The world needs a revolution in the way we manage water resources. Central to this revolution must be an understanding that there are many effective ways to manage water resources, and that the most effective management regime will vary depending on the particular circumstances and characteristics of a given area.

1.3 Management of Common-Pool Resources

Water, *inter alia* fish and timber, is an example of a common-pool resource. A common-pool resource is defined as "a valued natural or human-made resource or facility that is available to more than one person and subject to degradation as a result of overuse…for which exclusion from the resource is costly and one person's use subtracts from what is available to others" (Dietz, Dolšak, Ostrom, & Stern, 2002:18).[2] Though common-pool resources share the characteristics of subtractability and difficulty of exclusion, they often differ with regard to a series of other characteristics, namely renewability, scale, and cost of measurement (Dolšak & Ostrom, 2003). Subtractability and the difficulty of exclusion create two main potential problems in terms of incentives for humans using common-pool resources, the problem of overuse, and the free-rider problem, respectively. The problem of overuse includes both overharvesting, or taking too much of a resource out, and pollution, or putting too much of a contaminant into the resource, while the free-rider problem refers to the fact that the benefits of maintaining and improving both the resource and the rules that govern the resource are received by all users, though some users will have not made any contributions. While the term 'common-pool' focuses on characteristics of the resource itself, 'common property' suggests a type of management regime constructed by humans to regulate the use of the resource (Dietz et al., 2002). Given that the physical characteristics of a particular common-pool resource are difficult, if not impossible, to alter, solutions to the problems

[2] Though common-pool resources share the problem of difficult exclusion with public goods (leaving public goods also susceptible to the free-rider problem), they differ in regard to subtractability, or rivalness. With common-pool resources, an individual's use of the resource (fish, water, timber, etc.) subtracts from what is available to other users, both in the present and into the future. On the other hand, one person's use of a public good, such as a lighthouse, does not reduce the possibility for an infinite number of other persons to use the same lighthouse (Dietz et al., 2002).

posed by overuse and free-riding, must necessarily involve alteration within the behavior of resource users. Overuse and free-riding can be overcome if agreed upon rules are established which regulate individual actions and permit social costs to be balanced against social benefits (Dietz et al., 2002).

Common-pool resources are typically regulated by one of four types of property rights regimes: 1) open-access, 2) communal property, 3) state property, or 4) private property (Berkes & Farvar, 1989). With open-access property rights regimes, no individual or group owns the resource, and there is an absence of enforced property rights; no rules exist related to access or amount of harvest of the resource, permitting free access to everyone. In communal property rights regimes, resource rights are held by a group of users who can exclude others and determine how the resource should be used. Among state property rights regimes, ownership and management control is held by a government or crown who can regulate or subsidize the use of public resources. In private property rights regimes, resource rights are held by an individual or firm who can exclude others and who can decide the appropriate usage of the resource (Berkes & Farvar, 1989; Shen, 2003). However, most property regimes in practice do not obey the strict categories mentioned, and instead exhibit aspects of more than one regime in their attempts to manage common-pool resources.

Three broad metaphors are often cited to explain the difficulty of managing common-pool resources, predicting suboptimal use and/or ultimate destruction of the resource. In Hardin's (1968) seminal work, *The Tragedy of the Commons,* he argues that left to their own devices, humans will ultimately bring tragedy to the commons, and therefore, the only way to own and manage common-pool resources was either by state or private means. Secondly, Olson argues that "rational, self-interested individuals will not act to achieve their common or group interests" (Olson, 1965:2). Finally, self-interested behaviour results in classical Prisoner's Dilemmas, where rational actions by all parties involved result in lower utility for everyone – the Nash equilibrium.[3] These three metaphors, though compelling, do not fully explain all common-pool resource management scenarios in practice.

Hardin's arguments stimulated much subsequent research which challenged the validity of his claims, and though highly influential, his work has been criticized as oversimplified. "He missed the point that many social groups, including the herders on the commons that provided the metaphor for his analysis, have struggled successfully against threats of resource degradation by developing and maintaining self-governing institutions" (Dietz, Ostrom & Stern, 2003:1907). Olson also missed the point. Contrary to Olson's assumptions regarding human motivation, many communities emphasize co-operation and "*responsibility* to the community, rather than the unbridled individualism [and competition] glorified in some Western industrial cultures" (Berkes & Farvar, 1989:3-5). Thus, many individuals do not display the rational self-interest, which Olson suggests prohibits successful collective action. While self-interested behaviour can create Prisoner's Dilemmas, this need not always be the case. A variety of complex social arrangements and behaviour (for example, community sanctions) can serve to alter the payouts in the game model, such that the game no longer resembles that of a Prisoner's Dilemma, even if players are self-interested. Further, the Prisoner's Dilemma

[3] See for example, any introductory Economics textbook on game theory, such as Frank, B., & Bernanke, B. (2000). *Principles of Microeconomics*. Toronto: McGraw-Hill Ryerson.

assumes that the game is only played once. When the game is played in perpetuity, individual player's actions may change as their knowledge of the game changes.

Hardin's thesis, and the subsequent work of resource economists in the 1960s and 1970s, argued that unitary ownership of common-pool resources, by either the government or a private owner, would result in their improved management, and led to many policy innovations in this vein. The major policy reform in developing countries was to nationalize ownership of common-pool resources, from forests to in-shore fisheries ownership, by dismantling the existing regimes and transferring control to government (Dietz et al., 2002).

> Extensive research and experience since 1968 shows that these transfers of property rights were sometimes disastrous for the resources they were intended to protect. Instead of creating a single owner with a long-term interest in the resource, nationalizing common-pool resources typically led to (1) a rejection of any existing indigenous institutions — making the actions of local stewards to sustain a resource illegal; (2) poor monitoring of resource boundaries and harvesting practices because many governments did not have the resources to monitor the resources to which they asserted ownership; and (3) de facto open access conditions and a race to use of the resources. (Dietz et al., 2002:11)

Additionally, state-run enterprises have often been criticized as inefficient and their infrastructure deteriorating, since they lack the monetary incentives to achieve efficiency and the capital necessary for maintenance (Adam, 2004; Adam, 2005; Barlow & Clarke, 2004; Hacher, 2004; Reardon, 2004). Thus, the historical experience shows that, in many situations, "a de jure state state-owned resource turns into a de facto open-access resource" and its viability as a common-property resource management regime diminishes accordingly (Dolšak & Ostrom, 2003:20). This has been particularly pronounced in the developing country context, where governments are much more resource-constrained and may lack the political power to enforce human restraint.

As a solution to the failure of some state property regimes to successfully manage common-pool resources, privatization was advanced and implemented. The implementation of private property regimes, for common pool resources, it was argued, would result in increased equity in provision and increased efficiency in operation and maintenance (Perry, Rock & Seckler, 1997). The rise of neo-liberalism has served to further bolster the idea that privatization is the most appropriate means of managing common-pool resources. Consistent with this is the recognition of water as an economic good; proponents of privatization have argued that only when water resources are valued monetarily will the conservation and protection of water resources ensue (Perry et al., 1997). Many common-pool resources have been privatized, though the subsequent results have not been uniformly successful. In many cases, not only have the efficiency and infrastructure gains not been met, but undesired outcomes have also occurred. The private sector is profit-driven, which often results in pricing mechanisms that exclude the poor (Barlow & Clarke, 2004; Public Citizen, 2003; Vilas, 2004). "Poor people commonly pay ten times as much per litre for water of questionable quality as do richer people for water of good quality" (Brooks, 2003:30). Additionally, some contend that "the introduction of private property ... leads to the deterioration of common-pool resources and communities" (Dolšak & Ostrom, 2003:337). Due to the mixed results of these historical experiences, the argument that unitary ownership, in the form of either a state or private property regime, was the logical management regime for all common-pool resources, was called into question.

As a result of this questioning, a rich literature of case studies documenting hundreds of examples of long-term sustainable management of common-pool resources emerged. A review of this literature shows that, under some conditions, local groups can create communal property regimes to effectively manage common-pool resources, such that outcomes are much better than what Hardin's tragedy predicted. Where successful, local groups have created communal property regimes by establishing effective, local, self-governing resource institutions (Dietz et al., 2003). "Although these institutions have not always succeeded, neither have Hardin's preferred alternatives of private or state ownership" (Dietz et al., 2003:1907). However, Hardin was correct that "[f]reedom in a commons brings ruin to all" (Hardin, 1968:371). That is, these successful institutions cannot be characterized as open-access, where there is a free-for-all for resource use, but rather, are characterized as communal property regimes, where there are a set of norms and regulations in place to control resource usage.[4]

Ostrom (1990) formulates a list of 'design principles' (essential elements or conditions) to explain the success of long-enduring communal property institutions in sustaining their common-pool resources, and ensuring users' compliance with norms, generation after generation. Ostrom (1990) lists these principles, with the caveat that they may be neither necessary nor sufficient conditions to achieving these successful

[4] Where a common-pool resource, such as water, is plentiful, an open-access property rights regime can provide a viable means of regulating the resource, or rather that regulation becomes unnecessary, however there are extremely few examples remaining today of resources which are truly open and freely available to everyone (Shen, 2003).

institutions, just that her analysis shows their prevalence in numerous case studies of successful communal property regimes. The design principles are as follows:

1. Clearly defined boundaries

   Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must the boundaries of the CPR itself.[5]

2. Congruence between appropriation and provision rules and local conditions

   Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, material, and/or money.

3. Collective-choice arrangements

   Most individuals affected by operational rules can participate in modifying the operational rules.

4. Monitoring

   Monitors, who actively audit CPR conditions and appropriate behavior, are accountable to the appropriators or are the appropriators.

5. Graduated sanctions

   Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and context of the offense) by other appropriators, by officials accountable to these appropriators, or by both.

6. Conflict-resolution mechanisms

   Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.

7. Minimal recognition of rights to organize

   The rights of appropriators to devise their own institutions are not challenged by external governmental authorities. (Ostrom, 1990:90)

[5] Ostrom abbreviates common-pool resource as CPR.

In addition to the design principles for institutions, a series of factors which facilitate institutional effectiveness are set out:

1. the resources and use of the resources by humans can be monitored, and the information can be verified and understood at relatively low cost (e.g., trees are easier to monitor than fish, and lakes are easier to monitor than rivers);

2. rates of change in resources, resource-user populations, technology, and economic and social conditions are moderate;

3. communities maintain frequent face-to-face communication and dense social networks – sometimes called social capital – that increase the potential for trust, allow people to express and see emotional reactions to distrust, and lower the cost of monitoring behavior and inducing rule compliance;

4. outsiders can be excluded at relatively low cost from using the resource (new entrants add to the harvesting pressure and typically lack understanding of the rules; and

5. users support effective monitoring and rule enforcement. (Dietz et al., 2003:1908)

Further, attributes of both individual common-pool resource users and a group of users, as a whole, influence institutional effectiveness; the preferences and assets of individuals, and the size, cohesion, trust, and homogeneity of groups all affect the institutions governing common-pool resources (Dolšak & Ostrom, 2003).

"Empirical studies show that no single type of property regime works efficiently, fairly and sustainably in relation to all common pool resources, including water resources" (Shen, 2003:148). There will be scenarios where state or private property regimes perform well and perhaps even more efficiently than communal property regimes. Likewise, there are scenarios where communal property regimes are the preferable management type. However, there is a strong tendency within global development policy to ignore communal property management regimes (Dietz et al., 2003). To ignore communal property regimes when considering appropriate management regimes for common-pool resources is to potentially overlook useful tools, viable methods, and centuries of experience that may be quite useful for policy makers.

1.4 Communal Property Regimes: An Effective Management Alternative for Water

While different property regimes necessarily suggest a particular type of ownership, it is the management aspects of a regime that are the focus of this research. For example, it is possible to have state ownership of a resource, and communal management of the same resource. In some communal property regimes, the common-pool resource may not be legally owned by the community, however it is managed by the community. For the purposes of this research, the particular owner of the common-pool resource is not the focus, rather it is the community-based norms and rules, which impact how the common-pool resource is used that form the focus of this research. Community is "defined as some geographically delineated unit within a larger society" that uses a certain common-pool resource (Berg, 2004:260). The particular community-based norms and rules that are investigated in this research are the traditional water management practices of a community in Ladakh, northern India. The term 'traditional' defines practices, which have had "historical continuity among a group of people" (Berkes & Farvar, 1989:11). Throughout the subsequent chapters, the terms community-based management, traditional management, and communal property management are used synonymously.

The general purpose of this research is to investigate communal property regimes in the management of the common-pool resource, water. The decision to study the management of water was made on the basis of its importance as a development issue and of the current status of water management practices (as discussed in Sections 1.1 and 1.2). Specifically, it was the management of water in rural areas of developing countries that was of particular concern to the researcher. “About 900 million poor people – or three-quarters of the world’s 1.2 billion poorest people – live in remote, rural areas…” (United Nations Human Settlement Programme [UNHABITAT], 2004). In rural areas of developing countries, populations tend to be sparse, dispersed and inaccessible, challenging the effectiveness of state and private property regimes in the management of water resources in the rural locale (Black, 2004b; UNHABITAT, 2004). Section 1.3 of this chapter suggests that communal property regimes may be a viable water management alternative in a variety of settings, including rural areas. In an attempt to find environmentally sound rural water management strategies, the experience of Ladakh was discovered as an example of a long-enduring, rural, communal property water management regime. Ladakh was chosen as a case study for this precise reason. Further, Ladakh was also chosen for this research because it is a water scarce region. Though water scarce, Ladakhis have been able to survive for centuries in a water scarce, and rather inhospitable, environment by employing traditional water harvesting technologies and management systems. Preliminary research suggested that these systems increased sustainability (both ecologically and economically), increased distributional equity, and led to community development (Centre for Science and Environment [CSE], 1997). The guiding rationale for studying Ladakh is that, if Ladakhis can succeed in such water scarce conditions, then other communities could potentially succeed also.

Acknowledging that Ladakh has successfully managed scarce water resources for centuries, the primary purpose of this research was to determine what technological and institutional characteristics facilitated Ladakh's success in the past. The research then sought to ascertain whether these characteristics have been maintained in the present, or if there are factors that challenge the viability of common property resource management in Ladakh presently and into the future. Next, the research sought to address if and how these challenges could be overcome. Finally, the research sought to determine what the Ladakhi experience could offer other communities. That is, if why and how Ladakhis have been successful can be elucidated, then perhaps knowledge of these 'best practices' can be transferred to other communities struggling to achieve more effective water management, through the adoption or maintenance of communal property water management.

1.5 Research Methodology

1.5.1 Methodological Approach

In order to gain trust, connections, and entry into Ladakhi society (communities in Ladakh), a relationship was established, over the course of a year leading up to the research, with an international non-governmental organization (NGO) that had over thirty years experience working in the region of Ladakh. In exchange for the promise of assistance gaining entry, making connections with informants and participants, and providing a translator for interviews, the researcher volunteered for this NGO for several months, both in Canada, prior to departure, and in Ladakh, upon arrival. Limited assistance was eventually provided for establishing initial connections, but beyond that, the NGO's promises were not upheld. In fact, a translator was never provided, which significantly compromised the research. Significant adjustments had to be made to the intended methodological approach.

It was intended that the methodological approach of this field research would be mixed methods, with a quantitative focus. The main strategy of inquiry was intended to be the survey, specifically employing structured questionnaires to gather information on the water management system of several communities in Ladakh. Along with no longer having a translator, it was decided that, in any case, structured questionnaires would have been too formal a data collection method. It was suspected that, if questionnaires had been used, trust would have been breached, as suspicions would have been raised regarding the high level of formality. Additionally, for a population with significant illiteracy (in both Ladakhi and English), written questionnaires would be barring to many participants, and even for those who could read, it would be heavily taxing and time-consuming for them to decipher. In order to minimize the burden on those participating in this research, and to maximize their comfort-level, it was decided that semi-structured interviews would be the most culturally appropriate method of data collection.

The methodological approach, which was actually used, was primarily qualitative in nature. Specifically, the qualitative strategy of the case study was employed (Creswell, 2003). The case study strategy was chosen because it makes use of a multitude of research methods providing an in-depth study of a particular program, process or institution (in this case, the Ladakhi water management system), bounded by time and activity (Stake, 1995). The case study strategy was also chosen as an appropriate tool to explain causal factors and provide insights into a theoretical proposition (Berg, 2004). In this research, the theoretical proposition is the viability of communal property regimes for water management. The causal factors include the institutional design principles, user and resource characteristics, discussed in Section 1.3. Further, the case study strategy provides rich and detailed information which can be useful for generalizing the research findings from the individual case study to other development situations (Berg, 2004).

1.5.2 Methods of Data Collection

Typical of most case studies, a number of data-gathering methods were used, though semi-structured interviews formed the basis of this research. Other qualitative methods, such as researcher observation and document analysis, and, to a very limited extent, quantitative methods of data collection and analysis, such as census and meteorological data, were also employed.

Qualitative

- Semi-structured Interviews: Lying at the midpoint along the continuum of structure in interviewing, semi-structured interviews typically entail a set of predetermined questions, in a predetermined order, but allow for the freedom to digress, reorder the questions, and/or adjust the level of language or wording of the questions (Laws, 2003). One-to-one in-person interviews were conducted, which called for oral responses by the participants to both closed- and open-ended questions[6], and allowed for the aforementioned flexibility. The researcher's interviewing skills improved as the research progressed, and thus the information for some communities is more complete than for others.
- Observations: Visual examinations of objects (i.e. water infrastructure), processes, relationships and people were made, and these observations were recorded as field notes. For example, how and when people divert water to their fields was examined. "By directly observing what happens, the researcher can check

[6] See Appendix for a sample of the types of questions that were asked during these interviews.

whether what people say they do or think is reflected in their actual behaviour" (Laws, 2003:304).

- Text and Image Data: Various documents (including published sources) and imagery that pertain to the Ladakh's water management, such as maps, diagrams, and photographs of the communities were acquired from a variety of sources and carefully studied. Text and image data contribute to providing a more complete picture of the research problem by using all the methods available (Bogdan & Taylor, 1975).

Quantitative

- Census Data: Population data was utilized to obtain demographic statistics (such as size, growth, density and distribution) for the various Ladakhi communities studied. The Indian government collects this information every ten years; the last census poll in India was in 2001 (Census India, 2005).
- Meteorological data: Statistics regarding the temperature, precipitation, and weather patterns in the Ladakh region were collected from a variety of sources and analyzed for trends.

1.5.3 Selection of Research Sites and Participants

This study was confined to the region of Ladakh within the district of Leh. Leh District was chosen as it is this area in the central Indus Valley which is considered the 'heartland' of Ladakh (Loram, 2004). Because of the politically sensitive nature of the region, the research was restricted to the Leh, Kharu, and Khaltse Blocks of Leh District.

Communities within Leh District were selected according to a variety of characteristics they possessed. To determine if proximity to or from Leh town, the capital of the region, was a factor that affected the integrity of the traditional water management system, Leh was chosen, as well as five different villages which were located at approximately 10, 25, 45, 70, and 85 kilometres in distance from Leh. The reader should bear in mind that the roads, including the main highways, in Ladakh are often windy, single-laned, dilapidated[7], and sometimes unpaved. While a distance of 85 kilometres on a highway in Canada might take approximately 50 minutes to travel by vehicle, in Ladakh, this same distance could be a full day's journey by car, and even longer via other modes of transport (public buses, animals, by foot, etc.).

The villages chosen were in many ways determined by the insecurity and geography of the area. The desire was to study villages at varying proximity from Leh, but also in different directions from Leh – to the north, to the south, to the east and to the west – at different elevations (altitudes ranged from 3,250m – 3,700m) and with both northern and southern aspects. However, directly north of Leh is a stretch of road over the Khardung La that descends on the other side into the Nubra Valley. Nubra is one of the restricted areas where special permits are required. Southeast of Nubra Block lies Durbuk Block and Nyoma Block, also sensitive border regions where permits are required. With these extra logistical considerations, safety issues, heavy army presence and check points along the way, it was decided that the research would not be conducted in either of the Nubra, Durbuk or Nyoma Blocks. Directly south of Leh lies another geographic barrier, the Stok Mountain Range, and as a result, this research was confined to the corridor along the Indus River, to the northwest of Leh and to the southeast of Leh, throughout the Leh, Kharu, and Khaltse Blocks.

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[7] Not only are the roads dilapidated, but equally are most of the vehicles, including both public buses and private taxis (probably often due to the state of the roads).

Aspect refers to the direction to which a mountain slope faces. The aspect of a slope can produce very significant influences on its local climate, which can in turn influence snow melt, farming, et cetera. "In the Himalayas, this effect can be seen to an extreme degree, with south-facing slopes being warm, wet and forested, and north-facing slopes cold, dry but much more heavily glaciated" (Wikipedia, 2006). Thus, it was desirable to study both villages with a northern aspect and villages with a southern aspect, to see what, if any, impact aspect had on the water management systems. Therefore, within the three blocks, villages were selected accordingly.

Villages were selected that could be accessed by roads along bus routes because a) financial constraints were such that private taxis were not affordable, and instead public buses were relied upon for transportation to and from villages; b) travelling by bus allowed for most of the limited research time to be spent in the village rather than in transit by foot overland to more remote villages; and c) villages located along bus routes would increase the likelihood that some degree of English had penetrated the village, enabling easier communication. Having no translator posed a significant constraint to the research. In just a few short months, the researcher was able to learn the basics of the Ladakhi language to the point where conversation and comprehension in Ladakhi were made possible at a beginner level, however the ability level was not sufficient to conduct interviews solely in Ladakhi, and thus it was imperative to find participants with at least a basic level of proficiency in English. Therefore, not only did participants have to possess sufficient knowledge of the water management system, but they also had to be capable of explaining the system to the researcher. It is acknowledged that this selection criteria undoubtedly prevented certain participants from vocalizing their opinions and responses.

Excluded participants are expected to have been those less inclined to possess English language skills, most likely the elderly, the young, the very poor, and the disabled members of each community. For the most part, villages were selected where connections with people from those villages had been made, or where an informant had connections, however, some external variables also posed constraints to these plans. For example, during July and August 2006, the region experienced some pretty severe weather, and as a result, many roads and bridges were washed out due to flooding, preventing access to certain villages.

Participants in this study were selected via snowball sampling. Through the use of a few initial informants, the researcher was able to identify a few initial participants with characteristics relevant to the study. These participants were interviewed and then asked for the names of other people who possessed these same characteristics. By asking these initial participants for referrals, the sample eventually 'snowballs' from a few participants to many (Berg, 2004). This procedure is an effective way to locate participants with certain attributes or characteristics and/or those who are difficult to reach (Berg, 2004). In this study, participants possessing two main attributes, both sufficient knowledge of the water management system and the capability of explaining the system to the researcher, were sought. Not only did the referred participants have to possess these two main attributes, but the villages where they lived also had to possess the necessary characteristics pertaining to their distance from Leh, direction from Leh, altitude, aspect, accessibility, et cetera. Some villages, for example Alchi and Hemis Shukpachan, had local phone service within the village, but external phone lines were either unavailable or inoperable, making it difficult to reach potential participants. The use of snowball sampling in this study mitigated both of these obstacles for participant selection.

One of the constraints faced was the time-sensitive nature of the research to be conducted, in the region where it was to be conducted. The timing of the agricultural season, which generally begins with ploughing in April and ends with the harvest in September, is synchronized with the melting of snow in late spring and the falling of new snow in early autumn. In order to witness the water management system in action, it was vital then, to be in Ladakh conducting this field research during this short window of time. Additionally though, during the eight months of winter (between November and June), the two highways connecting Ladakh to the rest of India (the Leh-Srinagar and the Leh-Manali highways) remain closed, making access in and out of, and movement throughout, Ladakh extremely challenging (Monasterio, 2000). Therefore the time of year that this research could reasonably be conducted in Ladakh was virtually predetermined; this field research was conducted in Ladakh in the period between early July and early October, 2006. Thus, with only three months to work with, the number of villages to be studied, and the amount of time to be spent in each village, was limited. In the end, time was divided between Leh and five surrounding villages.

1.6 Overview of the Chapters to Follow

Following this introductory chapter, discussing water in the development context, the history of water management in India is examined in order to situate Ladakh within the broader Indian experience. In the third chapter, the case study of Ladakh is presented and the research results of the various communities investigated are described. Finally, in chapter four, the research results are analyzed and their significance explored in the context of the broader theoretical communal property discussion which was reviewed in the first chapter.

2. HISTORY OF WATER MANAGEMENT IN INDIA

2.1 Introduction

"India is experiencing a water crisis" (CSE, 2001). The problems are severe and widespread, and the following are but a few examples: a "growing frequency of pollution scares; of bottled water and 'owning the rain' scandals; the rapid rate of groundwater depletion; [and] the salinization of irrigated soil" (Black, 2004:133). The problem does not appear to be getting better. "Every third human being in the world without safe and adequate water supply is an Indian...[and]...every fourth being on the planet dying of water-borne or water-related diseases is an Indian" (Sainath, 1996: 24-25). Rising water consumption patterns, along with population increases, will only serve to worsen India's current water crisis.

But India has not always experienced water crisis, nor chronic water shortage. India has a rich history of water management. One of ancient history's most advanced civilizations was Indian, flourishing on the basis of its ability to successfully develop advanced water management systems (CSE, 1997). Integral to this management were technologies and institutions that allowed Indians to harvest, concentrate, collect, divert, and store water in a sustainable and ecologically sound manner. It would not be an overstatement to say that "Indians have historically been the world's greatest water harvesters" (CSE, 1997:25).

Thus, India possesses a plethora of knowledge, passed down over millennia, of water harvesting technologies and management systems that have worked in the past, but are currently either underemployed or are not employed at all. In India we find both the potential solutions to water problems, as well as those who most desperately need that knowledge to better their well-being – we need not look elsewhere to solve India's water crisis.

From the ancient Indus Valley Civilization, through the Age of Empires, and into modern day times, this chapter chronicles the history of water management in India. By carefully examining the history of water management in India, it is possible to find solutions to today's problems in yesterday's solutions. In particular, this chapter provides a historical backdrop from which to view the case study of Ladakh.

2.2 Ancient and Classical Periods

Approximately 10,000 years ago, as hunter-gatherer societies began to cultivate plants and domesticate animals in response to ecological conditions that diminished the viability of their traditional food acquisition practices, agricultural/pastoral societies began to emerge in India (Gadgil & Guha, 1992). These agricultural communities involved a more substantial division of labour than those of the hunter-gatherers, and thus were more heterogeneous in nature, as people tended to specialize by the kind of tasks they performed (i.e. crafts, trade, administration, and fighting forces) (Gadgil & Guha, 1992). Over the next 8,000 years, agricultural settlements spread across the Indian subcontinent, conquering hunter-gathering societies as they went (Possehl, 1982).

By about 2,500 BCE, the Indus Valley Civilization (Harappa) emerged as a conglomerate of many of these individual agricultural settlements (Kamra, 2005). The first evidence of water management in India is found from archaeological excavations of the Indus Valley Civilization period.[8] This urban civilization, based on agriculture and trade, is thought to have been advanced in its water supply and sewage disposal systems.

[8] It is likely that human settlements prior to this period did have some forms of water management, in particular the ability to store water for later use in cisterns, as knowledge of cisterns appears to be present in the establishment of the earliest cities (CSE, 1997).

Archaeological excavations suggest that wells dug for water were probably invented in Harappa, and revealed that, in one city, "every third house had a well" (CSE, 1997:19). Wells were often strategically situated at elevated locations within settlements, and evidence that the Harrapan Civilization was able to cultivate winter crops, indicates that these wells may have been used to irrigate the surrounding fields (CSE, 1997).

Approximately 2,000 BCE saw the climax of this flourishing civilization, but that was brought to a fairly abrupt end by the invasion of nomadic, horse-riding Indo-Aryans from Central Asia in about 1,500 BCE (Chakrabarty, 1986).[9] The next 500 years witnessed the decline of the Harappan Civilization, and with it, the introduction of the Varna or caste system by the Aryans to the pre-Aryans. The fair-skinned invaders practiced rituals of purity and pollution, as well as strict endogamy (Kamra, 2005). These aspects of Aryan culture were revealed in the Vedic texts (or Vedas), providing a literary record of this time period, and the foundations of what is modern-day Hinduism. At first, the newly conquered, dark-skinned pre-Aryans were reduced to servants and assigned tedious and low-status tasks. They were not assimilated through exogamy, and as such, two separate groups, divided by complexion (or Varna), emerged. Later on though, due to a shortage of Aryan females, among other reasons, exogamy emerged as the Aryans began to mix with their conquered, particularly with the previously wealthy and higher classes of the pre-Aryans (Kamra, 2005). This fusion of cultures subsequently led to the division of the two Varnas into four, with the Aryan elites taking up the highest Varna of the Brahmans (priests), followed by the Kshatriyas (warriors). Next were the

[9] Some Hindu nationalist scholars have argued that the Aryan Invasion theory is a myth, and that Aryans were not invaders, rather that they emanated from India itself, and thus were present on the subcontinent before the Harappan Civilization (see for example, (Frawley, n.d.)). Though this position has been strongly refuted (see for example, (Guha, 2005)), the debate continues, and thus merits acknowledgment.

Vaishyas (traders), and those with the darkest complexion were reduced to the lowest status in the society and assigned to the Shudra (manual labourers)[10] Varna (Dube, 2001). The initially nomadic, pastoral Vedic Aryans eventually settled and took to agriculture. This switch to agriculture necessitated a means of irrigating crops, and there is literary evidence of artificial water-channels used for irrigation in the Vedic period (Chakrabarty, 1986). Thus a newly organized Vedic Aryan society emerged.

"Gradually the Aryans expanded their colonies," and with this spread came a shift in the predominant belief system, as agriculture settlements enveloped the remaining areas inhabited by hunter-gather societies (Chakrabarty, 1986:254). The hunter-gatherers were conservation-oriented since they had strong incentives to maintain the resource base that was their source of food and livelihood. Consequently, hunter-gatherers worshipped the supernatural powers of trees, ponds, rivers and mountain peaks. In contrast, the colonizing Vedic Aryans had incentives for profligacy, as destruction of forests allowed for the further spread of agriculture as well as the subjugation of hunter-gatherers (Karve, 1974).

> Supernatural power would now no longer reside in specific trees, groves or ponds, but would be the more abstract forces of nature: earth, fire, wind, water, and sky, whose assistance could be invoked in the task of subordinating hunter-gatherers and colonizing their resource base. (Gadgil & Guha, 1992:78)

Fire as a tool to clear the forest, and water as a tool for irrigation, became the principal forces of nature celebrated by Vedic Aryans. Indeed the principal deities worshipped

[10] "However, nowhere [do] we find any scent of untouchability with regard to these sudras in the Vedic period, which disfigured the Hindu society in the later period of the Smrtis" (Chakrabarty, 1986:31).

were Agni (the god of fire and guardian of humanity), Varuna (the god of ocean and bringer of rain), and Indra (the god of rain and thunder) (Chakrabarty, 1986). The main ritual of Yanja, or fire worship, emerged in conjunction with these deities. Yanja involved the burning of huge quantities of wood and animal fat (Thapar, 1984).

The belief systems of Buddhism and Jainism emerged in approximately 550 BCE in oppositional response to the wasteful practices of Vedic society, but did not gain pre-eminence until later in the Mauryan Empire (Morrison, 2005). The Mauryan Empire, which flourished in approximately 320 BCE, established a new form of territorial control over living resources; for example, by maintaining forested areas as hunting preserves (Gadgil & Guha, 1992). The Mauryan Empire continued the Vedic Aryans' push for increased land control from which to establish further agriculture, in a much more organized and intense manner (Gadgil & Guha, 1992). It is from this time period that "the first convincing proof of a dam and an irrigation system in India has been dated" (CSE, 1997:21). In conjunction with dams and irrigation works, a new management structure emerged, with a class of officers who governed the irrigation system. Dams and irrigation works were constructed by villagers, with state support, and managed by the local inhabitants (CSE, 1997). This, perhaps, is the earliest record of communal property management of water in India, albeit under the purview of state ownership. Irrigation technologies allowed the Mauryans to increase agriculture productivity in colonized areas, resulting in ever-larger surpluses that could then be repatriated to the Empire providing an increased resource base from which to finance further expansion (Morrison, 2005).

The increased control by the Mauryan state broke down conservation as practiced by hunter-gatherers, and caused an erosion of the resource base. The acknowledgment of a degrading environmental situation and the need for increased conservation, led to the re-emergence of Buddhism, and the abandonment of the Yajna (Gadgil & Guha, 1992). Buddhism thrived in the Mauryan Empire following emperor Ashoka's conversion to Buddhism in approximately 260 BCE (Morrison, 2005). State policy changed to promote conservation and the prudent use of resources, such as restraints on the killing of animals as well as the planting and protection of trees (Gadgil & Guha, 1992). Though they rejected the supernatural, Buddhism and Jainism built upon the social conventions established by food-gathering societies, advocating that resources should not be used wastefully (Gadgil & Guha, 1992). Evidence of the tradition of water harvesting for conservation appears in ancient "Buddhist and Jain texts [which] contain several references to canals, tanks, embankments and wells" (CSE, 1997:11).

2.3 Pre-Colonial Period

The Gupta Empire (320-600 CE) was to follow from the fourth to seventh centuries (Morrison, 2005). Due to unknown causes (but possibly due to a decline in rainfall, a depletion of soil fertility, and/or a decline in agricultural surplus due to population growth) in both the Gupta and post-Gupta periods, India suffered a severe resource crunch, which Gadgil and Guha (1992) argue led to a unique system of cultural adaptation to the natural environment. It was at this time that Buddhism and Jainism lost their influence in India and Hinduism re-emerged and came into its prime, bringing with it a renewed reverence of plants, animals and landscape. Though the Varna, or caste system, was already present in Indian society, the resource crunch provided the impetus for the crystallization of this form of social organization, which resulted in the allocation of control over particular resources to particular castes (Gadgil & Guha, 1992). The village became the main unit of social organization, with each caste possessing high levels of specialization in resource protection and regulation. New rules governing diet, common access, and hunting materialized, and the prudent use of natural resources appeared once again (Gadgil & Guha, 1992).

The resource crunch existed in India from approximately the fourth to tenth centuries, and improvement to this situation was in part brought about by "the introduction of new technologies, such as irrigation tanks, which would lead to a rise in agricultural productivity and production" (Gadgil & Guha, 1992:106). In the post-Gupta period, the management and spread of the new technologies, for example tank irrigation systems with sluice gates, became centred on the temple, and were controlled by the Brahman caste (Joshi, 1997).

During the medieval period, especially under the rule of the Hindu Vijayanagar kings of the south (1336-1614 CE), the water harvesting tradition in India became well developed (CSE, 2001:5). The tax regime played an important part of this development. Taxes were collected as a percentage (approximately twenty percent) of total produce generated by a farm (CSE, 2001).[11] Thus, kings' revenue fluctuated with the success of local agriculture. In drought years, when total produce generated was significantly lower, so too were the kings' revenues. As agricultural prosperity was vital for increasing state revenue, agricultural production was intensified, and kings encouraged the building of water harvesting structures by offering fiscal incentives. Grants of tax-free lands were

[11] It should be noted that there were a variety of governance structures surrounding water, based on the leadership of the particular area. One such system was *goam* where the local people helped maintain the water infrastructure through voluntary labour (Suzuki & Dressel, 2002).

provided in return for the construction and maintenance of irrigation structures. Thus, the king had a vested interest in ensuring the success of local agriculture, and a large part of this was ensuring proper management of water resources (CSE, 2001).

Local communities were vested with the responsibility of water resource management (and in some cases ownership), with

> powers to arrange for construction, repairs and maintenance of tanks; powers regarding land transactions relating to irrigation; management of water supply; levy and collection of cess for irrigation and powers to assign cess; powers to engage and remunerate local functionaries; maintenance of records; dispute settlement; and, relations with the central government. (CSE, 1997:298)

Villages would allocate approximately five percent of their produce for maintenance of tanks and irrigation structures (CSE, 2001). Thus, there was strong interest at both the local and supralocal levels for proper water resource management (CSE, 1997).

During the Muslim Period (1500-1700 CE), political power shifted north to the Mughal Empire (Metcalf & Metcalf, 2002). The Mughal Empire maintained a similar tax regime to that of the southern Vijayanagar Empire. The control and management of resources, including water, remained under the purview of villages (Gadgil & Guha, 1992). Conservationism continued with some practices being advanced as religious edicts. The first European settlers arrived in 1498 (Morrison, 2005). By the mid-eighteenth century, the Mughal Empire's power had contracted being usurped by regional powers that were previously subordinate. "Among the new regional powers was a joint stock company of English traders, which, by century's end, was poised to claim the mantle of the Mughals as ruler of the subcontinent" (Metcalf & Metcalf, 2002:28).

By the end of the Mughal Empire, India had developed a myriad of advanced technologies to harvest, concentrate, collect, divert, and store water, along with the necessary institutions to manage these systems. While it is not possible to date the exact invention of many of the technologies used, it is important to outline their existence, as it is these technologies that can contribute to solving India's current water issues.

In the hill and mountain regions of India, where streams and rivers were plentiful, Indians constructed simple structures, allowing the diversion of water for irrigation through artificial channels (*guhls* and *kuhls*) (CSE, 1997). In *arid* and *semi-arid* areas, water was diverted to storage structures (called *zings* in Ladakh, *ahars* in South Bihar, and *keres* in Karnatake) during times of seasonal plenty, to ensure adequate water during the ensuing dry seasons (CSE, 1997). Rooftop rainwater harvesting, *kunds* (artificial wells with surrounding catchments sloped toward the well to increase run-off), stepwells and subterranean tanks were employed in the Thar Desert region of Rajasthan (CSE, 1997). In the floodplains of West Bengal, river embankments (*zamindari banks*) were built in such a way that would allow the rising river levels during the monsoon to be diverted to the fields, irrigating them, increasing soil fertility (through deposits of silt), controlling malaria (through fish that would eat mosquito larvae), and preventing flooding (CSE, 1997). In the coastal areas, such as the *khazana* lands of Goa, people developed sluice gates (shutter systems that open and close under tidal pressure) to regulate the changing salinity of surrounding freshwater in order to protect their rice fields (CSE, 1997). Horizontal wells (*surangams*), similar to the *qanats* of the Middle

East, were used in the mountainous region of the Eastern Ghats to turn hillside seepage into drinking water (CSE, 1997). The people of the northeastern hill ranges built intricate networks of bamboo pipelines to carry water from natural springs over difficult terrain to a convenient point where it could be used for drinking. In many areas, rain was considered the main source of water, most of which fell in a mere 100 hours each year during the monsoon season. People constructed many systems to capture the rain in order to meet their water demands for the rest of the year. One such catchment system was to build earthen dams (*khadins* of the Jaisalmer district and *johads* of the Alwar district in Rajasthan), which would contain the water and allow it to slowly percolate into the soil, replenishing the underground aquifers (CSE, 1997). "Thus, whether it was rainwater, streamwater, floodwater or groundwater, people developed ingenious ways to harvest and deliver that water for irrigation and for human and animal consumption" (CSE, 1997:28).

2.4 Colonial Period

From approximately 1750 to 1858, Britain increased its control over the Indian subcontinent through the British East India Company (EIC). While the EIC did not initially start out with the objective to conquer India, it did possess an insatiable desire for increased trade (Metcalf & Metcalf, 2002). In India, the EIC found "a land of abundant riches...[with]...surpluses generated at the village level," in large part due to the successful harvesting of water, developed from thousands of years of tradition in improving water management (CSE, 2001:5). In contrast, the British homeland was experiencing the Industrial Revolution, which had drastically transformed their natural resource usage. For example, the British had come to believe "that private property in land alone ensured stability and progress in society" (Metcalf & Metcalf, 2002:77); this belief took legislative shape in the zamindari land system, whereby the land owner (zamindar) had principal rights and responsibility of their estates, while peasants were relegated to tenant status with no rights. Prior to this system, property rights were shared amongst land 'owners,' peasant cultivators, and government, with the tax burden being shared by the former two entities. This tax was a proportion of the total produce generated on the land. Under the zamindari land system, the tax burden fell with the landowners only, whose land could be expropriated if they failed to pay the taxes assessed on the land. Taxes became fixed and payment became permitted only in cash (Tewari, 2005). The initial tax rates imposed by the British were excessively high, and one-third of all estates in Bengal state changed hands in the first twenty years of the zamindari land system. Even worse, the necessity to pay an inflexible tax in cash, resulted in zamindars switching their cultivation to cash crops, and/or selling high percentages of their food crops (Metcalf & Metcalf, 2002). With such a high tax burden, there was little production left to earmark for village maintenance of the traditional water management systems. Consequently India's water infrastructure came into disrepair, agriculture production suffered, and incomes declined, all of which resulted in famines becoming increasingly the norm (CSE, 1997).

The EIC's quest to secure increased trade, with the establishment of clearly delineated trading rights within India, was understandably met with conflict from those within Indian society who traditionally had rights over particular resources and commodities. The mercantilist success of the EIC relative to India's family merchants, combined with British allowances for the EIC to arm its ships against interlopers, created an entity with both economic and militaristic power. "With a larger revenue base, the Company could field a larger army than its Indian rivals, and organize a more efficient state structure" (Metcalf & Metcalf, 2002:54). During this period, millions of pounds sterling were transferred from India to English banks, with minimal benefit to Indian producers (CSE, 1997).

"The East India Company ruled India till 1857, the year of what the British call the Great Mutiny, and the Indians call the First War of Independence" (CSE, 1997:274). In 1858, the EIC's control over India was replaced by direct rule under the British Crown. Patterns of resource use that were predominant in industrial Britain began to emerge and change the traditional patterns of resource use in India. Three key aspects of this change were: "the elevation of commercial over subsistence uses [of natural resources], the delegitimization of the community, and the abandoning of restraints on resource exploitation" (Gadgil & Guha, 1992:116).

The introduction of the zamindari land system caused the deterioration of irrigation tanks, destroying the village-based water management systems and weakening traditional village authority. "The breakdown of traditional small-scale community irrigation systems was believed to be a factor in rural impoverishment" (Gagil & Guha, 1992:145). The British "took over the role of the main provider of water and replaced traditional decentralized systems with centralized ones," favouring large-scale works over small-scale works (CSE, 2001:1). However, government functionaries did a poor job of maintaining and operating the water system (CSE, 1997). Under British state-central rule, the disruption of the village social structure, and the removal of their governing power, led to a loss of local control over natural resources and a decline in traditional management and conservation measures.

Of utmost importance to the ecological cycle was the British takeover of forest management, which would have a devastating impact on India's water management.

> The revenue orientation of colonial land policy also worked towards the denudation of forests. As their removal added to the class of land assessed for revenue, forests were considered an obstruction to agriculture and consequently a bar to the prosperity of the Empire. (Gagil & Guha, 1992:120)

This process of deforestation greatly intensified with the building of the railway network, which was fostered by the Indian Forest Act of 1865. The British attached more importance to the development of railways than irrigation, "convinced that the railway would be the key to the spread of British power and civilization" (Metcalf & Metcalf, 2002:95). The reasoning behind this was three-fold: 1) to extend the market within India for British manufactured goods, 2) to extend Britain's ability to procure Indian raw materials for British manufacturers, and 3) to allow Britain's military to quickly concentrate troops wherever they were needed (Metcalf & Metcalf, 2002). As forests disappeared, the system that previously trapped the monsoon rains in the soil disappeared also. Deforestation left large swaths of desert where monsoon rains would merely run off to the ocean, instead of recharging the ground aquifers (Suzuki & Dressel, 2002). The analogy can be made of the water table as a bank account; constant withdrawals without any deposits will lead to bankruptcy (Narain, 2003). In this manner, aquifer recharge acts as a deposit to replenish the account, which is of utmost importance for long-term sustainability of water supply. "However, perhaps the most serious consequence of colonial forestry was the decline in traditional conservation and management systems around the forest" as the tendency was to "break up village communities" (Gagil & Guha, 1992:143).

2.5 Post-Colonial India

Prior to Independence, a debate ensued between Indian nationalists regarding the future planning process of India's development path once the British had left. On one side of the debate were those who advocated the Gandhian approach, and on the other side were the proponents of the 'modernizing' Nehru-Mahalanobis approach. The Gandhians argued that a better balance between man and nature in their approach to development, with the limitation of wants, and small-scale initiatives (i.e. hand spinning) carried out by self-reproducing village communities, was fundamental to recovering India's lost autonomy, and reviving the economies of the rural villages, where the majority of India's population lived.

> Gandhi's scheme was to begin with the villages, to stabilize and enrich their traditional way of life by use of labor-intensive manufacture and handicrafts, and to keep the nation's economic decision making as decentralized as possible, even if this slowed the pace of urban and industrial growth to a crawl. (Schumacher, 1973:5)

In short, the Gandhian approach argued for a revival of the development practices that India had not experienced since the Mughal period (Gadgil & Guha, 1992). Presumably then, this approach would have also advocated a revitalization of India's traditional water management systems.

In contrast, the Nehruvian supporters argued that it was precisely India's failure to adopt modernization, and its intellectual and economic backwardness, that permitted its subjugation by the British colonizers. Thus, they accepted a 'commodity-centered' approach and desired a quick transition to industrialization, urbanization, and utilization of a state-controlled strategy of development that would allow India to 'catch up' to the West (Gagil & Guha, 1992). The Nehru-Mahalanobis approach effortlessly won popular support and, as India gained Independence in 1947, it was this specific strategy of planning that took hold (Chakravarty, 1987). Influenced by Keynes' advocacy of state interventionism, Nehru pursued the vision of a mixed economy within a socialist framework of economic policy, and focused on building a strong state with the role of the redistribution of some assets (i.e. land), a regulatory role (i.e. licenses), and large public sector role of ownership (i.e. water). The notion of water as a public good emerged, and centralized state-control of this sector continued (CSE, 2001).

India's current water situation can in part be blamed on colonial rule, since the British had done much to destroy India's traditional water management systems. However, "no agency can be blamed more for this than the wretched Indian state" itself (CSE, 1997:29). It was the rising Indian capitalist class, a generation educated by the British, who formed the post-Independence Indian political leadership (CSE, 1997). Underlying these elites' "strategy of imitative industrialization was the adoption of the most 'modern' technologies, with little regard for their social or ecological consequences" (Gadgil & Guha, 1992:184). These new Indian bureaucrats held nothing but disdain for the traditional water technologies, and their decentralized management methods. Consequently, "no effort was made to revive these systems or build new systems in a way that complemented the traditional systems" (CSE, 1997:29). Instead, the Indian state opted for "modern science and technology, the messiah of high productivity" and the ensuing creation of large-scale water projects, such as mega-dams, and ever-deepening wells for groundwater extraction (CSE, 1997:311). Though well-meaning, NGOs (predominantly from the 1960s to 1980s) contributed to the heavy and unsustainable dependence on groundwater resources through the extensive provision of wells for drinking, animal needs, and irrigation (Suzuki & Dressel, 2002). As these wells allowed the underground aquifers to be depleted faster than they could be recharged, only a short period of time passed before wells had to be dug ever-deeper in order to reach water, and previous alternative sources of water, such as harvesting rainwater, were forgotten.

Structural Adjustment Programs (SAPs) began in India in 1991, and with SAPs came such policy prescriptions as deregulation and privatization (Dreze & Sen, 2002). Regarding the environment, and more specifically water resources, deregulation can easily lead to increased pollution of water bodies from which the poor collect their drinking water supplies, and the privatization of water leaves the poorest people unable to pay for drinking water (Ellwood, 2001). Furthermore, since 1991, India has seen a declining share of public expenditure on education, health and related sectors (i.e. water supply and sanitation infrastructure and maintenance) (Motiram, 2005). The case study of Coca-Cola in India is but one example of the impact SAPs have had on Indian water resources. Coca-Cola's practices in Kerala have continuously overdrawn common water supplies, while at the same time discharging toxic waste into the surrounding area that has polluted the groundwater table. What remains for local Indians is a shortage of drinking water, which is polluted (Rajeev, 2005).

In 2002, the Indian Supreme Court issued a directive to the national Bharatiya Janata Party (BJP) government suggesting that they undertake a grandiose project – the 'garland of rivers' proposal. This proposal, advocating the linking of thirty-seven of India's river systems (whereby water from these systems would be diverted throughout India and captured behind thirty-two major dams), exemplifies the modern-day solution to solving the country's water shortage crisis (Black, 2004). While the 'garland of rivers proposal' has not yet been fully executed, it shows that the dominant ideology regarding water management in India has not changed.

Pant (2003) succinctly summarizes the post-colonial impact of India's development policy on its traditional water management systems, as well as the current water situation in India:

> Today, unfortunately, this entire heritage, cultural and technological, lives in tatters. And no agency can be blamed more for this than we ourselves. As modern technology came in, people became dependent on piped water supply and in the bargain forgot the use of the old time-tested water harvesting techniques. Over the years, therefore, not only have we not developed our traditional wisdom further through the application of modern science and technology, we have permitted our knowledge and systems to atrophy in favour of exploitative and unsustainable methods. The net result is growing water distress in increasingly large parts of the country. (Pant, 2003:62)

Thus, instead of reversing the trends of the colonial period, the post-colonial period was marked by further downward trends with respect to water management.

2.6 Changing Currents: Reasons for Hope

India has a rich history of common property resource management, though colonization and globalization have diminished its predominance. Despite years of 'modernization' there are still pockets in India where the traditional water management systems are in place and in use. These areas tend to be rural and remote, particularly in the Himalayan states, where the "reach of water bureaucracies remains weak" (Agarwal & Narain, 1997:112). Though these pockets are few, there is an emerging campaign to revive traditional water management systems in India, particularly in Rajasthan. Additionally, in some parts of the country (i.e. in the city of Mumbai and in the state of Tamil Nadu), governments have legislated that "it is now mandatory for all [new] buildings to have rainwater harvesting devices" (Black, 2004:133). With the removal of the BJP government, perhaps there is a glimmer of hope that the new administration will adopt less socially and ecologically destructive water management policies. In looking to the past, it is possible to find solutions to the current water crisis in India. Part of this retrospective analysis must include an examination of the pockets in India where traditional water management systems still exist, a determination of what makes these systems work in their particular locale, and an analysis of whether aspects of these systems are applicable to the current problem in other areas of India or in other developing countries. The following chapters will investigate one such pocket – Ladakh.

3. CASE STUDY OF LADAKH

3.1. Ladakh: General Background

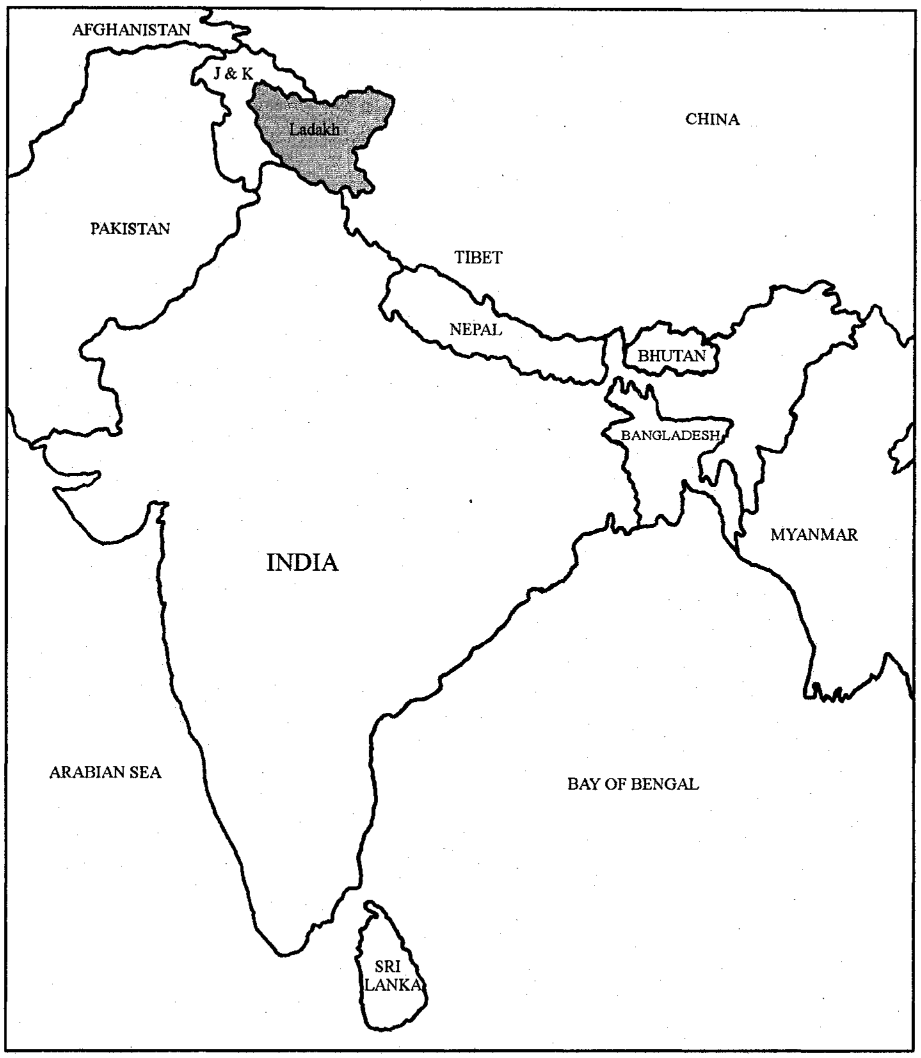

Figure 1: Location of Ladakh within India and South Asia.
Note: The borders on this map are not officially recognized. (Map by Natalie Boyd)

Ladakh is a semi-autonomous region, in the eastern half of Jammu and Kashmir state, in the far north of India (see Figure 1). Ladakh "shares its much disputed north-western border with Pakistan, while to the north lies the Chinese province of Sinkiang, and to the east, Chinese-occupied Tibet" (Loram, 2004:103).[12] Due to its location, Ladakh has become one of India's most important strategic zones, and a heavy military

[12] If the disputed region between India and Pakistan was settled in India's favour, then Ladakh would also share a short border with Afghanistan.

presence exists throughout the region (Goodall, 2004). Geographically situated on the western extension of the Tibetan Plateau, Ladakh lies nestled between the world's two highest mountain ranges – the Himalaya, to the south, and the Karakoram, to the north. Between these two vast ranges are the Ladakh and Zanskar mountains, located north and south of the Indus Valley respectively. The name Ladakh is derived from the Tibetan *la-dags*, meaning "land of high mountain passes," and, as its namesake suggests, Ladakh lies at altitudes ranging from about 2,750 to 7,670 metres above sea level (Harvey, 1983:14; Government of Jammu & Kashmir [GoJ&K], 2006c).

This high-altitude trans-Himalayan region is classified as a cold desert, due to its aridity and cold temperatures. Lying in the rain shadow of the Great Himalayan Range, Ladakh, characterized by its barren, lunar-like landscape, rarely receives precipitation in the form of rain. The Himalayas form an almost impenetrable barrier to the monsoon clouds of the Indian south, and as a result, mean annual precipitation is less than 150 millimetres, with a typical year exhibiting over 300 days of clear, sunny skies (Wiley, 1997). For comparison, the hot Thar Desert, of the more southern Indian state of Rajasthan, receives a similar meagre 100 millimetres of precipitation in the west, and about 500 millimetres in the east (Encyclopædia Britannica, 2007b; Rawat & Wikramanayake, 2001). In both cases, most of this rain falls during a short period from July to September, and recently, both Ladakh and Rajasthan have been experiencing significant increases in their annual average precipitation (Loram, 2004; Tyagi & Yadav, 2006). However, despite Ladakh's aridity, its landscape was not always so parched. In fact, "Ladakh was once covered by an extensive lake system, the vestiges of which still exist on its south-east plateaux" in a number of high-altitude fresh and salt water[13] lakes (GoJ&K, 2006a). Mineral and sulphur springs also speckle the dry landscape.

The majority of precipitation in Ladakh therefore falls in the form of snow. In central Ladakh, snowfall can be rather negligible in winter, however "in Zanskar and the far west of Ladakh, especially around Drass, substantial falls are common" (Loram, 2004:105). The region of Ladakh normally remains land-locked from November to June as the Leh-Srinagar and Leh-Manali highways, the two highways which connect Ladakh with the rest of the country, are kept closed because of the snowfall and extremes of winter weather (namely avalanches, ice, wind, and poor visibility on the narrow winding passes). The only route accessible to Ladakh during the winter is air, though the air services are infrequent and there are often cancellations of flights due to fog in Delhi and Leh (National Informatics Centre [NIC], 2006a).

Temperatures in Ladakh range from highs of 30 degrees Celsius in the peak of summer (July-August) to lows of -30 degrees Celsius[14] in the peak of winter (December-February), though summer days are usually quite mild averaging about 20 degrees Celsius, and winters are long and cold, with the average daily temperature hovering around -20 degrees Celsius (Jacobson, 2000; Loram, 2004; Wiley, 1997). "Given the mountainous conditions of Ladakh, there are many microclimates that are characterized by different temperatures, precipitation, and solar radiation, but in general, Ladakh is arid, dusty, windy, and cold for much of the year, and the air always hypoxic" (Wiley, 1997:276). Notably, Ladakh is considered one of the coldest, highest and driest inhabited

[13] Since ancient times, salt has been extracted from these lakes and traded for human consumption throughout Ladakh (Loram, 2004).
[14] In the Drass area (of Kargil District), the second coldest place in the world after Siberia, the temperatures can drop to as low as -50 degrees Celsius in winter (Government of Jammu & Kashmir, 2006b).

places on earth, and though the environment appears harsh and inhospitable, people have not only survived here, but have thrived here for centuries (Page, 1993).

Due to Ladakh's aridity and cold temperatures, the agricultural season is limited; generally, ploughing begins in April and the harvest is completed by September, however, depending on the elevation, climate, and water availability of a given village, the season could be as short as four months (GoJ&K, 2006c). Adding to these challenges, the fragile mountain soil, which is thin, sandy, and porous, is subject to erosion due to persistent winds and heavy snowfall throughout the year (NIC, 2006a). Soil erosion further contributes to the already ecologically marginal conditions for farming in Ladakh (Kala & Mathur, 2002). Yet, despite these conditions, narrow fertile valleys, scattered here and there, provide a stark contrast to the otherwise austere landscape. These lush patches of green that dot the dry landscape are villages of cultivated fields, which have been carved out of the rocks and sand of the desert and irrigated utilizing the ingenuity of an age-old system of diverting the meltwater, from higher altitudes, into an intricate system of channels (yuras). These channels, which were built centuries ago, bring this water to their fields, often over great distances and rough terrain. Several major river systems flow through Ladakh, including the Indus, Zanskar, Shyok, Nubra, Suru, and Drass Rivers. "Most villages and fields are situated on the relatively flat plains of the [these river valleys] or in subsidiary valleys along tributary streams" (Wiley, 1997:277). Thus, the location and size of each village depends on the topography, but more-so on the availability of water (Jacobson, 2000). Due to the scant rainfall in Ladakh, farmers have to primarily rely on glacial meltwater, snowmelt, springs (chumiks), and marsh (spang) water to irrigate their crops.

The principal crop is barley, and its roasted flour comprises the staple of the Ladakhi diet. Secondary crops include fast-growing varieties of wheat, peas, and mustard, and most households maintain a sizable vegetable garden of turnips, potatoes, onions, beans, cauliflower, carrots, cabbage and various greens. Within some villages, at elevations below 3,500 metres, there are orchards of apricots, apples, and walnut trees. In the subalpine zones, poplar and willow trees grow wherever there is water and, in the higher alpine zones, juniper trees, wild roses, and sea buckthorn bushes can be found amidst sparse, but hardy, low-lying shrubs (Loram, 2004). "Cultivation is possible only up to 4,000 metres, above which nomadic or seasonally nomadic populations live with their livestock" and instead depend largely on herding and animal husbandry for their livelihoods (Wiley, 1997:277).

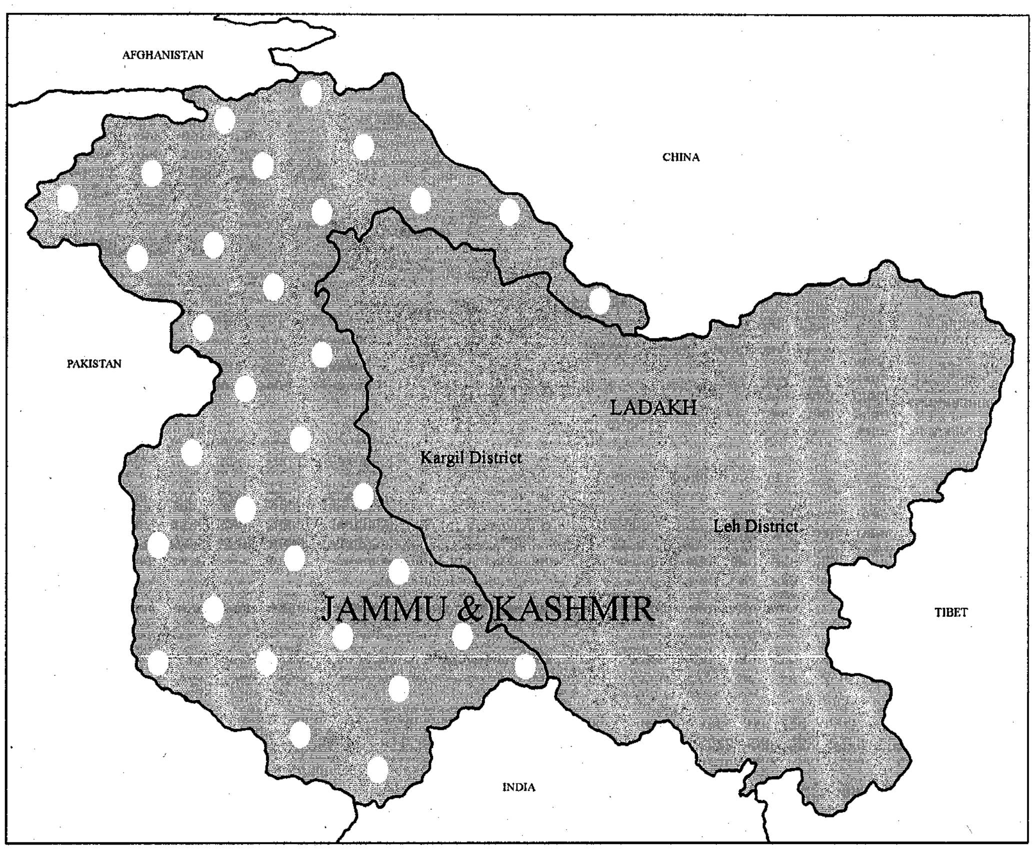

Figure 2: Location of Ladakh within the Indian state of Jammu & Kashmir.
Note: The borders on this map are not officially recognized. (Map by Natalie Boyd)

Ladakh is the largest and highest, yet least densely populated region in India (Wiley, 1997). Occupying almost two-thirds of the state of Jammu and Kashmir[15], Ladakh accounts for a little less than three percent of its population[16] (see Figure 2) (Sikand, 2006). Once an independent Buddhist kingdom, established in about 950 CE and with ruling dynasties that descended from the kings of old Tibet, Ladakh came under Dogra rule as a result of the Dogra invasion of 1834-1842 (Rizvi, 1983). In 1846, Ladakh was incorporated into the state of Jammu and Kashmir as a single district (Loram, 2004). "Even though the British had consolidated their rule in large parts of the country, the Kashmir territories were sold to the Dogras, although control was retained over economic affairs due to the lucrative trans-Himalayan trade" (Tiwari & Gupta, 2003:1). Partition in 1947 left Ladakh as part of the Indian state of Jammu and Kashmir, however, in July 1979, the district of Kargil bifurcated from the rest of the region, and Ladakh was divided (GoJ&K, 2006b). Ladakh now consists of two districts: the larger Leh District, in the northern and eastern parts of the region, and Kargil District, in the western and southern reaches of the region (Goodall, 2004). This study will be confined to the region of Ladakh within Leh District.

The creation of two districts reflects the religious divide within the region, and as a result, Leh District is predominantly comprised of Tibetan Buddhists, while Kargil District predominantly Shi'a Muslims (Sikand, 2006). As per the 2001 Census of India, Leh District has a population of 117,232 while the population of Kargil District is 119,307 (Government of India, 2001b). Though both districts have a roughly equal

[15] The whole of Ladakh covers a geographical area of about 96,700 square kilometres, including the 37,555 square kilometres that have been under Chinese occupation since 1962 (GoJ&K, 2006c).
[16] According to Census of India 2001 statistics, the total population of state of Jammu and Kashmir is 10,069,917 (Government of India, 2001a).

population, the population growth rate in Kargil District is considerably higher than in Leh District, and although, on the whole, Ladakh is still predominantly Buddhist, it might not be for very much longer (Sikand, 2006). Besides religion, these two districts stand in contrast with each other in terms of, *inter alia*, language, geography and climate[17]. Both districts are each further divided into blocks. Leh District is divided into six blocks – Leh, Kharu, Khaltse, Nubra, Durbuk, and Nyoma – and Kargil District into seven blocks – Kargil, Drass, Shakar-Chiktan, Sankoo, Zanskar, Taisuru, and Shargole (NIC, 2006b). The vast majority of the population of Ladakh still live as farmers in small, rural villages, though urbanization has, in the past few decades, become an ever-more pervasive trend (Goodall, 2004; Page, 1993; Wiley, 1997).

The Ladakhis are the result of a long blending of different ethnic groups, most importantly the Dards and the Tibetans (Monasterio, 2000). Originating from Gilgit in Pakistan, the Dards were Indo-Aryans and were the first people to settle in the region which is now known as Ladakh (NIC, 2006c). One group of Dards, known as *the Mons*, maintain their Buddhist heritage, yet are distinguished by their non-Tibetan features, and are thought to be the descendants of the original Dard settlers (Harvey, 1983). Another group of Dards, in the Drass area of Kargil District, at some point embraced Islam, and so lost their original cultural identity (Rizvi, 1983). And a third group of Dards, known as *Brokpa* and who live in the western Dha-Hanu area of Khaltse Block in Leh District, have retained much of their original culture and are the only Dards to have preserved their unique form of Buddhism, which is mixed with the pre-Buddhist animistic religion, Bon (Loram, 2004). This small community of about a couple thousand of Dards has

[17] In Kargil District, the predominant language is Kargali. Average elevations tend to be a little lower, thus the district experiences warmer temperatures in summer, and heavier snowfall in winter (NIC, 2006b).

resisted the ethnic blending that the majority of Ladakhis have experienced and instead appear to have preserved their Indo-Aryan purity down the centuries (GoJ&K, 2006c).

The Dard settlers were joined by Tibetan and Mongolian pastoral nomadic herders perhaps a millennium or so ago, but large-scale immigration from Tibet did not occur until around the eighth to tenth centuries, overwhelming Dard culture and largely obliterating their racial characteristics (GoJ&K, 2006c). Whereas, further to the west, present-day Ladakhi people's appearances suggest a more mixed origin, in central and eastern Ladakh, the great majority of people bear the physical features of their Tibetan origins, until, in the far eastern reaches of the Changthang area of Ladakh, an almost pure Tibetan population is found (Rizvi, 1983).

Not only do the majority of Ladakhis reflect their Tibetan heritage in their appearances, Ladakhi culture – art, architecture, dress, music, medicine, language, religion – does so as well (Norberg-Hodge, 1992). The dominant language in Ladakh is Ladakhi, which was derived from Tibetan and belongs to the Sino-Tibetan language phylum (Wiley, 1997). Tibetan Buddhism predominates in the region, with the Dalai Lama as the spiritual leader. In fact, "Ladakh was the conduit through which Buddhism reached Tibet from India and in the process it got deeply entrenched in the region from the very beginning" (GoJ&K, 2006a).

An intrinsic part of Ladakhi culture is the notion of mutual aid. "In traditional Ladakhi society, people have special links not only with their own family and immediate neighbors, but with households scattered throughout the entire region as well" (Norberg-Hodge, 1992:52). Thus, the individual is part of a web of supportive relationships and as a result, cooperation, rather than competition, shapes Ladakhi society. Cooperation is formalized in a number of social institutions. In one such institution, the *pashpun,* each family belongs to a group of households, sometimes from different villages, which help each other at the time of birth, marriage, and death (Page, 1993). Another institution, the system of *rares*, is the communal shepherding of animals, and *bes*, refers to shared labour where, for example, "some farmers will stagger the harvest, even when two fields are ripe at the same time, just so they can work together" (Norberg-Hodge, 1992:53). The practice of *lhangsde*, an extensive system of sharing resources, such as farm tools and draft animals, evolved to enable the labour-intensive activities, for example sowing and harvesting, to be completed as quickly as possible (Loram, 2004). The spirit of mutual support is especially evident in the distribution of water. Villages are divided up into *chutsos*, or groups of houses, and, over the centuries, a system of sharing has been developed which determines when each household can divert water from the main channel to its fields (Page, 1993). Also, other activities, such as the rebuilding of irrigation channels, involve the community as a whole, which is further evidence of the pervasive societal nature of cooperation.

For centuries, Ladakh's culture was preserved by its geographic isolation. Remote though it was, Ladakh was never totally isolated. Over the ages, the Silk Route from India to Central Asia passed through Ladakh, however the virtually insurmountable mountain ranges of the Himalaya and Karakoram protected Ladakh from the influences of the rest of the outside world. Colonialism never reached this far so the indigenous culture remained relatively intact (Schenk, 2003). Besides documenting the region via census records, economic statistics, area maps, and land surveys, the British generally left Ladakh untouched and it remained under Dogra rule until Partition in 1947 (Tiwari &

Gupta, 2003). Therefore, unlike the rest of India, the traditional water management system in Ladakh was not affected by colonialism. "This relative isolation of Ladakh was broken and altered at the time of Independence in 1947, bringing it within the purview of the Indian Nation State in the state of Jammu & Kashmir" (Tiwari & Gupta, 2003:2). Then, the first major change regarding external influence came as late as 1960, when the Indian government built a road from the Kashmir valley into Ladakh to defend its borders with China and Pakistan (Hales, 1986). Thousands of Indian troops began to move into the region, and the roads facilitated a new increased movement of goods in and out of Ladakh. And then in 1974, foreigners were permitted to begin visiting Ladakh, and the area was thrown open to tourism and development (Loram, 2004).

3.2 Leh District

This research was confined to the region of Ladakh within the district of Leh. Leh District comprises the heartland of Ladakh, located on the relatively flat plains of the Indus River Valley (see Figure 3). The mighty Indus River, one of the world's longest rivers, and from where India's name is derived, enters Ladakh in the east, from its origin near the holy Mt. Kailash in Tibet, and flows northward to the western side of Ladakh into northern Pakistan, where it then turns to flow south to the Arabian Sea near Karachi (Encyclopædia Britannica, 2007a). In central Ladakh, the Indus forms a broad valley, about 10 kilometres wide, between the Ladakh and Stok Mountain Ranges. Most villages and fields are situated along this valley, on both the north and south banks of the river, or in subsidiary valleys along tributary streams (Wiley, 1997). The two highways connecting Ladakh to the rest of India, the Leh-Srinagar and the Leh-Manali highways, also parallel the Indus River for much of its length through the district (from Khaltse in the northwest to Upshi in the southeast). Leh District is divided into six blocks - Leh, Kharu, Khaltse, Nubra, Durbuk, and Nyoma. This research was restricted to the Leh, Kharu, and Khaltse Blocks.

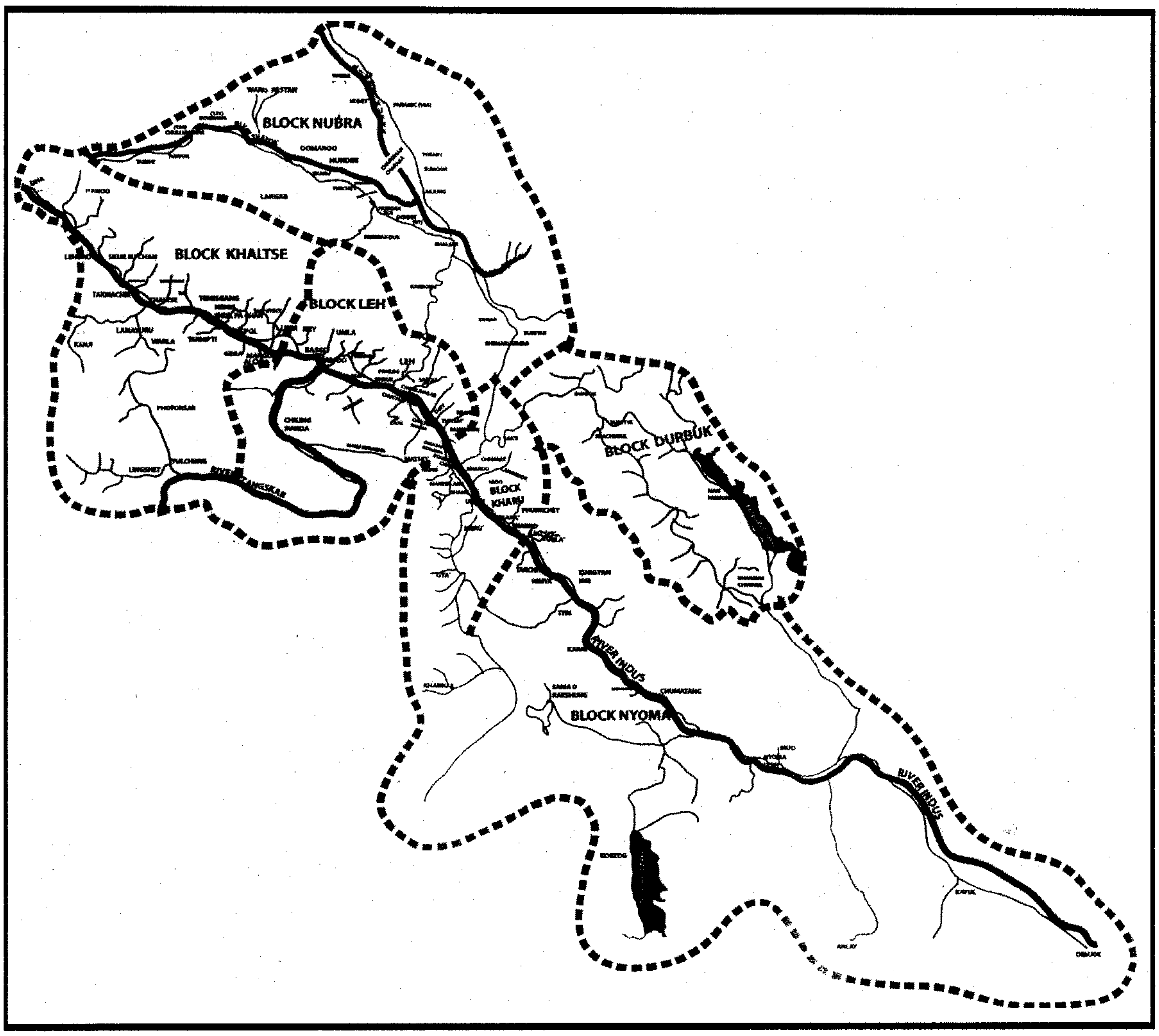

Figure 3: Map of Leh District.
Note: Map by Aaron Dana. Reprinted with permission.

3.2.1 Leh Block

In Leh Block, the town of Leh, and the villages of Saboo and Matho, were investigated (see Figure 4).

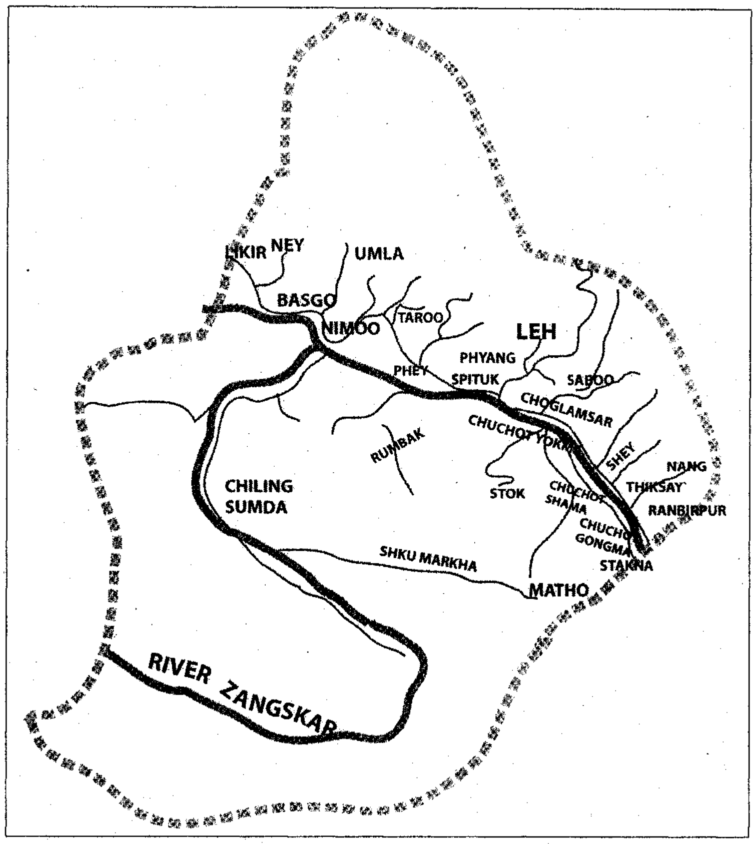

Figure 4: Map of Leh Block.
Note: Map by Aaron Dana. Reprinted with permission.

Leh

Leh, the capital of Ladakh, lies on the north side of the Indus River Valley, nestled between the Stok Mountains to the south and the Ladakh Range to the north. "In the 15th century both Leh and the village of Shey shared the responsibility of being the capitals of Upper Ladakh. Shey was the more fortified of the two, while Leh [situated at the foot of the Khardung La[18]] was in a prime position for trade" (Loram, 2004:117).

[18] Directly north of Leh is a stretch of road, claimed to be one of the highest motorable roads in the world, which passes over the Khardung La, a high mountain pass at 5602 metres altitude in the Ladakh Range, and descends on the other side into the Nubra Valley (Loram, 2004).

The Shey monastery remained the royal residence until the 'lion' King Sengge Namgyal built the Leh Palace and shifted his court to Leh in the 17th century, to be closer to the Khardung La, the gateway of the renowned Silk Route (Loram, 2004). It was due to this move that Leh became the regional capital and the kingdom of Ladakh attained its greatest geographical extent and glory. It did not take long before Leh blossomed into one of the busiest markets on this ancient route, as caravans carrying raw silk, spices, textiles, carpets, salt, tea, semi-precious stones and narcotics made Leh their midway stop along this long trade route between the Punjab and Central Asia (GoJ&K, 2006a). For centuries, this trade route was traversed by caravan traders from Turkistan, Afghanistan, Tibet, the Punjab, Kashmir, and Baltistan, and consequently, Leh developed into a bustling hub of merchants, as well as an important and prosperous centre of trade (Loram, 2004)). Leh's significance as a trading centre, however, was considerably diminished with the closing of the borders into Tibet and Central Asia by the Chinese authorities in 1959, yet Leh has remained the administrative and commercial capital of Ladakh to present day (Loram, 2004).

Situated at 3,500 metres altitude above sea level, the town of Leh, according to the 2001 census, hosts a population of 28,639 people, inhabiting 6,580 households (District Statistics and Evaluation Agency [DSEA], 2006:32). Formerly a central core of Old Leh town with surrounding villages, over the centuries of growth, these villages became absorbed into the core and are now more like neighbourhoods of the town proper. These neighbourhoods roughly correspond with the groupings of households called chutsos. Each chutso is determined geographically and serves to facilitate the distribution and management of water within a specific area of Leh. The 6,580 households in Leh are divided into nine such groupings, named Gangles, Horzey, Gonpa, Changspa, Chubi Yangtse, Tukcha, Sheldan, Shenam, and Skara.

Leh has a southern aspect, and its main tokpo, or principal stream, originates at Khardung La and is fed by the melting glaciers in the Ladakh Range, which lie to the north of the town. Barley and wheat are the two main crops that are grown in Leh. Water from the tokpo provides the primary source of water for irrigation for all of Leh, except Skara. Situated on the southern outskirts of Leh, Skara has no traditional or legal right to the tokpo coming down from the upper parts of town, and is therefore exclusively dependant on chumiks (springs) and spang (marshes) for drinking, domestic, and irrigation purposes.

The irrigation system of Leh town, spans a distance of over seven kilometres from Gangles, at the uppermost part of the town, to Shenam, which lies at the tail-end of the system. Water from the main tokpo first flows through Gangles Chutso, where it is diverted through yuras, or irrigation channels, to irrigate the fields in this area. Water from nearby chumiks is also collected in a zing, or man-made water storage reservoir, called Zing Gangles, which is used to supplement the water received through the yuras for irrigation. The water then flows on to do the same through the yuras of Horzey Chutso, and subsequently on to Gonpa Chutso. Around Gonpa, the main tokpo bifurcates into two tokpos – Sheldan/Tukcha Tokpo (to the left) and Shenam Tokpo (to the right). Water emerging from the chumiks in the phu, or alpine pasture area, above Gonpa forms the Gymsta Tokpo, which supplies water for both irrigation and domestic purposes to Gonpa Chutso, and merges with the Sheldan/Tukcha Tokpo just above the War Zing. Sheldan/Tukcha Tokpo flows down from War Zing toward Pagale Zing, after which it further bifurcates into Sheldan Tokpo and Sangto/Tukcha Tokpo. Sheldan Tokpo flows through Sheldan Chutso and then down into the grazing lands lying below. Sangto/Tukcha Tokpo[19] flows through Changspa Chutso, past Pharka Zing, Peyog Zing, and Sangto Zing, where it bifurcates once again to form the Tukcha Tokpo, which flows down through Tukcha Chutso, and the Sangto Tokpo, which carries water to Skara. Where the main tokpo bifurcates to the right near Gonpa, Shenam Tokpo flows down through Yangtse Chutso, toward Old Leh town near the palace ruins, past Karzoo Zing and Zing Chung, into Shenam Chutso and then down to the grazing lands below.

For over thirty years, the water from the tokpo has not been drinkable. In the upper reaches of the town, in Gangles and Horzey, people can still collect water directly from the tokpo for domestic purposes but down around the town centre, the water in the tokpos and yuras are much too polluted to be utilized. As a result, around the town centre, and elsewhere in Leh, the Public Health & Engineering (PHE) department of the Government of Jammu and Kashmir has installed several public stand posts for drinking water (see Figure 5). The state government department has also installed a piped-water system throughout Leh, from which the majority of people get their drinking water. This piped-water system, essentially a horizontal tube well, pumps potable water from an underground aquifer to tube wells, which then distributes the water to private connections at individual houses via (above-ground) steel pipes. This system, however, is inoperable for about six months of the year. At the end of October, the pipes are drained and closed, otherwise the water in the pipes would freeze in winter and burst the pipes. Therefore, from November until April, people get their drinking water delivered to their houses by

[19] The Sangto/Tukcha Tokpo and its tributaries will from herein be referred to as simply Tukcha Tokpo.

PHE water trucks (see Figure 6). The piped-water system does not reach some neighbourhoods; people living in these areas must rely on the PHE water trucks year-round. In some areas, like Changspa for example, people supplement these water sources by utilizing nearby chumiks for drinking and domestic purposes.

Figure 5: Public stand post.

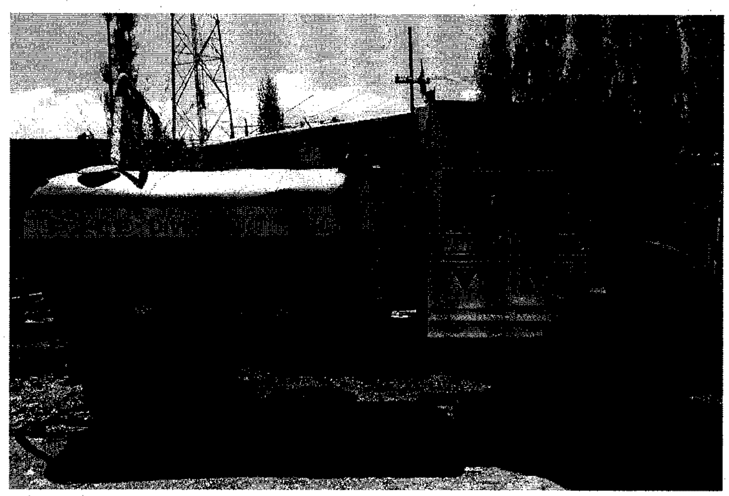

Figure 6: PHE water delivery truck.

The water management system in Leh begins with the selection and appointment of the churpuns, or water managers, which traditionally would be carried out by the goba, or headman. Though historically the position of the goba was inherited down a family line, now, the goba is an elected representative. The year this research was conducted, the goba was Sonam Zangpo of the Shenam Chutso. In earlier times, the goba would select a short list of up to fifteen eligible candidates for the position of churpun, who possessed qualities of leadership, responsibility, and influence. Then the lama (monk) at the Gangles Gompa (monastery) would draw lots and, after a puja (prayer ritual), seven of the potential candidates would be inaugurated as the churpuns for the coming agricultural season. Typically, two churpuns were chosen from Changspa Chutso, one from Chubi Yangtse, one from Shenam, one from Tukcha, and two from Sheldan.

Beginning at the onset of the agricultural season in mid-April and ending with the harvest in mid-September, the churpun's duties are to ensure that all fields receive water and that all minor repair and maintenance works are carried out. In earlier times, repair and maintenance of the entire system was completely carried out by the community. These days, all chutsos are responsible for the maintenance of yuras in their area, that is, to keep the yuras clean and repair broken yuras, however dependence on the government has grown such that now major repairs and maintenance, such as repairing zings, are undertaken by the local administration. It is the churpuns who determine when each household can divert water from the main tokpo to their fields, and if someone were to divert water to their fields without the churpun's permission, it is the churpun's responsibility to help resolve conflicts and to punish the perpetrator. Monetary and corporal punishment are the customary manners of punishment, and the severity of the violation determines the severity of the punishment. For example, in times of severe water shortage, or if large quantities of water have been illegally diverted, violators have been known to receive a hefty fine or beating.

Since 1965, though, the goba has not been involved in the selection or appointment of churpuns (Tiwari & Gupta, 2003). As the economy began to change from primarily a subsistence agrarian economy to primarily a monetary economy, people began to seek paid employment and regard the extra work and responsibility of the churpun as time-consuming and burdensome. One participant suggested that this was perhaps exacerbated by the pervasive army presence and population growth. As a result, the status of the churpun diminished and a new rotational system was created; the responsibility of the churpun for each chutso was rotated among the original households in Leh. However, as the population continued to grow, land became ever-more fragmented and the number of households increased substantially, and accordingly, so did the responsibilities of the churpuns. Where seven churpuns were earlier required to manage the irrigation system for all of Leh, now eleven are needed. The original households argued that the newly fragmented households also share in the responsibilities of becoming churpun, and since 1999-2000, each and every household in Leh, now has to take a turn at being churpun (Tiwari & Gupta, 2003).

In the past, the churpun would receive a load of unthreshed wheat from members of their chutso as compensation for their work, whereas now, churpuns receive monetary remuneration from the local administration. In some villages, a similar change from in-kind to cash compensation has also occurred, however it is only in Leh that the churpuns are paid by the government, and so are essentially now government employees. This change took place in Leh around 1984 as a direct result of the growing unwillingness among people to continue to carry out the role of the churpun (Tiwari & Gupta, 2003). Ever since that time, churpuns have received 3,000 INR (Indian Rupees)[20] for the five months that they are employed. However, despite this monetary incentive, many people have jobs or businesses to run, and so are unable to devote the required amount of time to fulfill their churpun duties. Under these circumstances, when their turn comes to be churpun, they hire another family or a migrant labourer (typically from Nepal or the Bihar state of India) to undertake the responsibility of churpun in their place. The negotiated amount can often be much greater than the government salary of 3,000 INR, however bargaining power is dependant on water availability. If water is scarce, the role of the churpun is more difficult, and so a higher price can be demanded. The year this

[20] 1 CAD = 38 INR.

research was conducted, churpuns in Leh worked for the first month or so of the agricultural season, and then due to the heavy rains, the water supply was abundant so their duties were discontinued. Nevertheless, they were still paid for the full five months.

"In 1971 there was an acute shortage of water in Leh[21] and it was agreed upon by the people that the existing system of water distribution was not effective enough as the tail-end fields were not receiving sufficient water" (Tiwari & Gupta, 2003:10). In an attempt to ameliorate this problem, a new system of water distribution was created. In this new system, the upper three chutsos[22] were included, and in addition to the tokpo-wise rotation, a temporal rotation was also introduced.

With the new temporal rotation, the day is divided into four time-periods, and during each period, water is diverted to a particular area of Leh. Between the hours of 4:00 am and 10:00 am, water is diverted from the main tokpo into the yuras throughout Gangles, Horzey, and Gonpa. Beginning in Gangles, water is distributed from the top-most yura to the bottom-most yura, working down one by one into each subsequent yura. When all the fields in Gangles have been irrigated, water is released into the yuras in Horzey in the same manner, and then finally into those in Gonpa. "If the allotted time runs out before all the fields in a certain area are irrigated, the next day irrigation begins from the field where it was left off the previous day" (Tiwari & Gupta, 2003:11).

Next, between the hours of 10:00 am and 4:00 pm, water is diverted tokpo-wise between Sheldan, Tukcha, and Shenam Tokpos, to irrigate the fields in Sheldan Chutso, Tukcha Chutso, and Shenam Chutso respectively. The system of water distribution

[21] It was during this year that the elders of Leh last recall the skargya, or carved wooden seal, being used. For more detail on the use of the seal, see the Chemray section of this chapter.

[22] Ganles, Horzey, and Gonpa were not included in the old system as they apparently had access to sufficient water from their chumiks and the main tokpo. Therefore, in the old system, water was distributed on a rotational basis into the three tokpos that flowed through the lower chutsos in Leh.

between these three tokpos occurs in that order, and is the same as it was in the old system. First, water is released into Sheldan Tokpo, and once all the fields in this area are irrigated then water is released into Tukcha Tokpo. After all the fields along Tukcha Tokpo are irrigated, finally water is diverted into Shenam Tokpo.

Around March, in preparation for the coming agricultural season, the fields in Shenam and Tukcha receive tha chu, or dry water. Tha chu moistens the barren soil in preparation for ploughing and sowing. Water stored in Karzoo Zing is used for Shenam's tha chu, and water from Tukcha tokpo is used for Tukcha's tha chu. Once the churpuns are appointed and War and Pagale Zings have been filled by the spring snowmelt, water is released into Sheldan Tokpo, signalling the beginning of the water rotation schedule for the current agricultural season. It takes about one month for all the fields along Sheldan Tokpo to be receive tha chu, but after all three chutsos have completed their tha chu, then the rotation becomes a regular 15-20 day cycle between the three tokpos (Tiwari & Gupta, 2003). When Sheldan finishes tha chu, the fields are ploughed and sown, and once small shoots begin to appear, then water is transferred to Tukcha Tokpo for dol chu, or the first irrigation after sowing. After all the fields in Tukcha Chutso have received dol chu, then water is shifted to Shenam Tokpo for Shenam's fields to receive dol chu, and subsequently, it is diverted back to Sheldan again. This cycle repeats until the crops are ripe for harvest. During these cycles, the day water will go to Sheldan Tokpo, for example, for 15 days during which Tukcha will receive night water. The day water for the following 15 days will go to Tukcha and the night water to Shenam, and during the 15 days that Shenam receives day water, Sheldan will receive the night water. At the beginning of the agricultural season, the water is generally the most scarce, and so the irrigation system is strictly implemented, but once the glaciers begin to melt and the water in the main tokpo is more abundant, water is then released into all three tokpos simultaneously.

From 4:00 pm until 8:00 pm, the neighbourhoods included in the Chubi Yangste and Changspa Chutsos receive water. Between these hours, water from the main tokpo is diverted to yuras in these areas to irrigate their fields. Again, water is first distributed to the uppermost yuras and then shifted to the ones below, and so on, during the time-period allotted to these two chutsos.

The final time-period, between 8:00 pm and 4:00 am, water is diverted to the three major zings where it is stored over night and released the following morning to irrigate the fields below. Depending on the ongoing tokpo-wise rotation, if its Shenam Tokpo's turn to receive water, then night water flowing down Shenam Tokpo is stored in Karzoo Zing and released the following morning to irrigate the fields throughout Shenam Chutso. Likewise, night water flowing down Sheldan and Tukcha Tokpos is stored in the War and Pagale Zings and released the following morning to irrigate the fields throughout Sheldan and Tukcha Chutsos.

It was decided that this new system would be tried for twenty years, after which its effectiveness would be re-evaluated. Over thirty-five years have passed, the system continues to remain the same, and the general consensus is that no modifications are presently required (Tiwari & Gupta, 2003).

Saboo

Situated at approximately 3,600 metres altitude and 10 kilometres to the southeast of Leh, lies the village of Saboo. Of the villages investigated in this case study, Saboo was the closest proximity to Leh. The name Saboo, or alternately spelled Sabu, is derived from an older name, Saphut, which refers to the good fertility of the soil in the area. Located on the north side of the Indus River, Saboo has a southern aspect, and its main tokpo (Saboo Tokpo) is fed by the melting glaciers in the Ladakh Range to the north.

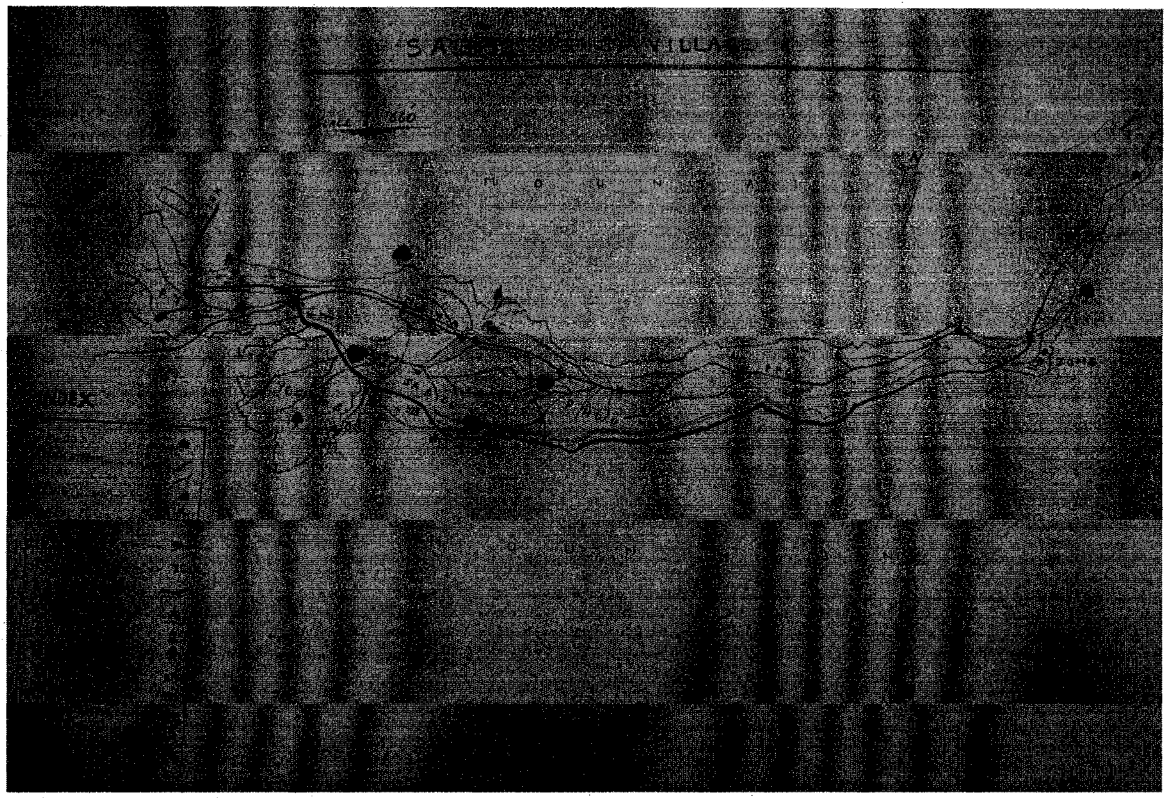

Figure 7: Map of Saboo showing chutso divisions.

According to the 2001 census, the village of Saboo has a population of 1,680 which comprises 261 households (DSEA, 2006). These households are divided into five chutsos: Phoo Chutso, Saboo Chutso, Meyak Chutso, Yognos Chutso, and Ayou Chutso (see Figure 7). Zong is not a chutso, but rather the estate land of the gompa.

The jurisdiction of the churpuns in Saboo is from the top of Phoo Chutso to the bridge that divides Yognos Chutso from Ayou Chutso. Ayou Chutso has no right, legal or traditional, to the the water from Saboo Tokpo and therefore is not under the purview of a churpun. Instead, Ayou relies exclusively on chumik water for irrigation, as well as for all other domestic water needs. The three small zings in Ayou are filled by water diverted from the chumiks by the bridge. In earlier times, one churpun was needed to oversee the water management for all of Saboo. As more land came under cultivation, a second churpun came to be required. Now, more than 400 hectares of land are under cultivation in Saboo, and accordingly, more churpuns are necessary to oversee the proper irrigation of this land. There are presently four churpuns in Saboo, one for each of the four other chutsos.

Coinciding with the agricultural season in Saboo, the churpuns' duties begin in early April and end in early September, ceremoniously marked by a puja. At the beginning of each agricultural season, new churpuns are appointed. It is the duty of the churpun to inform each household when it is their time to irrigate each of their fields; the churpun will visit (or, in recent times, telephone) the household and give advance notice that their barley fields, for example, are to be irrigated the following day. One household described that their three barley fields took approximately three days to irrigate, then they would wait about a week or so until the churpun notified them again that it was their turn to irrigate those fields for another three days. Formerly, the churpun was compensated for his labour with grain; each family gave the churpun a donation of barley or wheat. Currently, compensation is monetary. A cash payment is made by each household to the churpun in their chutso. One participant reported paying the churpun a total of 75 INR for the entire agricultural season, though each family's payment amount is determined by the size of their land holdings.

Each churpun is appointed by the village goba. The goba, or traditional village head, is himself an appointed representative, and serves as a government employee for a maximum of three years. The churpuns and the goba work together to solve water-related problems. For example, a churpun will inform the goba if a villager is caught diverting water to his field without the permission of the churpun. The goba will then determine the severity of the infraction, in this case theft, and issue a penalty accordingly. Penalties are typically in the form of a fine; the amount of the fine is reflective of the severity of the infraction. In cases where a large amount of water has been stolen, or when the village is experiencing immediate water shortage, fines can reach 500 INR or more.

Fed by the tokpo, the zings in Saboo are filled through the night and used the following day to irrigate the fields that lie below. Though rare, after a heavy rain, it is possible to fill all zings in one day. Phoo Chutso relies primarily on the tokpo for its water needs, and uses Zing Sarno. Saboo Chutso uses Zing Lo, Meyak Chutso uses Zing Yourgog, and Yognos Chutso uses Zing Yognos. Zing Yognos, which filled by both the tokpo and nearby chumiks, serves the majority of the population of Saboo, and so in 2001, it was renovated and enlarged by Leh Nutrition Project (see Figure 8). Each zing has an overflow outlet and a locking valve, which only the churpun has the key to open and close (see Figure 9). Thus, the zings are under complete control of the churpuns.

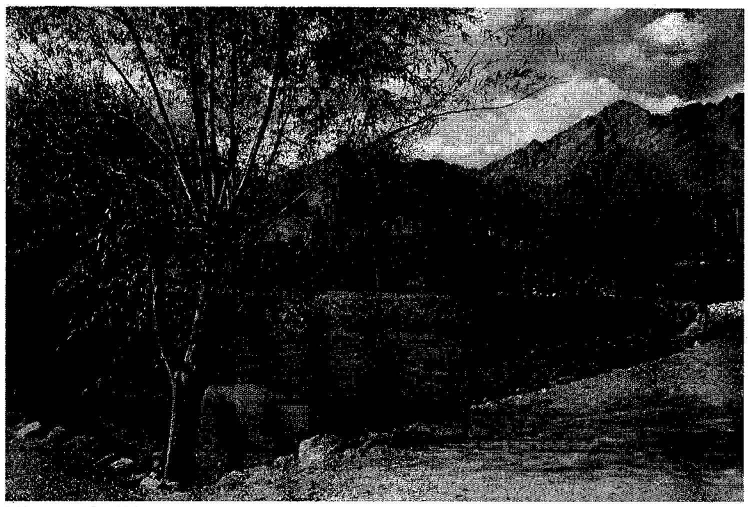

Figure 8: Zing Yognos when empty.

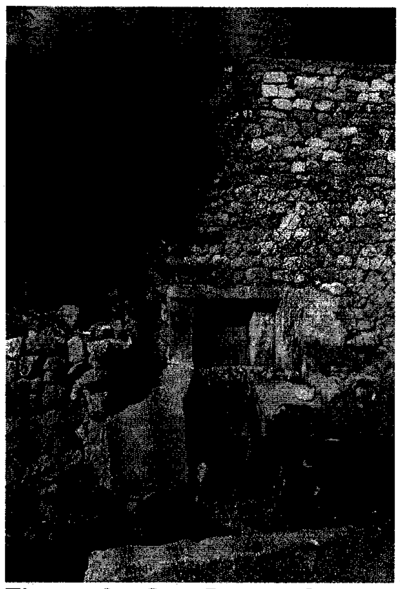

Figure 9: Overflow outlet and locking valve on Zing Yognos.

Numerous chumiks are located throughout the village of Saboo. Villagers rely primarily on the chumiks as a year-round source of potable water. Approximately six hand-pumps are situated throughout the village, and can also be relied upon year-round for drinking water, as they are not susceptible to freezing during the winter months. In addition to the hand-pumps, the state government has also recently installed a piped-water system which brings potable meltwater from the kangri (glacier-covered mountain) above Saboo, down to various points around the village. In the winter, however, these pipes are drained and closed, or otherwise they would freeze and burst.

In Saboo, both wheat and barley are grown as the principal crops[23]. The growing period for wheat is about 120 days, from the time of ploughing and sowing until the harvest, compared to about 90 days for barley. Therefore, the agricultural season begins first with the wheat fields, and then, approximately one month later, the barley fields are begun. The irrigation schedule in Saboo is described in the following paragraphs.

[23] From PioGang in Phoo Chutso to Zong, however, only barley is grown. The altitude is higher here (3,700 metres) and so the climate is colder, making the growing season in this area too short to grow wheat.

The irrigation schedule begins in early spring, usually early April, when the meltwater begins to flow down through the tokpo[24]. First, the wheat fields receive tha chu, or dry water. Tha chu moistens the barren soil in preparation for ploughing and sowing. In each chutso, the churpun selects the order that each field is watered. The churpun diverts the water from the tokpo to a particular yura and then instructs the families, whose fields lie along that yura, to, one after the other, divert water to their fields. If the land is flat, then the water will not flow. Families, therefore, must furrow each of their fields, according to the field's particular slope and characteristics, so that when water is diverted to their fields, it will flow through each bed to the next. Once all fields along a particular yura have been watered, the churpun closes that yura with a ska (closure comprised of boulders and sod). If the ska is found washed away, then the churpun knows someone has diverted the water without his approval, and violators are penalized. The churpun then diverts the water from the tokpo to another yura, and instructs those families to irrigate their fields (see Figure 10). The period of time that each field receives water depends on the size of the field. One by one, water is allowed to flow through each yura and all the fields are watered; the churpun ensures that no field in the village is missed. After all the wheat fields have received tha chu, then the barley fields receive tha chu. About a month will have passed from the time the first wheat fields received tha chu until the time they are ploughed and sown. Crops are ploughed and sown simultaneously, and once the wheat fields have been ploughed and sown, then so are the barley fields. It takes about one month for all the fields to be complete.

[24] Sometimes, before the kangri begins to melt in spring, khyak chu, or the remainder of the frozen winter water in the tokpo and zings, is released to water the grazing fields.

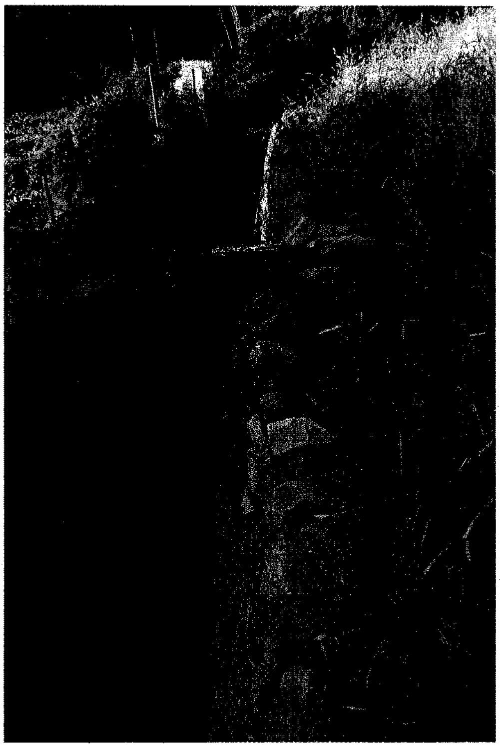

Figure 10: Yura running between footpath and field.

Once small shoots begin to appear, the wheat fields are given their first irrigation, called dol chu. After all the wheat fields have received dol chu, which takes about two weeks, then all the barley fields receive dol chu. Next, the wheat fields are given shak chu, or the second irrigation. Shak chu is given once the shoots become dry and yellow in colour. It takes about two weeks for all wheat fields to receive shak chu, and then afterward, all the barley fields receive shak chu. It is vital to irrigate on time at these phases (dol chu and shak chu), otherwise the crops will die. From this point onwards, the crops are strong and healthy, so now more water can be given; all the crops in the village are watered every week or so until they are harvested. The year this research was conducted, the growing season ended in the first week of September, and by the end of the month, the harvest had been completed.

Matho

Across from Saboo, on the south side of the Indus River, lies the village of Matho. According to the 2001 census, the village of Matho has a population of 1,288 which comprises 258 households (DSEA, 2006). Matho is situated at approximately 3,600 metres altitude, and about 25 kilometres southeast from Leh. Though not too far from the region's capital, because of its location on the lesser travelled side of the river, Matho is in many ways more remote than its proximity to Leh might suggest. This made communications and gathering information in Matho quite challenging. Therefore, the data for Matho is quite limited, though important to include nonetheless.

Having a northern aspect, Matho would be much drier were it not for Matho Kangri, which lies just south of the village, at 5,800 metres altitude, among the Stok Mountain Range. Matho Kangri provides the village of Matho with an abundant source of water as its melting glacier feeds the village's main tokpo. Participants in Matho reported that water from this kangri is plentiful enough such that there is no longer a need for a churpun. In fact, there has not been a churpun in Matho for some time now. It is unknown if any chutsos exist in Matho any longer, however there did exist a defined schedule of when each villager could divert water from the main stream to irrigate their fields. The year this research was conducted, the harvest in Matho commenced in mid-August, beginning with the harvesting of fodder for the livestock, to dry and store for the coming winter. It is expected that the remainder of the harvest would have been completed by mid-September. The irrigation channels seemed well-maintained; villagers are responsible for minor repairs to the yuras and the government is responsible for major repairs. The heavy rains and flooding that occurred throughout much of Ladakh during

July and August 2006 did not have a significant impact on Matho, however, it was reported that significant repairs were necessary in Matho after heavy rains of the previous summer of 2005. There is one large zing in Matho, which is still used to store water throughout the night to be released the following day to thirsty fields below it. In the absence of the churpun, it was unknown to the participants interviewed as to who maintains and operates the zing.

In the summer time, chumiks become available as a source of potable water. People in Matho have historically met all their year-round household water needs from the tokpo, and report that water quality has not been a problem. However, a year ago, hand-pumps began to appear throughout the village, financed and installed by the state government. Now, collecting water for household needs from the hand-pumps has replaced collecting water from the tokpo for many families in Matho. It is unclear exactly what the water source for the hand-pumps is, but it is suspected that the water is from an underground aquifer. Some hand-pumps are operational throughout the winter, but villagers who live nearby hand-pumps that are prone to freezing in winter, must resort to collecting their water from the tokpo. There have not been any reports of mechanical problems with the hand-pumps thus far, however villagers have not been taught how to repair them, and so, should they ever require repair, the government will have to be responsible for it.

3.2.2 Kharu Block

In Kharu Block, the village of Chemray was investigated (see Figure 11).

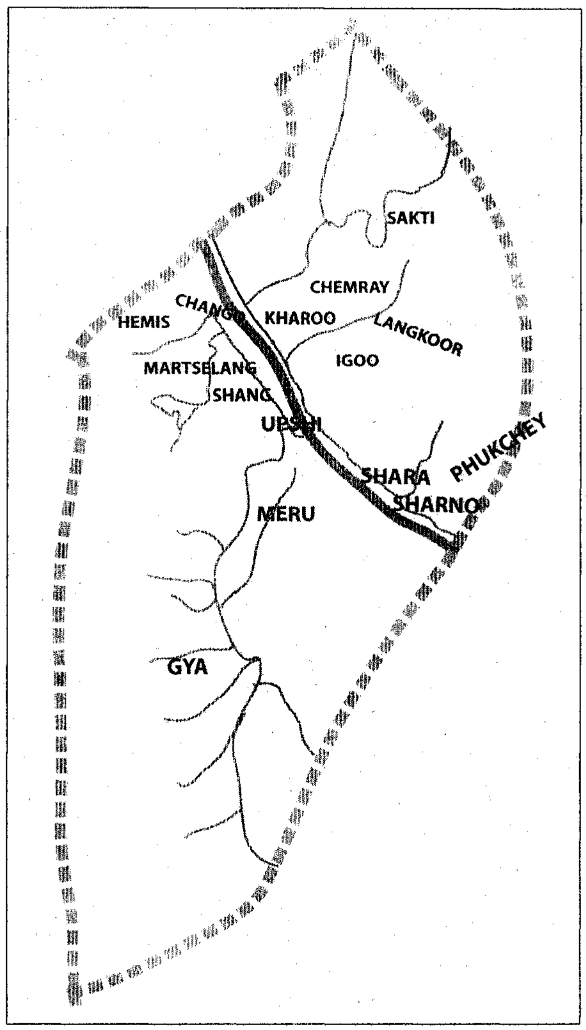

Figure 11: Map of Kharu Block.
Note: Map by Aaron Dana. Reprinted with permission.

Chemray

The village of Chemray is situated on the north side of the Indus River, at a distance of approximately 45 kilometres to the southeast of Leh. Chemray, or alternately spelled Chemrey, Chemre, or Chemde, has a southern aspect and lies at an elevation of 3,700 metres. The other villages in this case study are all independent entities. Chemray, however, provides an interesting contrast to these other villages, in that Chemray is situated in a fairly long valley, between the upper village of Sakti and the lower village of Kharu (or alternatively, Kharoo). Of the three villages in this watershed, Sakti is the largest in terms of population, Chemray the longest (approximately 11.5 kilometres long), and Kharu the smallest, both in population and area (Dawa, Dana, & Namgyal, 2000). Two tokpos (Takkar Tokpo and Taknak Tokpo), originating from the melting snowbanks and glaciers of the Ladakh Range to the north of the watershed, flow through Sakti village and join at the chu dzomsa (confluence of two rivers) to become Chemray Tokpo. Chemray Tokpo then flows through the length of both Chemray and Kharu villages, until it joins the Indus River. Kharu village has no legal or traditional right to the water from the tokpo, and so instead, must rely on the chumik and spang water of Shagang Gnema Spang as the source for irrigating their fields (Dawa et al., 2000). Chemray and Sakti, on the other hand, both have rights to this water, and so over the centuries had to develop a system in order to share this water between the two villages. This system of sharing the water, called pabchu, "is perhaps unique to this watershed, though similar practices are prevalent in other large watersheds in the region" (Dawa et al., 2000:237). Therefore, for Chemray, not only will the internal management of water *within* the village boundaries be described, but additionally, so will the management of water *between* the two villages.

According to the 2001 census, the village of Chemray has a population of 1,202 which comprises 303 households (DSEA, 2006). These households are divided into four chutsos: Nala Chutso, Peu Chutso, Gamat Chutso, and Yognos Chutso. Chemray Tokpo provides the primary source of water for irrigation for all four chutsos in Chemray. In all chutsos but Nala Chutso, oozing spang water also feeds into the tokpo. Four families[25] in Chemray, however, have no right to the tokpo; alternatively, they have an independent

[25] Kalaksa family, Jonggar family, and two families by the name of Tongstoth.

zing and yura (Ramram) which channels the chumik and spang water from Dablung (Spang Chenmo) to irrigate their fields (Dawa et al., 2000). About five years ago, the Public Health & Engineering (PHE) department of the Government of Jammu and Kashmir installed a piped-water system throughout Chemray. This piped-water system, essentially a horizontal tube well, pumps potable water from an underground aquifer to tube wells and then distributes the water throughout the village via (above-ground) steel pipes. However, the pipes freeze in winter, rendering this system inoperable for upwards of six months of the year. Shortly after the installation of the piped-water system, the state government also installed several hand-pumps throughout the village for drinking water (see Figure 12). Fortunately, the hand-pumps do not suffer from the same freezing problem in winter, and thus provide the villagers with a reliable, perennial source of drinking water. Participants reported that within Peu and Gamat Chutsos, the chumiks serve as an additional source of year-round potable water.

Figure 12: Hand-pump in front of Kalakska house.

Numerous zings, speckled throughout the village, are fed by Chemray Tokpo. During the agricultural season, by diverting water from the tokpo to the zings, the zings are typically filled throughout the night, and then the following day, the water contained in the zings is released to irrigate the fields below. There are two zings in Nala Chutso: Nala Kogma Zing and Nala Yokma Zing. There are three zings in Peu Chutso: Kuyur Zing, Yarlok Zing, and Ramram Zing. There is one zing in Gamat Chutso, named Zeuma Zing, and one zing in Yognos Chutso, named Zing Chenmo.

At the top of the village, water is plentiful, so no churpun is needed to manage the water in Nala and Peu chutsos. Water is in shorter supply as it reaches the lower chutsos of Gamat and Yognos, therefore Gamat Chutso and Yognos Chutso each have one churpun. The two churpuns in Chemray, during the agricultural season of 2006, were from the Changtukpa family in Gamat and the Numpa family in Yognos.

Each agricultural season, new churpuns are appointed by the chagzot, or manager, of the Chemray gompa. The chagzot has a list of all the households in each chutso, and by rotation, as they have done for centuries, each household has its turn to carry out the yearly churpun duties. The newly appointed churpuns are each ceremoniously presented with an official thetse[26] (carved wooden seal), over which they have control throughout the current agricultural season (see Figure 13). They retain possession of the thetses until the following year, when they are returned to the gompa to be given to the next churpuns. The thetses are used by the churpuns to officially mark the closing of a particular yura, in order to divert water to another yura. The churpun closes the yura with a ska (closure comprised of boulders and sod) and then stamps the thetse into the wet soil or clay of the yurgo (the head of the yura) to cast an imprint of the seal. If the impression in the soil is

[26] Formerly called a pangya.

found washed away, then the churpun knows someone has diverted the water without his approval, and violators are penalized.

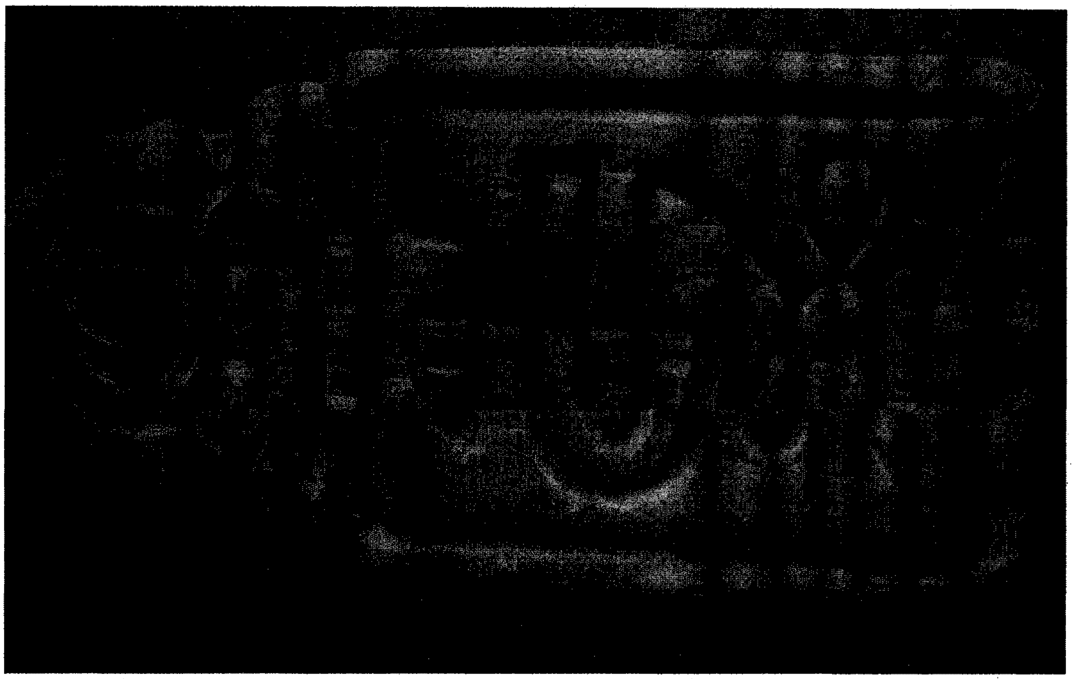

Figure 13: An official thetse.

In the past, penalties were jointly determined by the villagers of the chutso where the infraction occurred and meted by the churpun. For example, the perpetrator of the violation could be made to do extra community work, give a public apology for their wrongdoing, or give a gift of chang (local brew made from fermented barley) and kataks (ceremonial white scarves) to the aggrieved party. Nowadays, a fine of about 500 INR is the typical penalty for stealing water, though the severity of the fine depends on the severity of the water scarcity in the village at the time that the infraction was committed.

The villages of Chemray and Sakti were always in an adversarial situation as they were dependent on the same tokpo for irrigation, however Sakti, located in the upper reaches of the watershed, obviously enjoyed a natural advantage (Dawa et al., 2000). Disputes inevitably arose between the two villages, and in an attempt to resolve these disputes, a system of sharing water for irrigation developed between Chemray and Sakti.

This centuries old system is known as the Pabchu system. From the verb pabches meaning to lower or bring down, the literal translation of pabchu is then 'to bring down water'. For equitable distribution of the limited water in the watershed, for two nights and the intervening day, the water from Taggar and Taknak Tokpos is diverted to Chemray, by closing the mouths of all the upstream yuras in Sakti. "The earliest historical reference to the Pabchu system is found in an order issued by King Jamyang Namgyal in 1571 A.D." (Dawa et al., 2000:245). The particulars of the pabchu evolved over time, and then, during the reign of King Nyima Namgyal (1694-1729), the agreement of the pabchu was formally codified; this original document is, still to this day, held in trust by the Chemray Gompa.

Barley is the principal crop grown in Chemray, although, in some fields, peas and mustard are also grown[27]. The growing, and irrigation, of barley follows a precise 90-day schedule. At the onset of the agricultural season, typically in early May, the ambient temperature is not high enough to induce melting of the snowbanks, let alone the glaciers. At this time, khyak chu, or the remainder of the frozen winter water in the tokpo and zings, is given to moisten the barren soil in preparation for ploughing and sowing. Within one week, all fields in the entire village receive this initial watering. A ten-day break elapses, and then all the fields are ploughed and sown over the course of the next seven days.

After one week, small shoots begin to appear. The amount of water in the tokpo at this time is critical, as this is the time when the crop requires its first irrigation, called dol chu. The melting of the snowbanks and glaciers is generally underway by this time,

[27] Typically wheat is not grown in Chemray; the altitude is 3,700 metres and so the climate is colder, making the growing season too short to grow wheat, though a very limited area in the lower reaches of the village is used to grow wheat.

however water levels in the tokpo are usually still insufficient to provide enough water for the first irrigation, such that the villagers of Chemray must ask for the pabchu to begin.

In Chemray, the agricultural season, and therefore the water management system, is dictated by the Tibetan Calendar. On the third day of the third month of the Tibetan Calendar, the chagzot and the two churpuns go to the *gabokuna* (the name of the deity in the centre of Sakti) and have a puja, giving offerings of kataks and chang. In earlier times, it was on this day that pabchu would begin. Nowadays, this day is marked by a puja, but the actual pabchu does not begin until the eighth day of the fifth month of the Tibetan Calendar. On the eighth day of the fifth month, Chemray villagers bring sha (the meat, typically of a sheep or goat) and chang to the goba of Sakti and ask that pabchu begin the following day[28]. This customary offering is aptly named *Sha-Chang* and is contributed by the Chemray Gompa, though of late, 500 INR is paid in lieu of the sha. The request is granted, and the next day begins pabchu.

It takes eight days time to irrigate all of Chemray's fields – pabchu coincides with days one and two of this irrigation schedule. Throughout day one, the village of Sakti has rights to the tokpo, but late that afternoon, one representative from each family in both Gamat and Yognos Chutsos[29], led by the two churpuns and a lama from the Chemray Gompa (usually the chagzot), departs for Sakti, diverting the water from various yuras along the way. The churpuns close all the yuras above Zeuma Zing, with skas and affix an impression of the thetses on each of the yurgos, up to the chu dzomsa. At that point,

[28] In times of extreme water shortage, Chemray may need to begin pabchu earlier than the agreement allows. If Chemray needs water, and is unable to wait until pabchu, then the churpuns bring chang to the goba of Sakti and ask for *shabe* (a "special request" for an early pabchu).
[29] All the families of Gamat and Yognos Chutsos are responsible for the management of pabchu, however, the families of Nala and Peu Chutsos do not participate in the pabchu.

one churpun proceeds to Takkar Tokpo, and the other churpun to Taknak Tokpo, repeating the procedure on each yura throughout Sakti. In the meantime, each of the representatives station themselves at each of the yurgos, where they will stand watch over the yuras to guard the water from potential theft. If a family refuses to send a representative to stand watch over night, they will be charged a fine of 500 INR by the other families. At about 5:00 pm, the five yuras between Zeuma Zing and Zing Chenmo are simultaneously closed, and representatives from Yognos position themselves as the watch and ward of these yurgos. The representatives camp out at their yurgos through the nightas the water flows directly down the tokpo and into both Zeuma Zing and Zing Chenmo. The two zings are filled, relatively equally, for the whole night and the water is released into the yuras under them and used to irrigate the fields throughout Gamat and Yognos Chutsos the following day. The two churpuns and the lama walk around upper Chemray and throughout Sakti during the night[30] to confirm that the water is properly distributed and to ensure that no one tries to steal water. If it is discovered that water has been illegally diverted to a yura in upper Chemray or Sakti at some point through the night, the perpetrators of the violation are charged 500 INR.

Throughout the following day and the next night, the representatives continue to stand watch and the water continues to flow down the tokpo into the two lower chutsos of Chemray, however, between 10:00 am – 5:00pm on day two, some areas of upper Chemray and Sakti receive a special concession, called *Do-Tam*. "Do-Tam means a mark on a stone, a sort of gauge to determine the depth of water to be let into the yura" (Dawa et al., 2000:247). When shadows begin to appear on the hillsides, at about 5:00

[30] It is due to these night duties of the churpun that women have traditionally not served in this role. Besides it being considered unsafe for women, it would also take them away from their babies, who likely would require nursing through the night.

pm, on the evening of the second day, Do-Tam ceases and the yurgos of those yuras are again sealed. Water continues to flow down the tokpo and fill Zeuma Zing and Zing Chenmo throughout the second night, until the sparrows begin to chirp (at approximately 4:00 am on the morning of day three). This signals the time for the representatives of Gamat and Yognos, who have been guarding the yuras, to return to their homes – the end of pabchu – and the farmers of both Sakti and Nala and Peu Chustsos in Chemrey to again divert the water from the tokpo to their yuras - the beginning of the six day non-pabchu period.

In Chemray, throughout the non-pabchu period, water from the tokpo is used, during all the days, by the villagers of Nala and Peu Chutsos, and during the nights, alternating between Gamat and Yognos Chutsos, in an arrangement called *ziray* (Dawa et al., 2000). On the nights of days three and four, the villagers of Gamat get the ziray, so they close all the yuras of Nala and Peu and divert water throughout the nights to Zeuma Zing. Zeuma Zing is filled and the water stored for subsequent use, to irrigate the fields in Gamat Chutso. On the fifth night, the villagers of Yognos get the ziray, so they close all the yuras of Nala, Peu, and Gamat and divert water throughout the nights to Zing Chenmo. Zing Chenmo is filled, and the water is stored and later used during the day for irrigation in Yognos Chutso. On the sixth and seventh nights, Gamat again receives the ziray, and on the eighth night, the ziray goes to Yoknos. Thus, over the six non-pabchu days, Gamat receives water four nights and Yognos two nights.

After all of Chemray's fields have received their first irrigation, then a break of seven days follows. Following this break, Chemray's fields receive their second irrigation. If necessary, another pabchu is requested. Every time Chemray requires an additional pabchu, a pot of chang is delivered one day earlier to the goba of Sakti. Once the second irrigation cycle has been completed, which also takes eight days, another seven-day break follows. A third eight-day irrigation cycle ensues. At this point, all subsequent irrigations occur at shorter intervals. After a break of five days, all fields are irrigated for a fourth time over the course of eight days. Then, after another five-day break transpires, all fields receive their fifth and final irrigation. This final irrigation takes seven days to complete and is then followed by the harvest.

Harvest usually takes place during the end of the seventh month of the Tibetan Calendar. The year this research was conducted, Peu Chutso began the harvest in the last week of August, next Gamat and Yognos Chutsos harvested their crops, and finally, Nala Chutso finished the harvest at the end of the first week in September.

3.2.3 Khaltse Block

In Khaltse Block, the villages of Alchi and Hemis Shukpachan were investigated (see Figure 14).

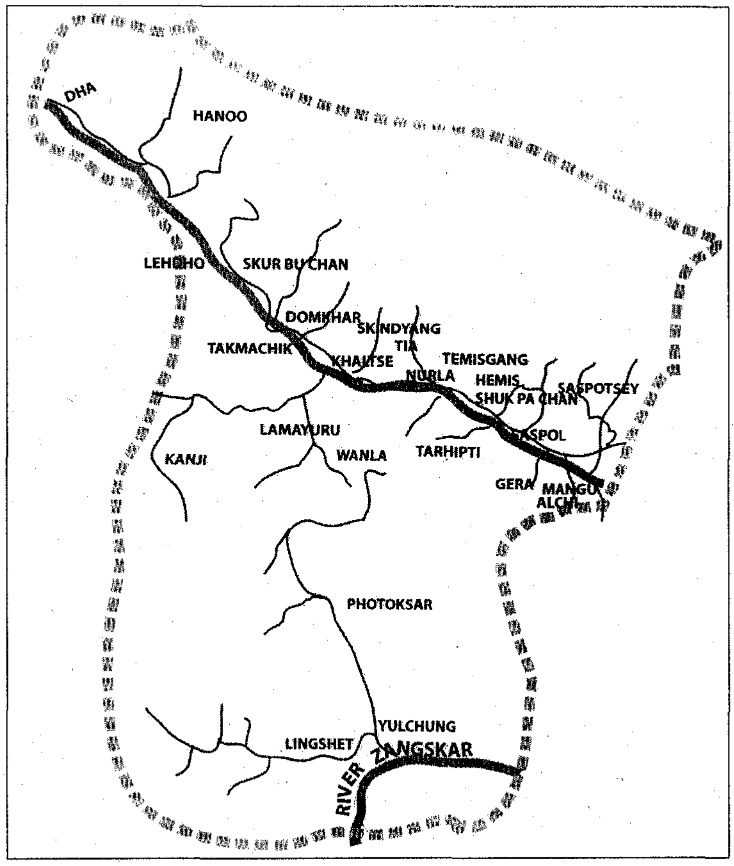

Figure 14: Map of Khaltse Block.
Note: Map by Aaron Dana. Reprinted with permission.

Alchi

Approximately 70 kilometres southwest from Leh, on the south side of the Indus River, lies the village of Alchi. Alchi is located on an alluvial fan (Dawa et al., 2000:236). At 3,250 metres altitude, Alchi was the village with the lowest altitude in this case study. Like Matho, Alchi has a northern aspect, but unlike Matho, "Alchi suffers from a chronic shortage of water as there are no glaciers above" (Dawa et al., 2000:237). Instead, Alchi's water is dependant on the previous winter's snowfall, mainly from Stakspi La (5,200 metres) to the south. However, "the limited snowbanks are not adequate enough to last the entire agricultural season. Consequently, shortage of water during the latter part of the season is the constraint as far as this village is concerned," whereas most other villages in the district experience water shortage in early spring (Dawa et al., 2000:237). Due to its chronic water shortage, the agricultural season in Alchi is typically only four months in duration – from late March until late July – and therefore, it is significantly shorter, and ends earlier, than most other villages in the district. This fact makes Alchi particularly interesting to study. The limited supply of water forces Alchi to be judicious in the distribution of water. The following section documents in precise detail the strictly regimented schedule that villagers adhere to in order to ensure enough water reaches each and every field in the village during the agricultural season, such that there will be enough food to eat for the remaining eight months of the year.

According to the 2001 census, the village of Alchi has a population of 741 which comprises 148 households (DSEA, 2006). These households are divided into four chutsos: Gompa Chutso, Shangrong Chutso, Choskor Chutso, and Yulkor Chutso. Historically, there has been one churpun for all of Alchi, however due to both increasing water scarcity and population, the duties of the churpun have become too taxing for only one person to manage such that, last year, instead of electing one churpun as usual, the villagers of Alchi elected four – one for each chutso.

But the agricultural season of 2006 was different once again. The previous winter experienced more snow than usual, and so the subsequent snowmelt during the agricultural season was sufficient to only require the work of one churpun. The churpun elected was from the Shangrong Chutso. The churpun is typically elected in March and the end of their responsibilities is marked by the end of the harvest (the end of July). Each spring there is a new election. The responsibilities of the churpun are to ensure the proper distribution of water, to watch for anyone stealing water, and to penalize those caught stealing. Penalties for stealing typically result in a fine of 100 INR, but increase with the severity of the crime. For example, if someone were to divert water without permission during a time of extreme scarcity, the penalty would be much more severe than if the same offence were committed in times of adequate water amounts.

Churpuns are compensated for their work by the villagers themselves, but no money changes hands. Because the churpun's time during the agricultural season is spent managing the village's water and not tending to his fields, the rest of the village ensures that he has enough food to eat by compensating him with food. Each household gives the churpun equal amounts of barley – one bucket or approximately 15 kilograms – though smaller households give a little less.

The goba, still plays an active role in Alchi. Though historically this position was inherited down a family line, now, each year, a new goba is selected by lottery. The year this research was conducted, the goba was Tsering Stobden of the Shanara family of the Shangrong Chutso. Traditionally, the goba's main role was that of the village problem solver. For example, together with the churpun, the goba resolves quarrels over water. Whomever is found to be at fault, the perpetrator of the violation, must apologize and give kataks to the aggrieved party. Nowadays, the goba receives a small salary, of about 3,000-4,000 INR per year, from the state government. In return, the goba is expected to assist in the carrying out of government programs and administration, in addition to maintaining the goba's traditional roles.

There is one zing in Alchi, Khangltak Zing, which is located high above the village. There is a locking door on the zing that only the churpun has the key to. Meltwater is collected into the zing in the night, and released to fields during the day, as the churpun deems necessary. This zing, however, is currently in poor condition. It has been leaking and so is inadequate for storing night water, and has not been in use for about three years. Individual storage tanks are not permitted (as they would be akin to hoarding water and further cause the deterioration of the traditional distribution system).

Traditionally, the yuras in Alchi were built by the villagers, using mud and stones. The villagers have collectively been responsible for the maintenance and repair of yuras and the zing, however, in recent years, the state government has provided some assistance in this regard. For example, heavy rains occurred throughout Ladakh, during late July and early August of 2006[31], causing some yurgos in Alchi to be washed away. Alchi residents repaired this damage temporarily, but await the state government to finance and conduct more permanent repairs. The government has also been employing migrant workers to replace the old yuras with new ones made of cement (see Figure 15). Participants reported that, in an attempt to make one bag of cement mix go farther, workers have been witnessed watering it down too much. There is fear that these new, modern yuras are not going to last anywhere as long as the old ones. Additionally, the new ones will not be able to be repaired using local materials, and so the government will have to be relied upon to fix any minor or major problem. This government assistance has been helpful in many ways, but disabling in others. Ladakhis used to be completely self-reliant, but now dependence on external assistance has developed, leaving people

[31] The heavy rains did not benefit the crops during the growing season, but nor did they damage them as the harvest had been completed by late July.

awaiting assistance, while their zing, for example, has been in disrepair for about three years.

Figure 15: Workers replacing previous mud and stone yuras with cement yuras.

About ten years prior, the state government began installing a piped-water system throughout Alchi. Potable water from snowmelt is funnelled from high above the village through steel pipes and distributed to each of the four chutsos (see Figure 16). Participants interviewed reported that the pipe leading to their neighbourhood, which they share with about ten other families, was installed just three years ago. Prior to the installation of the piped-water system, villagers met their year-round drinking water needs from the main tokpo, Alchi Tokpo. At the end of October/beginning of November, the pipes are drained and closed[32], otherwise the water in the pipes would freeze in

[32] Tsering Angchuk of Haltukpa house in Yulkor Chutso is a government employee who is responsible for this task, as well as for the maintenance/repair of the pipes.

winter[33] and burst the pipes. From that point on, until late April/early May, villagers collect their drinking water from the main tokpo. One participant interviewed reported that twice a day in winter, she walks to the tokpo to collect water for her family's drinking, cooking, and (dish) washing needs (bathing and clothes washing takes place at the water's edge, and so does not require the transport of water). On each trip, she collects two 20 litre containers of water for her family of three, which averages out to just over 25 litres of water per person per day. This participant estimated that each trip took approximately five minutes to walk to the tokpo, five minutes to fill her containers, and five minutes to walk back to her house. Thus, for her, at least 30 minutes of each day, for about six months of the year, is spent collecting water.

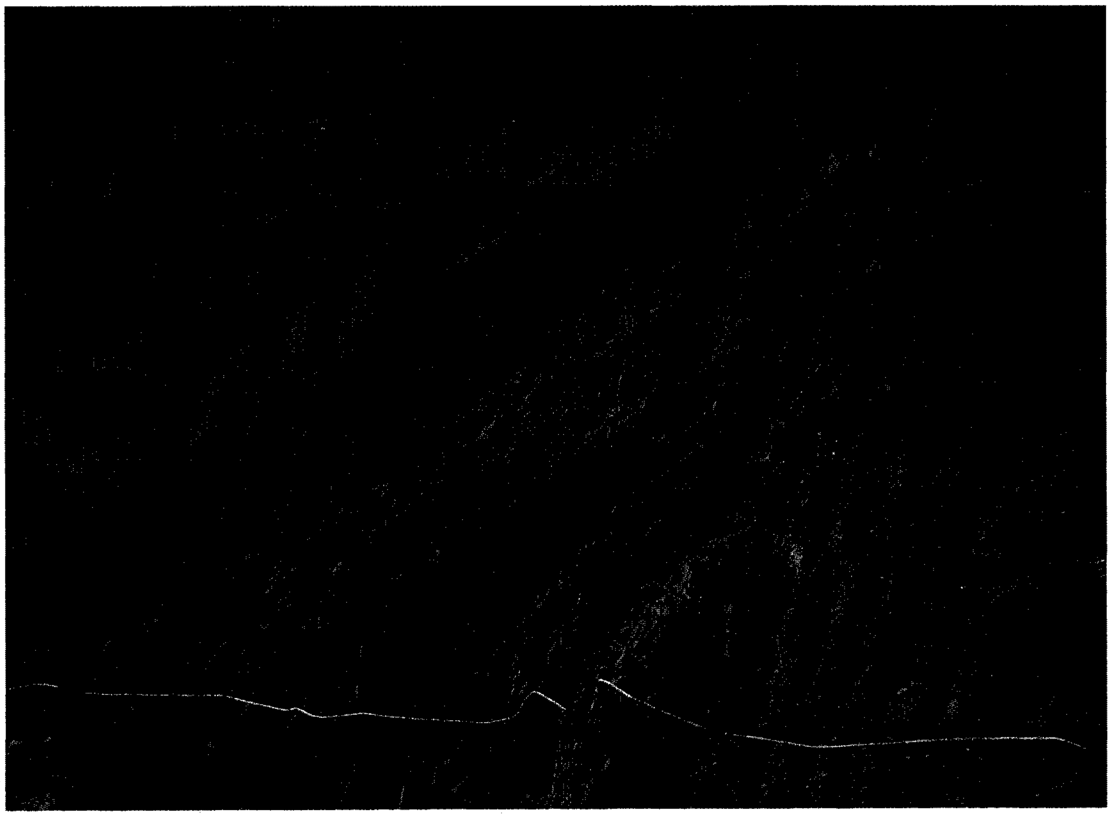

Figure 16: Piped-water system.

[33] The pipes in Alchi are wrapped, as are those in Hemis Shukpachan (to be discussed in the following section), but perhaps because the water in Alchi's pipes originates from snowmelt, it is colder and therefore more prone to freezing. Conversely, in Hemis Shukpachan, the water in the pipes is spring water, originating from the earth, which is perhaps slightly warmer than snowmelt water in Alchi.

Villagers in Choskor Chutso rely less on the tokpo as they have both chumiks and a hand-pump nearby. The hand-pump does not freeze during winter and so provides this chutso with a convenient perennial source of drinking water. This hand-pump, the only one in the village, was installed by the state government about five years ago. Villagers in Yulkor Chutso, however, experience more hardship during the winter. None of the yuras within this chutso contain any water during the winter, so villagers who live in this area must walk long distances to retrieve drinking water from the main tokpo. A hand-pump in this chutso would significantly ease their burden, reported one participant.

Regarding water quality, participants commented that the water quality is deteriorating. Due to an influx of migrant workers to assist with the harvest in Alchi, and many other villages throughout Ladakh, a number of outsiders, unaccustomed to the rules regarding water usage, have been polluting the water source. For example, some of these migrant workers have been witnessed washing in the tokpo and using it as a toilet. Traditionally, it was everyone's collective duty to keep the tokpo clean for drinking water, and certain tributaries were dedicated for washing water and irrigation. Polluting the village's main drinking water source was unheard of, and accordingly, no rules were established to penalize those caught polluting water. It is unsure whether this current pollution has yet led to any incidents of health issues, though government sources concur that the only sources of potable water in Alchi are chumiks and a hand-pump (DSEA, 2006). However, these two sources are located at significant distance from the majority of Alchi's residents, and so in winter, when the piped-water system is inoperable, collecting drinking water from the tokpo remains the more preferred option for most people.

Barley is the main crop grown in Alchi, but mustard seed, vegetables, apples, apricots, and walnuts are grown as well. Having a longer growing period – the growing period for wheat is about 120 days compared to about 90 days for barley – wheat would require more water to grow, and so, due to the shortage of water in Alchi, wheat is not grown. Villagers in Alchi adhere to a precise irrigation schedule in order to ensure that enough water reaches all of the fields during the agricultural season. The following paragraphs describe this schedule.

Ston chu, or autumn water, refers to the watering of the fields in October and November, so that the water soaks into the soil to freeze through winter. In spring, this frozen water melts, priming the fields to be ploughed in late March/early April. Having received ston chu, fields do not need to be watered before ploughing. In Alchi, two chutsos, Yulkor and Gompa, receive ston chu. The other two chutsos, Shangrong and Choskor, both have very steep slopes, so they do not receive ston chu. In autumn, after the harvest, the fields are barren. If the fields on such steep slopes were to receive ston chu, instead of being absorbed by the soil, the water would just run off, likely carrying the soil with it. Instead, fields in Shangrong and Choskor receive tha chu, or dry water, which refers to the watering of the dry fields prior to ploughing.

Alchi's snow usually begins to melt in late March/early April, at which point tha chu begins. The order in which fields receive pre-ploughing water is determined by a lottery system. Families' names are written on ballots (two families per ballot) and when drawn, those two families are permitted to water their fields for 24 hours. Only tha chu is by lottery and only during tha chu do each family receive water for the same amount of time. In all subsequent waterings though, the churpun selects the order that each field is watered. Typically, the churpun, starting at the field at the top of each yura and working downward[34], instructs families, one after the other, to water their fields, ensuring that each field is watered. The churpun marks the ska with a pile of stones. If the stones are found moved or washed away, then he knows someone has diverted the water without his approval. Violators are penalized. The period of time that each field receives water is no longer equal, but rather depends on the size of the field.

Those families in Yulkor and Gompa who received ston chu, plough and sow their fields first, and after all of Shangrong and Choskor families have received tha chu, then they too plough and sow their fields. If water is scarce, then those who plough first, Yulkor and Gompa, receive dol chu first. Dol chu is the first irrigation given after the shoots appear. If there is sufficient water, then all four chutsos receive dol chu simultaneously. After all chutsos have received dol chu, then Yulkor and Gompa receive shak chu, or the second irrigation given once the shoots become dry and yellow in colour. If too much water is given at this stage, the water will rot and spoil the crops, therefore limited water is given at shak chu. Afterward, Shangrong and Choskor receive shak chu. Next, Yulkor and Gompa receive non chu, or the third irrigation. At this phase, the crops are strong and healthy, so now more water can be given. Then, Shangrong and Choskor receive non chu. From this point onwards, all the crops in the village are watered as much and as often as possible until they are harvested. The runoff from melting snow usually becomes a trickle in Alchi by July, and the harvest is coordinated accordingly. In Alchi, the harvest is typically finished by the end of July.

[34] Or conversely, the churpun starts at the field at the bottom of each yura and works upward.

Hemis Shukpachan

The village of Hemis Shukpachan, lies approximately 85 kilometres to the northwest of Leh. Of the villages investigated in this case study, Hemis Shukpachan was the furthest away from Leh. Hemis Shukpachan is situated at an elevation of 3,700 metres, on the north side of the Indus River, in a region of Ladakh known as Sham. The village is nestled in a valley between two steep rocky hillsides, with the glacier-covered Shaili Kangri (5,600 metres) visible to the north and the snow-covered Mangyu Ri (4,290 metres) visible to the south. So Hemis Shukpachan is literally surrounded by mountains on all sides (see Figure 17).

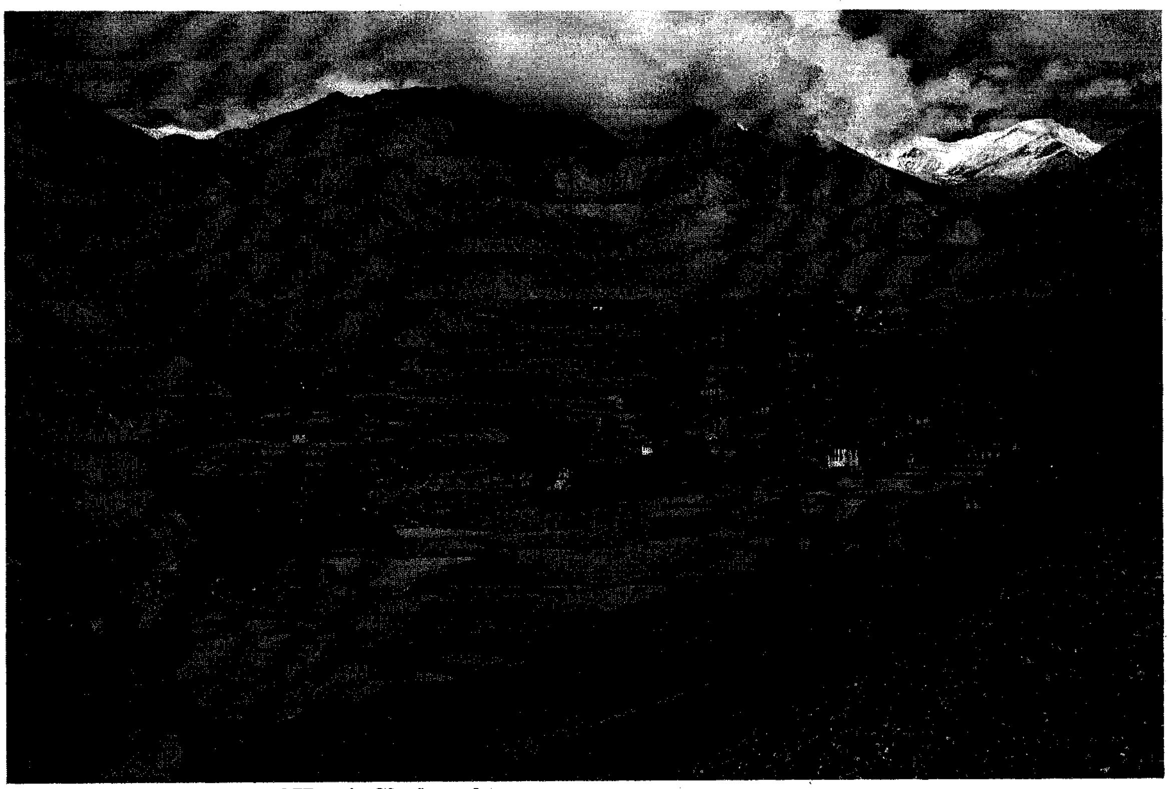

Figure 17: The village of Hemis Shukpachan.

As Hemis Shukpachan has a southern aspect, the village's main tokpo (Akhur Tokpo) is fed by the melting glacier of the Shaili Kangri of the Ladakh Range to the north, cutting through the middle of the village, with the houses and fields to either side, and flowing down into a gorge to the south. The tokpo provides a perennial source of water for the village. Historically, villagers collected their drinking water from nearby springs in summer, and from the tokpo in winter, when the springs had been covered over by snow and/or ice. Though last year, a piped-water system was financed and installed by the government to carry potable water directly from the springs to various points throughout the village. Though this piped-water system is in its infancy, as of yet, it has not frozen and remains operable throughout the winter months.

According to the 2001 census, the village of Hemis Shukpachan has a population of 947 which comprises 182 households (DSEA, 2006). These households are divided into four chutsos. The names of these chutsos are unknown, and it was unclear if there is still someone responsible for the role of the churpun. It was evident however, that there did exist delineated rules for managing the water (i.e. when each household could divert water from the tokpo to irrigate their fields) and five operational zings were present throughout the village. One chutso was witnessed repairing a yura, which had been damaged by the previous days' heavy rains, that brings water to the fields in their area. It took this group of villagers three days to rebuild this yura. It was reported that villagers had collectively built the yuras long ago and that they continue to repair them, however now the state government is relied upon for more major repairs to the water management infrastructure through out the village. For example, it was expected that before too long, a zing, which had been destroyed by the flooding from the heavy rains, would be repaired by the government. A participant commented that, were it not for the government's assistance, it would otherwise take the villagers approximately one month of labour to rebuild this zing.

In Hemis Shukpachan, due to its higher elevation, the agricultural season begins and ends a bit later than other villages. The agricultural season begins with the ploughing of the fields and sowing of the seeds in late May, however, at this time of year there is limited water, so irrigation schedules are more strictly adhered to. Once the glaciers above the village begin to melt in late June, water becomes more plentiful and, as a result, rules become more relaxed. The growing season continues through July and August, until the harvest. The year this research was conducted, the harvest, inaugurated with a puja (holy offering to the village oracles) by the Togoche family, began in the first week of September. It is expected that the remainder of the harvest would have been completed by the first week of October.

3.3 Conclusion

This chapter has provided, in detail, the case study of Ladakh, one of the few remaining pockets in India where the traditional water management systems are in place and in use. In Ladakh, the communal system of water management is broadly similar across the region, however, as described, within each particular village, subtle variations are present. In the subsequent chapter, these variations and the intricacies of the system as a whole are discussed with respect to how they have enabled Ladakh's successful water management over the centuries.

4. DISCUSSION

In the previous chapter, the case study of Ladakh was presented and the manner in which various Ladakhi communities have successfully managed their scarce water resources for centuries was described. This chapter begins with a discussion of the impact that the particular characteristics of both the resource and the resource users have had on water management in Ladakh, followed by an analysis of the particular institutional characteristics that have facilitated Ladakh's success in the past and into the present. Next, the current challenges to sustaining the Ladakhi institution of communal water management into the future are identified, and the possibility of overcoming these challenges is explored. Finally, some of the 'best practices' of Ladakh's communal water management system are brought to light in the hope that they might offer other communities insight on how to achieve more effective water management.

4.1 The Impact of Resource Characteristics on Water Management

Water is an example of a common-pool resource. Water shares the characteristics of subtractability and difficulty of exclusion with other common-pool resources, however water differs from other common-pool resources with regard to a series of other characteristics, namely renewability, scale, and cost of measurement. These characteristics are important because they influence how rules must be crafted in order to effectively manage water.

4.1.1 Renewability

Water is a renewable resource. "Renewability relates to the rate at which resource units that are extracted [or contaminated]...replace themselves over time" (Dietz et al., 2002:22). The rate of renewability falls on a spectrum between resources that will not renew themselves within human timeframes, such as oil, to resources that will renew themselves within a few generations, such as forests, to resources that may renew themselves within a single generation, such as some animal species. "Resources that regenerate slowly are more challenging to manage" (Dietz et al., 2002:22). However, the rate of renewability depends highly on human interaction with the resource. For water, the rate of renewability depends on the source of the water, as well as on human interaction. Besides scant rainfall, Ladakhis' water has traditionally been drawn from a mixture of glacial and snow melt, and surface springs and marshes. More recently, underground aquifers have also been utilized as a source for domestic water use. Regarding renewability, it is possible to recharge some underground aquifers within a resource user's lifespan, however, it is difficult to imagine replenishing a mountain glacier within that same lifespan. Nevertheless, the Ladakhi communal water management system was established to manage glacial and snow meltwater, taking into consideration the availability of springs and marshes, but did not incorporate aquifer sources. As a result, Ladakhis do not traditionally possess knowledge regarding aquifer recharge and management. This poses a problem as Ladakhis move to a greater reliance on aquifer extraction for their water needs.

4.1.2 Scale

Scale refers to the size or "sheer extent of the resource" (Dietz et al., 2002:23). The scale of a common-pool resource impacts both the number of resource users and the heterogeneity of users and their uses. The greater the extent of the resource, the greater the likelihood that the resource users will be numerous. Conversely, a small pond will likely attract fewer users than a large ocean. To continue with this example, the group of users of the pond are likely to be less heterogeneous than the users of the ocean, and accordingly, the diversity of their usage will also be less heterogeneous. That being said, "the literature on *local* [emphasis added] common-pool resources suggests that a greater number of users does not necessarily impede cooperation, even though this may increase costs of devising, monitoring, and enforcing the rules," though it suggests …"different, even opposing effects of heterogeneity among [users] on cooperation" (Dietz et al., 2002:23). Cooperation among resource users is important as it facilitates the management of the resource.

Regarding the scale of water in Ladakh, as previously mentioned, Ladakh is a water scarce region. In the past, when most resource users in Ladakh were using the water for the same purposes, agriculture, homogeneity in usage facilitated cooperation. In the present, though Ladakhi society is still primarily agrarian, heterogeneity has emerged with respect to both water usage and population. With regard to usage, if less people are farming, this may put less pressure on finite water resource, which facilitates management. In contrast, if all tourists have flush toilets, then water usage goes up, and management is more difficult. Regardless of use though, the amount of water is finite. With regard to population, as new users are added to the system, both usage and heterogeneity will likely increase. New entrants add to the harvesting pressure and typically lack understanding of the rules, and therefore, increases in population heterogeneity will likely impede cooperation, thereby impeding successful management.

4.1.3 Cost of Measurement

The ability to measure common-pool resources is conducive to effective management of resources, and is vital to ensure long-term sustainability of a given resource. The quantity of the resource used must be measurable in order to ascertain current usage and to devise rules to limit usage, in order to ensure future usage. Cost of measurement is affected by the mobility and storability of the resource. "Mobile resources, such as wildlife and undamned river water, are much harder to measure and account for than stable resources, such as forests and pasture lands" (Dietz et al., 2002:24). Water is highly mobile. The mobility of water makes measurement, and thus management, of water much more difficult. The ability to store mobile resources can mitigate this difficulty, as it facilitates measurement of the resource. In Ladakh, water is stored in zings, and available stock and usage is monitored by the churpun. Additionally, the smaller the scale of the common-pool resource, the easier it will be to measure, monitor, and manage (Dolšak & Ostrom, 2003).

4.2 The Impact of Resource User Characteristics on Water Management

While the focus of this research was on how the institutional characteristics of Ladakh's communal water management have facilitated its effectiveness over time, attributes of both individual common-pool resource users and a group of users, as a whole, also influence institutional effectiveness; the preferences and assets of individuals, and the size, cohesion, trust, and homogeneity of groups all affect the institutions governing common-pool resources. Where water users "maintain frequent face-to-face communication and dense social networks – sometimes called social capital – that increase the potential for trust, allow people to express and see emotional reactions to distrust, and lower the cost of monitoring behavior and inducing rule compliance" institutional effectiveness is facilitated (Dietz et al., 2003:1908). This description aptly represents what relations between water users in Ladakh have been traditionally like. An intrinsic part of Ladakhi culture is the notion of mutual aid and, as a result, individuals are part of a web of supportive relationships. In addition to the communal system of water management, cooperation is formalized in a number of social institutions, such as the pashpun, bes, rares, and lhangsde. Thus, it is cooperation, rather than competition, that shapes Ladakhi society. Though additional data was not collected on the impacts that resource user characteristics have on water management, their influence is still worthy of mention.

4.3 Institutional Characteristics: Past and Present

The physical characteristics of water, as a common-pool resource, affect its manageability, as do the characteristics of the water resource users. However, these characteristics alone are not determinative. The institutional characteristics of Ladakh's communal water management system must also be examined in order to explain its long-enduring success in sustaining local water resources, and ensuring water users' compliance with rules, generation after generation. Two other common-pool resource characteristics – subtractability and difficulty of exclusion – apply to water as they do to all other common-pool resources. Ladakh's success over the centuries can be attributed to its continued ability to overcome the common problems that these two characteristics can pose – overuse and free-riding. Agreed-upon rules have been established to regulate overuse, however, traditionally in Ladakh, free-riding has not been a problem.

> Most users [who] ... live in the same village where their families have lived for generations and intend to live in the same villages for generations to come [and] ... would prefer to find ways of limiting their own use so long as others also committed themselves to stinting. Village institutions would provide

> mechanisms to enable users to arrive at agreements (within the village context) that would assure each user that others were conforming to the agreed-on set of rules. (Dietz et al., 2002:12)

In village dynamics such as these, where water users maintain frequent face-to-face communication and dense social networks, the strategy of free-riding is minimized, and instead, coordination and cooperation dominates. Acknowledging that Ladakh has successfully managed scarce water resources for centuries, the primary purpose of this research was to determine what institutional characteristics facilitated Ladakh's success in the past.[35] In order to analyze which institutional characteristics facilitated past and present success, Ostrom's (1990) 'design principles' are used to frame the following discussion.

4.3.1 Clearly Defined Boundaries

In Ladakh, the boundaries of the water resource are clearly defined along village lines, and, within a village, with respect to who can use the resource, how they can use it, and who is excluded from using it.[36] It is important to note that Ladakh's system of communal water management pertains primarily to the agricultural usage of water. The right to withdraw water is held by village households, and determined based on the size of their agricultural landholdings.[37] Water use from recent additional sources, such as hand-pumps, water deliver tankers, and piped-water systems, is not regulated and falls outside the boundaries of Ladakh's communal water management system.

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[35] It is important to note that there are other factors that have also facilitated Ladakh's success, such as climate and topography.

[36] Though Leh is larger than a village, for the purposes of this discussion, Leh will be included in the use of the word "village" unless otherwise noted.

[37] More than 90% of Ladakhi families own their own land (Page, 1993).

How water is used has historically been limited to agricultural use, but it is not entirely clear whether the water usage is *restricted* to agricultural use. As livelihoods have recently become more diversified, so too have the types of water usage. For example, the introduction of tourism, has led to the construction of guesthouses with western-style flush toilets[38], which require water. Though these guesthouse owners do not necessarily have fields to water, they now have toilets to flush, and thus still have water needs. Guesthouses in Leh do not draw their water from yuras, but rather typically rely on the water delivery tankers for their water needs. It is not clear whether water users would be permitted to draw from the yuras for alternate uses such as these if so requested.

Due to Ladakh's relative geographical isolation, the difficulty of excluding outsiders, until recently, has been minimal. Though outsiders regularly passed through Ladakh (i.e. caravan traders), outsiders settling in Ladakh was relatively rare. Now, however, outsiders settling in Ladakh has become more of a common occurrence. As a result, excluding outsiders has become more difficult. Exclusion has been accomplished by limiting harvesting based on agricultural landholding, and restricting withdrawal based on time, place, and quantity. Where exclusion has not been as successful, however, is with regard to the contamination of the water resource. The mobility of water makes monitoring its abuse difficult. Traditionally, it was everyone's collective duty to keep the tokpo clean for drinking water, and certain tributaries were dedicated for washing water and irrigation. Polluting the village's main drinking water source was unheard of, and accordingly, no rules were established to penalize those caught polluting water. Instead, social norms were relied on to ensure compliance. However, limiting

[38] Traditional Ladakhi toilets are dry composting toilets, which do not require any water.

access alone will not ensure the sustainability of the resource or the management institution, effective rules to minimize free-riding and overuse by the water users still need to be devised and enforced.

4.3.2 Congruence between appropriation and provision rules and local conditions

The success of Ladakh's long-enduring institution of communal water management has been facilitated by the establishment of appropriation rules. Restrictions on water appropriation are based on time, place, and quantity and are carefully tailored to local conditions. Water users must contribute material, money, and/or labour to ensure provision and full functioning of the system.

Time Restrictions

Rigid time restrictions are placed on when individual users can irrigate their fields. In Alchi, two of the chutsos have very steep slopes, so they do not receive ston chu (autumn water) and instead receive tha chu the following spring. The order in which fields receive tha chu is determined by a lottery system and each family receives water for the same amount of time. In Leh, restrictions, based on chutso divisions, are determined by both a temporal rotation system and a tokpo-wise rotation system. With the temporal rotation system, the day is divided into four time-periods, and during each period, water is diverted to a particular area of Leh. In the second system, water is diverted tokpo-wise between three tokpos, to irrigate the fields of three chutos in their vicinity. The system of water distribution between these three tokpos occurs in a pre-determined order. In Chemray, the frequency of watering, their duration, and the intervening breaks are all pre-determined. From the time of sowing to the time of harvest, there are five periods of irrigation, each of eight days in length, and, between each irrigation, a break of pre-determined length occurs. In Saboo, irrigation timing is based on crop type. In order to take into consideration the growing period for each crop, irrigation is alternated between wheat and barley fields; wheat fields are irrigated first, followed by barley fields, and so on.

Place Restrictions

Restrictions on water appropriation are also based on place depending on local conditions. For example, where some users have access to alternate water sources restrictions are placed on their rights to withdraw water from the main tokpo. In particular, all water users in Kharu village (below Chemray), Ayou Chutso in Saboo, Skara Chutso in Leh, and four families in Chemray, have no legal or traditional right to the water from the tokpo in their respective villages, and so instead, must rely on the chumik and spang water for drinking, domestic, and irrigation purposes.

Usage of water for domestic purposes is not regulated with respect to time or quantity, however, where users can perform certain domestic tasks is regulated; regulation is achieved through social norms/coercion, not through the formal churpun monitoring mechanism. For example, washing of clothes and dishes is prohibited in certain streams from which people collect their drinking water. This has become less applicable as of late, for the usage of streams for drinking water has declined due to the introduction of hand pumps.

Quantity Restrictions

Rigid restrictions are placed on how much water individual users can withdraw to irrigate their fields. In Ladakh, when quantity is used to determine water appropriation, the measurement is not a metric volume, but rather is based on the amount of water necessary to irrigate a given field. In Saboo, one household described that their three barley fields took approximately three days to irrigate, and while it may seem that water is being distributed based on water time, it is more appropriate to say that water is being distributed based on the quantity needed. In Alchi, for the initial pre-sowing irrigations, all households receive the same amount of water (based on a time allocation), however subsequent irrigations are based on field size.

In general, across Ladakh, appropriation rules are relaxed when water availability is plentiful. For example, when there is heavy rainfall, or increased meltwater, water may be released to multiple users simultaneously, instead of in the normal ordered sequence. Participants noted that the role of the churpun becomes more difficult in times of water scarcity because his responsibility increases, whereas in times of plenty, the role of the churpun may cease altogether.

Provision Rules

There are two elements to the provision of water in Ladakh, the physical system itself, and the system of rules and regulations governing the provision of water. Water users make material, monetary, and labour contributions to both elements of the system, but these contributions vary across the region of Ladakh depending on the local conditions. Labour is contributed to the upkeep of the physical system. In earlier times, repair and maintenance of the entire system was completely carried out by the community. These days, each chutso in a given village is responsible for the maintenance of yuras in their area, that is, to keep the yuras clean and repair broken yuras, however dependence on the government has grown such that now major repairs and maintenance, such as repairing zings, are undertaken by the local administration.

Material, monetary, and labour contributions are also made for the effective enforcement of rules and regulations. In Alchi, churpuns are compensated in-kind for their work by the villagers themselves; each household gives the churpun equal amounts of barley – one bucket or approximately 15 kilograms – though smaller households give a little less. In Saboo and Leh, the churpun was formerly also compensated in-kind, but now is compensated monetarily for duration of the five-month growing period. In Saboo, the churpun is paid by each household based on the size of their landholdings; one participant reported paying the churpun a total of 75 INR for the entire agricultural season. In contrast, the churpuns in Leh receive fixed monetary remuneration of 3,000 INR from the local administration, which is not based on landholdings nor on the level of responsibility vis-a-vis water availability. Labour is also contributed to the enforcement of rules of regulations. For example, in Chemrary, each family from two of the four chutsos, must contribute a night watchman to prevent illegal appropriation. Failure to carry-out this duty when it is the family's turn, results in a 500 INR fine to discourage further free-riding.

4.3.3 Collective-choice arrangements

While the data acquired in this research did show the modification of operation rules over time, the degree to which individual users participated in and affected these changes was not determined.

4.3.4 Monitoring

Monitoring is an essential part of the Ladakhi communal water management institution, which has facilitated its success over the centuries. The churpuns, or village water managers, play the primary role of monitoring both the overriding conditions of the water resource as well as the behaviour of individual users. Churpuns are accountable to the water users through in-kind or monetary remuneration, with the exception of Leh, where the churpun is a government employee. In Alchi, churpuns are elected by the villagers, and in Saboo, churpuns are appointed by the goba. In both Chemray and Leh, however, by rotation, each household has its turn to carry out the yearly churpun duties. In cases like these, accountability to water users is further fostered.

The churpun's duties are to ensure that all fields receive water and that all minor repair and maintenance works are carried out. It is the churpuns who determine when each household can divert water from the main tokpo to their fields, and if someone were to divert water to their fields without the churpun's permission, it is the churpun's responsibility to enforce institutional rules, help resolve conflicts, and to punish the perpetrator. Also, churpuns are responsible for ensuring that the zings are filled through the night and released the following day to irrigate the fields that lie below. As only the churpun has the key to open and close the locking valve on each zing, the zings are under complete control of the churpuns.

Perhaps the best example of monitoring was exhibited in Chemray. During the agricultural season, each churpun has exclusive control over an official thetse (carved wooden seal). The thetses are used to mark the closing of a yura, such that if the impression left by them has been disturbed, the churpun is able to easily detect unauthorized water use, and penalize the violator.

4.3.5 Graduated sanctions

Ladakh has always had a system of sanctions in place to deal with water users who violate the operational rules of the communal water management institution. Not only are there sanctions, but sanctions are graduated depending on the severity and context of the offence. Typically, sanctions are determined and meted out by the churpun. In Alchi, penalties for those caught stealing water, typically result in a fine of 100 INR, but increase with the severity of the crime. For example, if someone were to divert water without permission during a time of extreme scarcity, the penalty would be much more severe than if the same offence were committed in times of adequate water amounts. In Leh, monetary and corporal punishment are the customary manners of punishment, and, as in Alchi, the severity of the violation determines the severity of the punishment. For example, in times of severe water shortage, or if large quantities of water have been illegally diverted, violators have been known to receive a hefty fine or beating. In Saboo, it is the goba who determines the severity of the infraction, and issues the penalty accordingly. Penalties are typically in the form of a fine and are meted out by the churpun; fines can reach 500 INR or more. Historically in Chemray, penalties were jointly determined by the villagers of the chutso where the infraction occurred, and meted out by the churpun. For example, the perpetrator of the violation could be made to do extra community work, give a public apology for their wrongdoing, or give a gift of chang (local brew made from fermented barley) and kataks (ceremonial white scarves) to the aggrieved party. Nowadays, a fine of about 500 INR is the typical penalty for stealing water, though the severity of the fine depends on the severity of the water scarcity in the village at the time that the infraction was committed. In villages or chutsos where no churpun exists, sanctions are meted out by fellow water users.

4.3.6 Conflict-resolution mechanisms

In Ladakh, conflict-resolution mechanisms are achieved through official and unofficial avenues. In Saboo, the churpuns and the goba work together to solve water-related problems. For example, a churpun will inform the goba if a villager is caught diverting water to his field without the permission of the churpun. The goba will then determine the severity of the infraction, in this case theft, and issue a penalty accordingly. In Alchi, traditionally, the goba's main role was that of the village problem solver. For example, together with the churpun, the goba resolves quarrels over water. Whomever is found to be at fault – the perpetrator of the violation – must apologize and give kataks to the aggrieved party. For Chemray and Sakti, the two villages, which share the same tokpo, the pabchu system was developed in order to attain a more equitable distribution of the water between the villages. Disputes inevitably arose between the two villages, and in an attempt to resolve these disputes, a system of sharing water for irrigation developed between Chemray and Sakti. In appreciation for sharing, a customary offering, aptly named *Sha-Chang*, is contributed by the Chemray Gompa to the goba of Sakti, though of late, 500 INR is paid in lieu of the sha (meat).

However, the social stigma of conflict, particularly of losing one's temper, most likely plays the biggest role in mitigating conflicts over, *inter alia*, water in Ladakh. "A concern not to offend or upset another is deeply rooted in Ladakhi society; people avoid situations that might lead to friction or conflict. When someone transgresses this unwritten law, ... extreme tolerance is the response" (Norberg-Hodge, 1992:46). Because conflict avoidance is so deeply entrenched in Ladakhi society, third-parties often intervene as an intermediary. In contrast to western culture, this intervention is welcomed and is not seen as meddling. "This mechanism prevents problems from arising in the first place" and the possibility of direct confrontation can be avoided (Norberg-Hodge, 1992:47).

4.3.7 Minimal recognition of rights to organize

In previous times, the rights of Ladakhi water users to devise their own endogenous communal water management institution does not appear to have been challenged by external forces. Increasingly though, the Indian state is playing a greater role in the management of all aspects of Ladakh's affairs, including its communal water management institution. For example, where traditionally the goba and churpun formed the highest level of authority within the institution, now a state-appointed level of government (the Panchayat) has assumed the top role of oversight. Although the Panchayat gives at least minimal recognition to the legitimacy of the Ladakhi's rights to organize, develop and enforce rules of the communal water management system, it is foreseeable that this formerly endogenously governed institution could be usurped by external control.

4.4 Current Challenges to Sustaining the Ladakhi Institution

After analyzing the institutional characteristics of Ladakh's communal water management system, which have facilitated its past success and have been maintained in the present, the research sought to ascertain whether there are factors that challenge the viability of sustaining Ladakh's communal water management institution, presently and into the future. Ladakh's system of communal water management is challenged by such broad external factors as population growth, urbanization, modernization, changing livelihoods, weakening of the social fabric, increasing dependence on government, and climate change, and these factors will be described throughout this section.

Until the borders between China and India were closed in 1959, Ladakhi livelihoods primarily consisted of pastoral nomadism, subsistence agriculture, and trade. After this time, trade into Central Asia ceased, however the looming war with China in 1962 led to new roads being built into Ladakh, and a deployment of troops throughout the region. Since the 1960s, thousands of Indian troops have moved into Ladakh (with most being stationed in and around Leh) (Loram, 2004). The pervasive army presence continues to this day. This has resulted in significant population increases, particularly in Leh, and changes to water user needs and increased water demands. The different food crop preferences of the Indian army encouraged a shift in Ladakhi agricultural production, away from traditional crops (such as barley), and toward cash crops (such as potatoes and vegetables) that could be sold to the army. This placed further stress on already limited water resources, beyond the effect of the population increase, because the new crops require more water to grow than the traditional Ladakhi crops.

Additionally, the new roads facilitated trade with the rest of India, bringing in a host of new products, subsidized food stuffs, as well as new ideas about modernization and development. As chapter two showed, at this time, the Indian state was pursuing a development strategy based on central state efforts to foster industrial modernization, and it was this definition of development that was introduced in Ladakh. The new roads also allowed the introduction of tourism into Ladakh. Since 1974, when Ladakh opened up to tourism, there has been a steady rise in the influx of tourists, with the number surging from 18,000 annually in 2000 to 43,508 in 2006, breaking the previous year's record

(J&K Tourism Department, 2006). Tourism led to further changes in previous livelihood patterns. With the rising numbers of tourists has come the rising demand for goods outside the scope of the local economy, namely food preferences akin to those of the army (Tiwari & Gupta, 2003). Tourists have not only increased the number of water users, placing increased demands on the water system, but they have also placed new water demands on the system. For example, the proliferation of tourist-specific amenities such as, flush toilets, showers, and sinks, have permitted a profligate use of water, which was previously unheard of in Ladakhi society. These tourist demands have not only placed a significant additional strain on already scarce water supplies, but have also led to significant contamination of the water. The flushing of chemicals and human excrement into the water supply has left the streams in and around Leh no longer fit to drink from, and water-borne illnesses are on the rise. Solid waste, from plastic water bottles to processed and packaged food wrappers, previously non-existent in Ladakh, can now be found piled up in the streets, landfills, and clogging the water channels (see Figure 18). As it has becomes ever-more difficult to exclude 'outsiders,' problems of overuse, such as these, have become more difficult to monitor, control, and contain.

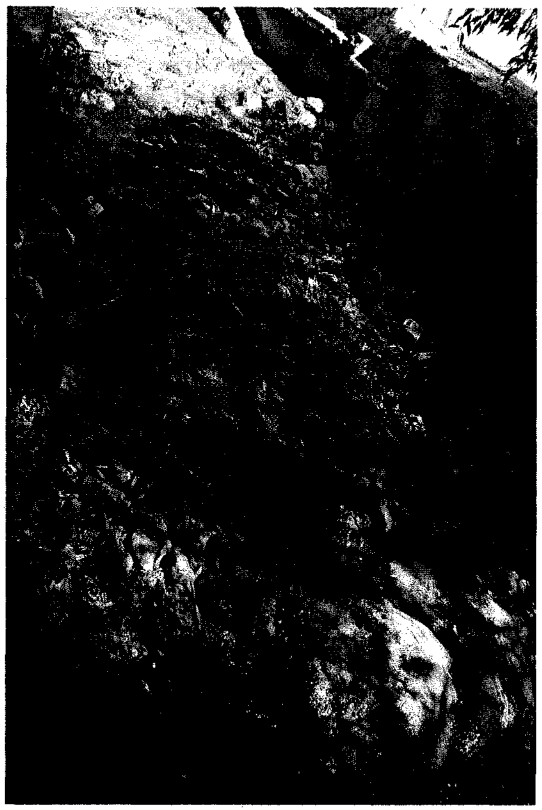

Figure 18: Solid waste in Leh yura.

The diversified livelihood opportunities brought about by the presence of both the Indian army and tourism in Ladakh led to a transition from an economy based on herding, agriculture and trade to an economy based on cash. The emerging cash economy, fostered urbanization, particularly to Leh, by drawing people away from farms and into town, in order to seek paid employment, and the greater economic prosperity that jobs in the service sector promised. As a result of the subsidized food imports, and the strong push for modernization, local agriculture became less attractive and so there has been little incentive to continue farming (Page, 1993). This substantial population growth in Leh from the army, tourists, and the process of urbanization has had a profound effect on Ladakh's system of communal water management. As a result, more people have to share a finite amount of water; the same amount of water now has to be split in so many extra ways. Some scholars have argued that, in the past, Ladakhis have been able to maintain a harmonious balance with their environment, due to the practice of fraternal polyandry (the marriage of one woman to more than one brother), combined with the practice of sending away at least one child to pursue monastic education, and the practice of primogeniture (the system of inheritance or succession by the firstborn, specifically the eldest son). Polyandry in particular, limited population growth (while maintaining "a labor force within the household large enough to carry out labor-intensive subsistence agriculture"), by constraining fertility, in order to maintain a balance between population and constrained resources (Wiley, 1997:279). When new economic opportunities arose, with the arrival of the military and tourism, sons who did not desire to join a polyandrous union, were enabled to leave the family, and pursue livelihood alternatives elsewhere (Wiley, 1997). Where previously the economic situation in Ladakh presented virtually no alternatives to polyandry, now the availability of choice has diminished the predominance of this practice, and thus there no longer exists a strong population limiting mechanism. The population of Leh town rose from a mere "2,895 persons in 1911 to 3,720 in 1961" (Tiwari & Gupta, 2003:3). As of the 2001 census, Leh hosts a population of 28,639, not including the transient or temporary residents (army, tourists, migrants), which only continues to soar (DSEA, 2006:32). In one respect, churpuns in Leh have borne the brunt of this increase in water scarcity, as when water is more scarce, their responsibilities become more difficult. However, in another respect, as more people in Leh stop farming, and instead pursue paid employment, there may be fewer fields that need irrigation, and thus churpuns' work possibly decreases.

As a result of the diversification of livelihoods, people in Leh began to have jobs or businesses to run, and so became unable to devote the required amount of time to fulfill their churpun duties. The position of the churpun came to be seen as burdensome, and consequently, it came to be assumed on a turn-by-turn basis in 1965. Since 1999, all households in Leh are required, by rotation, to assume the role of churpun. As a result of this rotational system, the churpuns are no longer selected according to their ability to manage the irrigation system, and, accordingly, not all churpuns possess the requisite leadership attributes to effectively carry out their responsibilities. Further, the practice of employing migrant workers as churpuns, from the Bihar state of India or Nepal, who are obviously not familiar with the functioning of the system, has led to problems and disputes (Tiwari & Gupta, 2003). Consequently, the effectiveness and the longevity of the communal water management system in Leh is in grave jeopardy.

Additionally, the diversification of livelihoods has had a strong impact on communal water management at the village level. In both Leh and outlying villages, all family members have traditionally lived in the same household and worked their family fields together. Now, many husbands and children are leaving the villages to go live, work, and attend school in urban centres, such as Leh. As a result of this process of urbanization, many village households now have an acute labour shortage. As they try to hang on to farming (usually left to the women of the older generations), most of these households have few other options but to import Indian and Nepali labourers. The past success of Ladakh's water management has been facilitated in part due to dense social networks between water users, which have led to increased trust between water users. These labourers are not part of the villages' dense social networks, and because they are outsiders, there exists an increased potential for distrust toward them by the other villagers; distrust amongst water users does not facilitate the successful management of water. Furthermore, outside labourers, generally, do not know about the community norms regarding water polluting. For example, Ladakhis use dry composting toilets (that turn human excreta into rich organic manure) whereas most other Indians use water for their sanitation needs. Participants in Alchi complained that migrant workers were washing their bodies and clothes in the tokpo, and using it as a toilet. Though it appears that the quantity of water Ladakhi's receive is still sufficient to meet their individual needs, the quality of the water in villages is now being called into question.

The push for modernization has been accompanied by the notions of the importance of formal school education and the stigmatization of farming. As a result, there has been an overwhelming trend for Ladakhi families to send their children to school. Children who attend village schools, are away from the household and farm through the day, but still contribute to the family tasks in the evenings, and on weekends. Where village schools do not exist, or where families have the means to afford 'better' schooling, children are sent to boarding schools in urban centres, and therefore do not contribute to the family tasks. As children leave the land to participate in formal education, and eventually the cash economy, they do not acquire the traditional education, which includes knowledge of the communal water management system. Participants in both Alchi and Saboo expressed the concern over the longevity of the system. One Saboo participant explained that whereas knowledge of the role of the churpun was traditionally passed down from generation to generation, now the younger generation is not interested in learning the old ways. At present, only the elders know all the yuras and which fields belong to each family, so when it is a person's turn to be churpun they lack the requisite knowledge to manage the irrigation system and consequently must go to the elders for assistance. Once the elders die (within the next 10-20 years), there is a strong fear within the older generation that the traditional system will fall apart.

Further, as the predominance of agriculture diminishes, and houses are built where fields once grew, the rationale for maintaining the communal water management system also diminishes. Ladakh's communal water management system is premised on the widespread practice of agriculture, and supported by the fact that the social benefit of the system is approximately equal to the sum of each household's benefit; in the past, this encouraged households to participate in the upkeep and management of the system because their mutual efforts resulted in mutual benefits. If a time comes when fields are no longer being irrigated to grow crops, then there will no longer be a need for the system. Even if a portion of the population does not abandon agriculture, those households who do, no longer have the same incentive to contribute to the upkeep and management. In Chemray, for example, the system of the pabchu has only worked because there have been enough volunteers to stand watch over the yuras. If households were to cease their contributions to the pabchu nightwatch duties, then the likelihood that the water resource will be properly monitored decreases, and opportunities for overuse and free-riding increase.

Traditionally, family members lived together in the same household and landholdings were kept intact, though recently, as a result of urbanization and modernization, families are splitting into ever-smaller nuclear units, and likewise their landholdings are being split into smaller and smaller pieces (Page, 1993). New houses are built where fields once grew, and even if children do not move away from their families in the village to urban areas, the recent trend has been to move into these separate dwellings. Commercialization, which tends to increase income differentiation in communities, also appears to be "destroying the social fabric of communities, replacing traditional principles of cooperation with those of competition and causing resource deterioration" (Dolšak, & Ostrom, 2003:18). As community ties are weakened and competition increases, the old system of mutual aid, that formerly permeated all aspects of Ladakhi society, is at risk of breaking down. "Groups with longer traditions of mutual trust and close-knit communities that enable resource users to reciprocate behaviour are more likely than other groups to succeed in devising and sustaining successful institutions" (Dolšak, & Ostrom, 2003:6). The long-enduring success of Ladakh's communal system of water management can, in part, be attributed to the Ladakhi societal nature of cooperation and mutual support. However, in addition to the communal system of water management, voluntary systems of shared labour and resources, such as the pashpun, bes, rares, and lhangsde, have now come under threat; "now that everyone's gone off looking for paid jobs, you can't get any help with ploughing or harvesting without paying for it" (Page, 1993). Thus, as family members move away and live apart, and neighbours become engaged with other activities, water users no longer maintain frequent face-to-face communication and the dense social networks, that once facilitated the success of the water management institution, begin to deteriorate.

This weakening is further compounded by a loss of self-reliance due to an ever-growing dependence on the government. As previously mentioned, in earlier times, repair and maintenance of the entire system was completely carried out by the community. Nowadays, minor repairs and maintenance, such as repairing yuras, are still undertaken by the community, however, dependence on external assistance has grown, such that major repairs and maintenance (i.e. the repair of zings), are undertaken by the local administration. In Alchi, for example, villagers have been awaiting assistance while their zing has been in disrepair for about three years. In places where contractors have been sent to undertake repairs, more modern materials, such as cement, are used, rather than the traditional, and locally available, stones and mud. When these cement repairs themselves need repairing, Ladakhis no longer have the ability and materials necessary to repair the infrastructure. There is a fear that these new, cement structures are not going to last anywhere as long as the old ones, thereby threatening the sustainability of the physical system. Since the new structures will not be able to be repaired using local materials, the government will have to be relied upon even for minor repairs, perpetuating further this dependence. Additionally, one participant reported that in Leh, with the establishment of the Ladakh Autonomous Hill Development Council in 1995, this government assistance is now within closer reach, which has only served to exacerbate this tendency. Though these changes have not completely overwhelmed Ladakhi society, and thus the communal water management system, the continued effectiveness and longevity of the system remains uncertain.

These external factors, while more apparent and intense in Leh, were prevalent in all villages investigated in this case study. Consequently, the question of *proximity* to Leh did not seem to be a factor in maintaining the integrity of the traditional water management system as, even in Hemis Shukpachan, the furthest village from Leh (approximately 85 kilometres away), the effects of these external factors were witnessed. Likewise, *direction* from Leh, did not appear to be factor in maintaining the integrity of the traditional water management system, nor did the *altitude* or *aspect* of a particular village. What did seem to be a factor, however, was the water *source*, and therefore the *amount* of water available to a particular community. For example, no glaciers are located above Alchi, and instead Alchi's water is dependent on the previous winter's snowfall. As a result, Alchi suffers from a chronic shortage of water, but the limited supply of water forces Alchi to be judicious in the distribution of water and follow a precise and regimented irrigation schedule. It can thus be generally surmised that, Alchi's chronic water shortage has kept its rules strictly enforced and traditional water management system strongly intact. Similarly, Chemray's *close proximity to another community*, resulting in the necessity to *share* water with the other community, seems to have served to strengthen both the internal management of water within the village boundaries, and the management of water between the two villages.

If all these aforementioned external factors were not enough, climate change also poses a significant challenge to the viability of sustaining Ladakh's communal water management institution, presently and into the future. As a result of climate change, temperatures around the globe have been increasingly rising. Warming is having profound affects on many ecosystems around the world, however the melting of mountain glaciers is of particular relevance to this research.

> The Himalayan Glaciers on the Tibetan Plateau have been among the most affected by global warming. The Himalayas ... provide more than half of the drinking water for 40% of the world's population – through seven Asian river systems [the Indus River, Ganges River, Brahmaputra River, Salween River, Yangtze River, Mekong River, and Yellow River] that all originate on the

> same plateau. Within the next half-century, that 40% of the world's people may well face a very serious drinking water shortage, unless the world acts boldly and quickly to mitigate global warming. (Gore, 2006:58)

One participant reported that, over his lifetime, he had personally witnessed the reduction of the glaciers visible from his home in Skara, on the outskirts of Leh, by nearly half their size. At the time of the interview, he was 67 years old, which provides evidence of the rapid pace of change that is taking place. In addition to the reduction in glacial size, rising temperatures will cause snow and ice on mountain peaks to melt earlier than normal and at greater rates. This advancement in the timing of glacier and snowmelt, and the subsequent changes in meltwater runoff rates and seasonality will have serious consequences for populations, like Ladakhis, who rely on agriculture for their livelihoods (Gore, 2006). In dry (arid or semi-arid) regions like Ladakh, even small changes can put significant stress on water supplies. "Those living in fragile deserts and on mountainsides are most vulnerable to climatic and environmental changes wrought by pressure of people on the land, deforestation, soil erosion, and disruptions to river flows from dams and upstream pipelines" (Black, 2004b:131).

"These changes will be further complicated by shifts in precipitation regimes and a possible intensification and increased frequency of hydrologic events" (Gore, 2006:264). These predicted effects are already being observed in Ladakh. Though the data available is limited, Figure 19 clearly depicts the recent trends in precipitation in Leh. Annual rainfall is on the increase (besides an aberration in 2005). Unfortunately, at the time the data was collected, 2006 data was unavailable. However, due to the heavy, and reportedly unprecedented, rainfall directly observed by the researcher during the

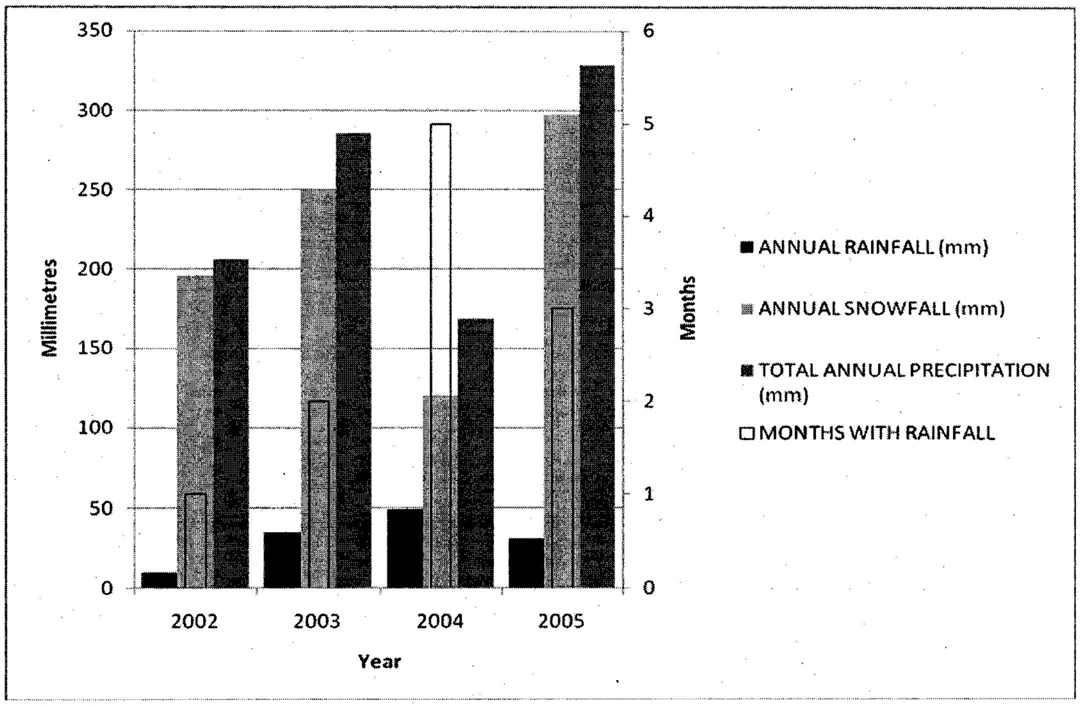

Figure 19: Recent precipitation trends in Leh.
Note: Raw meteorological data from Field Research Laboratory, 2006.

period of field work, the annual rainfall for 2006 was undoubtedly higher than that of 2004. Despite an anomaly in 2004, both the annual snowfall and the total annual precipitation are also on the rise. Additionally, the number of months per year experiencing rainfall is growing. Not only is the number of months in which rain is falling noteworthy, but also the month during which the majority of the rain is falling. For example, in 2003, the month of May experienced the heaviest rainfall. At this time of year, the crops require significant watering, and therefore the rainfall is welcomed. The worry though is that the concentrated rain could cause the erosion of the topsoil. In 2004, most of the year's rain fell during the month of October, which has dire consequences for crops. By October, all the crops are harvested and rainfall is no longer vital; it is during the growing months when crops need that rainfall. In 2005, July experienced the brunt of the year's rainfall and as a result, fields were flattened by the weight of the rainwater and crops were waterlogged. Again in 2006, the months of July and August experienced extremely heavy rains which had devastating effects on crop yields and livestock, not to mention houses, water infrastructure (particularly yuras and zings), roads, bridges, and the like.

Regarding the possible intensification and increased frequency of hydrologic events, Ladakh has already begun to observe those as well. The incessant heavy rainfall during the summer of 2006 (July 24 – August 22) triggered flash floods which affected almost the entirety of the region of Ladakh (Anderson, 2006). In particular, 20 villages in Ladakh were submerged (see Figure 20). As a result of these severe floods causing houses to collapse, at least nineteen people were killed, and many more injured (The Tribune, 2006). Over 800 people were evacuated and taken to safer areas, namely to five tented camps (Anderson, 2006). The flooding also caused landslides, which washed away roads, left 22 bridges broken and closed the Leh-Srinagar highway for days (United Nations Development Program, 2006).

Figure 20: House submerged by flooding in the village of Rong, Nubra Block.

A further phenomenon resulting from climate change is that mosquitoes are now climbing to higher elevations, thereby increasing human vulnerability to new and unfamiliar diseases. "Before 1970, cold temperatures caused freezing at high elevations and limited mosquitoes and mosquito-borne illnesses to lower elevations. Today, increased warmth has caused some mosquitoes and mosquito-borne diseases to migrate to higher altitudes" (Gore, 2006:173). Historically, mosquitoes, and mosquito-borne illnesses, like Malaria and Dengue Fever, were unheard of in Ladakh. They did not exist. Now, however, mosquitoes are beginning to appear in Ladakh. The presence of mosquitoes in Ladakh was observed during the research period.

4.5 Overcoming Challenges

Given the pressing challenges described in section 4.4, the research sought to address if and how these challenges could be overcome. For common-pool resource management institutions to be successful, they must be able to adapt to changing circumstances (Dietz et al., 2003). However, adaptability is difficult if change transpires too quickly. Thus, when "rates of change in resources, resource-user populations, technology, and economic and social conditions are moderate" institutional effectiveness is facilitated (Dietz et al., 2003:1908).

Examples of Ladakh's communal water management system adapting to accommodate changing circumstances were noted. In Alchi, Saboo, and Leh, increased churpun responsibility, resulting from water scarcity, increased cultivation, and population pressures, have led to the increase in the number of churpuns necessary to manage the water in each of these communities. In 1965, as a direct result of the growing unwillingness among people to continue to carry-out the role of the churpun, a rotational system was instituted in Leh. Then in 1971, as a result of an acute shortage of water in Leh, the water distribution rules were adjusted to ameliorate former deficiencies. In 1984, cash payment of churpuns in Leh was instituted as an incentive to have this important role filled. Most recently, the rotational system instituted in 1965 was amended to include new households in Leh that had emerged as a result of land fragmentation; as of 1999, each household in Leh must serve by rotation as churpun.

New indigenous technology has also been developed in Ladakh to address water scarcity, in particular during the critical seed-sowing period in early spring. Artificial glaciers have been developed that permit the freezing of water in artificial terraced structures at mid-altitudes. Water, that would otherwise be 'wasted' as it trickles to lower elevations, is channelled to these structures in the fall, where they are frozen through the winter; the artificial glaciers melt earlier in the spring than the higher natural glaciers, because their structures are strategically built at lower altitudes and thus they are exposed to rising temperatures first. This technique can be used to provide much needed water during the critical sowing period in early spring, which mitigates water scarcity, and increases the possibility of having two consecutive harvests in one agricultural season. This technology also results in the additional benefit of increasing spring and groundwater recharge (Leh Nutrition Project, 2006).

These examples show that both the institutional and technological aspects of Ladakh's communal water management system have adapted to the changing external conditions that it faces. Just because adaptations are taking place though, does not necessarily mean that the long-term viability of the system will be assured. For example, while the decision to adopt a rotational system of churpun selection in Leh was made in an attempt to achieve equity, it inadvertently has impacted the management quality of the system. In Leh, the churpuns were formerly selected based on merit qualities and appointed by goba. Now that the rotational system is in place, the churpuns are appointed based on a household's turn, and not necessarily on their ability to undertake the churpun duties. Further, the cash payment of the churpun means that some people hire third-parties to fulfill their churpun obligations if they are too busy with other, more profitable opportunities. Unfortunately, it appears that quality is suffering at the expense of equity.

Based on the data acquired, it is not possible to say whether Ladakh's communal water management system will last into the future. As it stands right now, the communal water management system remains quite entrenched in Ladakhi society. However, the *pace* of change that Ladakh is undergoing is rapid, and attributable to many external factors (Goodall, 2004). Some of these external factors, such as climate change, are global in scope, and thus beyond the means of Ladakhis alone to overcome. Other factors though are certainly within the means of Ladakhis to address and overcome. For success to continue, in the face of such rapid changes and influences, Ladakh's institutions must be able to sustain this adaptation into the future.

4.6 Into the Future: The Way Forward

Finally, the research sought to determine what the Ladakhi experience could offer other communities. "The best available knowledge strongly suggests that the search for a single best strategy will be futile," however, this case study, and a rich body of other case studies, has shown that depending on the characteristics of the resource and of the users, communal institutions can be the preferred choice for ensuring the sustainable management of common-pool resources (Dietz et al, 2002:25). The 'best practices' that can be elucidated out of this, and other, case studies, and potentially transferred to other communities struggling to achieve more effective water management, are the notions of economic efficiency, sustainability, equity, accountability and adaptability that are inherent in many communal property management regimes (Dietz et al, 2002).

Ladakh's system appears particularly strong with respect to sustainability, equity, and accountability. Ladakhis have long recognized that their very existence demands the sustainable use of their water resources, and this awareness is embedded into every aspect of their institutional arrangement. Ladakh's communal water management is sustainable because it is endogenously developed, and for the most part, is still not dependent on external financial or material resources for its upkeep. Ladakhis use local building materials and reverence of water is a community norm. In these ways, the institution achieves ecological harmony with the fragile ecosystem that is Ladakh. Equity is fostered by a spirit of communalism, by equitable participation, by the way the position of churpun is appointed (to ensure that no one monopolizes this critical post), and by the way water is distributed (to ensure that each farmer receives adequate quantities of water for their needs) (Agarwal & Narain, 1997). Accountability is achieved through community participation, and an elaborate system of norms and rules to regulate who can use the water, how they can use it, and who can be excluded.

While the Ladakhi experience is not perfect, and its communal water management system faces challenges, it does provide a treasure trove of knowledge for other communities seeking to more effectively manage their water resources. Communities seeking to utilize this knowledge must recognize that Ladakh's communal water management system cannot, and should not, be copied *in toto*, and that part of Ladakh's success has been the ability to craft a system specifically tailored to their unique circumstances; however, once this is acknowledged, the case of Ladakh can provide useful suggestions for the establishment or improvement of a community's communal water management system.

The world needs a revolution in the way we manage water resources. The Earth's water must be shared between people in different regions and different nations, but also between humans and nature. A wealth of knowledge exists throughout the world of how to best manage water resources in specific contexts – the Ladakhi experience is one example of this knowledge. The question for the global community is whether we have the ability and willingness to implement this knowledge in order to improve the management of our water resources. We simply cannot wait for the next generation to do it for us. As we wait, knowledge disappears and people die. The time is now.

REFERENCES

Adam, A. (2004). Ghana: Public-Community Partnerships. In B. Brennan, B. Hack, O. Hoedeman, S. Kishimoto, & P. Terhorst (Eds.), *Reclaiming Public Water! Participatory Alternatives to Privatization*, (pp. 12-14). Amsterdam: Transnational Institute (TNI) & Corporate Europe Observatory (CEO).

Adam, A. (2005). Against the Current: Community-Controlled Water Control in Savelugu, Ghana. In B. Balanya, B. Brennan, O. Hoedeman, S. Kishimoto, & P. Terhorst (Eds.), *Reclaiming Public Water – Achievements, Struggles and Visions from Around the World*, (pp. 139-147). Porto Alegre: Transnational Institute (TNI) & Corporate Europe Observatory (CEO).

Agarwal, A., & Narain, S. (1997). Dying Wisdom: The Decline and Revival of Traditional Water Harvesting Systems in India. *The Ecologist, 27(3)*:112-116.

Anderson, E.K. (2006). *2006 Global Register of Major Flood Events*. Dartmouth Flood Observatory (DFO), Dartmouth College, USA. Retrieved January 21, 2007, from http://www.dartmouth.edu/~floods/Archives/2006sum.htm

Barlow, M., & Clarke, T. (2004). The Struggle for Latin America's Water. *Report on Water, 38(1)*:15-18.

Berg, B.L. (2004). *Qualitative Research Methods for the Social Sciences* (5th ed.). Boston: Pearson Education, Inc.

Berkes, F., & Farvar, M.T. (1989). Introduction and Overview. In F. Berkes (Ed.), *Common Property Resources: Ecology and Community-Based Sustainable Development* (pp. 1-17). London, Belhaven Press.

Black, M. (2004a). *The No-Nonsense Guide to Water*. Toronto: New Internationalist Publications and Between the Lines.

Black, M. (2004b). *Water, Life Force*. Toronto: New Internationalist Publications.

Bogdan, R., & Taylor, S.J. (1975). *Introduction to Qualitative Research Methods*. New York: John Wiley.

Brooks, D.B. (2003). Against the Flow. *Alternatives Journal, 29(2)*:29-33.

Chakrabarty, H. (1986). *Socio Economic Life of India in the Vedic Period.* Calcutta: Sanskrit Pustak Bhandar.

Chakravarty, S. (1987). *Development Planning: The Indian Experience.* Oxford: Clarendon Press.

Chaturvedi, M. (2006, October 23). The Last Drop. *The New Yorker*, 61-71.

Census India. (2005). *Census of India.* Retrieved August 20, 2005, from http://www.censusindia.net/

Centre for Science and Environment. (1997). *Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems*. New Delhi: Centre for Science and Environment.

Centre for Science and Environment. (2001). *Making Water Everybody's Business: Practice and Policy of Water Harvesting*. New Delhi: Centre for Science and Environment.

Creswell, J.W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (2nd ed.). Thousand Oaks: Sage Publications.

Dawa, S., Dana, D., & Namgyal, P. (2000). Water Harvesting Technologies and Management System in a Micro-watershed in Ladakh, India. In M. Banskota & S. R. Chalise (Eds.), *Waters of Life: Perspectives of Water Harvesting in the Hindu Kush-Himalayas, Volume II,* (pp. 235-253). Kathmandu: International Centre for Integrated Mountain Development.

De Villiers, M. (2003). *Water: The Fate of Our Most Precious Resource.* Toronto: McClelland & Stewart Ltd.

Dietz, T., Dolšak, N., Ostrom, E., & Stern, P.C. (2002). The Drama of the Commons. In E. Ostrom, T. Dietz, N. Dolšak, P.C. Stern, S. Stonich & E.U. Weber (Eds.), *The Drama of the Commons* (pp. 3-35). Washington, D.C.: National Academy Press.

Dietz, T. Ostrom, E. & Stern, P.C. (2003). The Struggle to Govern the Commons. *Science*, *302*:1907-1912.

District Statistics and Evaluation Agency. (2006). *Blockwise Village Amenity Directory: District Leh.* Leh: Ladakh Autonomous Hill Development Council.

Dolšak, N. & Ostrom, E. (2003). The Challenges of the Commons. In N. Dolšak & E. Ostrom (Eds.), *The Commons in the New Millennium: Challenges and Adaptations* (pp. 3-34). Cambridge: MIT Press.

Drèze, J. & Sen, A. (2002). *India: Development and Participation.* Oxford: Oxford University Press.

Dube, S.C. (2001). *Indian Society.* India: National Book Trust.

Ellwood, W. (2001). *The No-nonsense Guide to Globalization.* Toronto: New Internationalist Publications Ltd.

Encyclopædia Britannica. (2007a). *Indus River*. Retrieved January 21, 2007, from http://www.britannica.com/eb/article-9110542/Indus-River

Encyclopædia Britannica. (2007b). *Thar Desert*. Retrieved January 7, 2007, from http://concise.britannica.com/ebc/article-9071941/Thar,-Desert

Falkenmark, M., & Rockström, J. (2004). *Balancing Water for Humans and Nature: The New Approach in Ecohydrology*. London: Earthscan.

Field Research Laboratory. (2006). [Meteorological Data in Leh, 2000-2005]. Unpublished raw data.

Figuères, C.M., Rockström, J., & Tortajada, C. (2003). Conclusion: The Way Forward. In C.M. Figuères, C. Tortajada & J. Rockström (Eds.), *Rethinking Water Management: Innovative Approaches to Contemporary Issues* (pp. 228-236). London: Earthscan Publications Ltd.

Food and Agriculture Organization. (2006). *Coping with Water Scarcity: A Strategic Issue and Priority for System-Wide Action.* Retrieved March 26, 2007, from ftp://ftp.fao.org/agl/aglw/docs/waterscarcity.pdf

Frank, B., & Bernanke, B. (2000). *Principles of Microeconomics*. Toronto: McGraw-Hill Ryerson.

Frawley, D. (n.d.). *The Myth of the Aryan Invasion of India*. Retrieved January 15, 2006, from http://www.hindunet.org/hindu_history/ancient/aryan/aryan_frawley.html

Gadgil, M., & Guha, R. (1992). *This Fissured Land: An Ecological History of India.* New Delhi: Oxford University Press.

Gleick, P. H. (1993). *Water in Crisis: A Guide to the World's Freshwater Resources*. New York: Oxford University Press.

Goodall, S.K. (2004). Rural-to-urban Migration and Urbanization in Leh, Ladakh: A Case Study of Three Nomadic Pastoral Communities. *Mountain Research and Development, 24(3)*:220-227.

Gore, A. (2006). *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It*. Emmaus, PA: Rodale Press.

Government of India. (2001a). Distribution *of Population, Sex Ratio, Density and Decadal Growth Rate of Population: 2001.* Retrieved December 16, 2006, from http://www.censusindia.net/data/ppt_t1.PDF

Government of India. (2001b). *District Wise Population – Census 2001.* Retrieved December 16, 2006, from http://doda.gov.in/census01/district/popres.asp

Government of Jammu & Kashmir. (2006a). *Ladakh: General Information.* Retrieved January 15, 2007, from http://www.jktourism.org/cities/ladakh/gen.htm

Government of Jammu & Kashmir. (2006b). *The Official Website of Jammu & Kashmir Government, India: Kargil District.* Retrieved December 16, 2006, from http://jammukashmir.nic.in/profile/kargil.htm

Government of Jammu & Kashmir. (2006c). *The Official Website of Jammu and Kashmir Government, India: Ladakh.* Retrieved December 16, 2006, from http://jammukashmir.nic.in/tourism/ladakh/welcome.html

Guha, S. (2005). Negotiating Evidence: History, Archaeology and the Indus Civilization. *Modern Asian Studies, 39(2)*:399-426.

Hacher, S. (2004). *Argentina Water Privatization Scheme Runs Dry*. CorpWatch. Retrieved February 27, 2005, from http://www.corpwatch.org/article.php?id=10088

Hales, C. (1986). *Cultural Survival: The Ladakh Project.* Retrieved January 15, 2007, from http://www.cs.org/publications/csq/csq-article.cfm?id=538

Hardin, G. (1968). The Tragedy of the Commons. *Science, 162*:1243-1248.

Harvey, A. (1983). *A Journey in Ladakh.* London: Jonathan Cape Limited.

Hunt, C. E. (2004). *Thirsty Planet: Strategies for Sustainable Water Management.* London: Zed Books Ltd.

J&K Tourism Department. (2006). *Reach Ladakh Local News: Tourism Sets a New Record in Leh.* Retrieved January 22, 2007, from http://www.reachladakh.com/travel_news.asp

Jacobson, A. (2000, November-December). *Solar Energy Measurements for Ladakh, India.* Paper presented at the 24th National Renewable Energy Convention 2000 of the Solar Energy Society of India, Mumbai, India. Retrieved December 16, 2006, from http://www.humboldt.edu/~aej1/Ladakh_solar_data_NREC2000.pdf

Joshi, S. (1997). *City Life During Gupta Period.* Delhi: Gyan Sagar Publications.

Kala, C.P., & Mathur, V.B. (2002). Patterns of Plant Species Distribution in the Trans-Himalayan Region of Ladakh, India. *Journal of Vegetation Science, 13(6)*:751-754.

Kamra, O. (2005). Monday, September 19, 2005, *Indian Society* class notes.

Karve, I. (1974). *Yuganta. The End of an Epoch.* New Delhi: Sangam Books, Poona, and Orient Longman Ltd.

Laws, S. (2003). *Research for Development: A Practical Guide.* London: Sage Publications Ltd.

Leh Nutrition Project. (2006). *Artificial Glacier.* Leh, Ladakh: Chewang Norphel.

Loram, C. (2004). *Trekking in Ladakh* (3rd ed.). Surrey: Trailblazer Publications.

Metcalf, B.D. & Metcalf, T.R. (2002). *A Concise History of India.* Cambridge: Cambridge University Press.

Monasterio, E. (2000). An Experience of Psychiatry in Ladakh, India. *Australasian Psychiatry, 8(3)*:216-219. Retrieved December 16, 2006, from http://www.blackwell-synergy.com/doi/pdf/10.1046/j.1440-1665.2000.00262.x?cookieSet=1

Morrison, J. (2005). Wednesday, September 21, 2005, *Indian Society* class notes.

Motiram, S. (2005). Monday, November 28, 2005, *Indian Society* class notes.

Narain, S. (2003). Harvesting the Raindrop. *New Internationalist, 354*:25-26.

National Informatics Centre. (2006a). *Leh, Roof of the World...Approach.* Retrieved January 15, 2006, from http://leh.nic.in/profile.htm

National Informatics Centre. (2006b). *Official Website of Jammu & Kashmir: District Kargil.* Retrieved December 16, 2006, from http://kargil.nic.in/profile/profile.htm

National Informatics Centre. (2006c). *Official Website of Jammu & Kashmir: District Kargil.* Retrieved December 16, 2006, from http://kargil.nic.in/tourism/tourism.htm

New Internationalist. (2003). Water Facts. *New Internationalist, 354*:18-19.

Norberg-Hodge, H. (1992). *Ancient Futures: Learning From Ladakh.* Delhi: Oxford University Press.

Olson, M. (1965). *The Logic of Collective Action: Public Goods and the Theory of Groups*. Cambridge: Harvard University Press.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge: Cambridge University Press.

Page, J. (Producer). (1993). *Ancient Futures: Learning From Ladakh* [Documentary]. United Kingdom: International Society for Ecology and Culture.

Pant, K.C. (2003). *India's Development Scenario: Next Decade and Beyond...(Vol.2)* New Delhi: Academic Foundation.

Perry, C.J., Rock, M.T., & Seckler, D.W. (1997). *Water as an Economic Good: A Solution or a Problem?* Colombo, Sri Lanka: International Irrigation Management Institute.

Possehl, G.L. (1982). *Harappan Civilization: A Contemporary Perspective.* New Delhi: Oxford.

Postel, S. (1992). *Last Oasis: Facing Water Scarcity.* New York: W. W. Norton & Company.

Public Citizen. (2003). *Water Privatization Fiascos: Broken Promises and Social Turmoil.* Washington: Water For All Campaign.

Rajeev, D. (2005). *India: Everything Gets Worse With Coca-Cola.* Retrieved January 23, 2006 from http://www.corpwatch.org/article.php?id=12590

Rawat, G.S., & Wikramanayake, E.D. (2001). *World Wildlife Fund: Thar Desert.* Retrieved January 7, 2007, from http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im1304_full.html

Reardon, S. (Producer). (2004). *Dead in the Water* [Documentary]. Canada: Canadian Broadcasting Corporation and National Film Board (CBC/NFB).

Rizvi, J. (1983). *Ladakh: Crossroads of High Asia.* Oxford: Oxford University Press.

Sainath, P. (1996). *Everybody Loves a Good Drought: Stories from India's Poorest Districts.* New Delhi: Penguin Books.

Schenk, C. (Producer). (2003). *Paradise with Side Effects* [Documentary]. Germany: Capricorn Film.

Schumacher, E.F. (1973). *Small is Beautiful: Economics as if People Mattered.* New York: Harper & Row, Publishers, Inc.

Shen, D. (2003). Water Rights and Their Management: A Comparative Country Study and its Implication for China. In C.M. Figuères, C. Tortajada & J. Rockström (Eds.), *Rethinking Water Management: Innovative Approaches to Contemporary Issues* (pp. 144-163). London: Earthscan Publications Ltd.

Shiva, V. (2002). *Water Wars: Privatization, Pollution, and Profit.* Toronto: Between the Lines.

Sikand, Y. (2006). *Muslim-Buddhist Clashes in Ladakh: The Politics Behind the 'Religious' Conflict.* Retrieved December 16, 2006, from http://www.countercurrents.org/comm-sikand130206.htm

Stake, R.E. (1995). *The Art of Case Study Research.* Thousand Oaks: Sage Publications.

Suzuki, D., & Dressel, H. (2002). *Good News for a Change: Hope for a Troubled Planet.* Toronto: Stoddart Publishing Co. Limited.

Tewari, M. (2005). Wednesday, October 12, 2005, *Indian Society* class notes.

Thapar, R. (1984). *From Lineage to State.* Oxford University Press: Bombay.

The Tribune. (2006, August 7). *Army Evacuates 500 From Flood-Hit Ladakh.* Retrieved January 21, 2007, from http://www.tribuneindia.com/2006/20060807/j&k.htm#1

Tiwari, S., & Gupta, R. (2003, July). *An Ethnography of the Traditional Irrigation Practices of Leh Town: Changing Currents.* Paper presented at the 11th Colloquium of the International Association for Ladakh Studies, Leh, India.

Tyagi, B.K., & Yadav, S.P. (2006). Correlation of Irrigation and Flood Water Management with Malaria in the Thar Desert. *Regional Health Forum WHO South-East Asia Region (Volume 2, Number 2).* Retrieved January 7, 2007, from http://www.searo.who.int/EN/Section1243/Section1310/Section1343/Section1344/Section1350_5236.htm

United Nations Department of Economic and Social Affairs. (2000). *Charting the Progress of Populations.* New York: UN-DESA Population Division.

United Nations Development Program. (2006, September 4). *India: Situation Report Floods 4.* Retrieved January 21, 2007, from http://www.reliefweb.int/rw/RWB.NSF/db900SID/KHII-6TC2U9?OpenDocument

United Nations Educational, Scientific and Cultural Organization. (2006). *Water a Shared Responsibility: The United Nations World Water Development Report 2.* Paris: UNESCO.

United Nations Human Settlement Programme. (2004). Cities – Engines of Rural Development. *Habitat Debate, 10(3)*:1-24.

Vilas, C.M. (2004). Water Privatization in Buenos Aires. *NACLA Report on the Americas, 38(1)*:34-40.

Wikipedia (2006). *Aspect (geography).* Retrieved February 6, 2007, from http://en.wikipedia.org/wiki/Aspect_(geography)

Wiley, A.S. (1997). A Role for Biology in the Cultural Ecology of Ladakh. *Human Ecology, 25(2)*:273-295.

World Commission on Environment and Development. (1987). *Our Common Future.* Oxford: Oxford University Press.

World Health Organization. (2004). *Water, Sanitation and Hygiene Links to Health Facts and Figures*. Retrieved March 26, 2007, from http://www.who.int/water_sanitation_health/factsfigures2005.pdf

APPENDIX

Sample of questions asked during interviews:

1) How many households/people inhabit this village?
2) How many chutsos are in this village? What are the names of the chutsos?
3) How many churpuns are in this village?
4) How is/are the churpuns appointed? By whom? How often?
5) What are the churpun's responsibilities/duties?
6) Has the churpun been active during this agricultural season? Last season?
7) When do the churpun's duties begin and end?
8) Is the churpun compensated? If so, in what form? How much? By whom?
9) What is the penalty for someone caught stealing water? Polluting water?
10) What are the sources of water here? Which chutsos utilize each source?
11) Where do people get their drinking water from? What about during winter?
12) Do you think the water is safe to drink? If not, why not?
13) Have you heard of people in this village getting sick from drinking the water?
14) Are there hand-pumps in the village? How many? How long have they been there? Who built/financed them? Who maintains them? What is the source of water for the hand-pumps? Do they freeze in winter?
15) Is there a piped-water system in this village? How long has it been there? Who built/financed it? Who maintains it? What is the source of water for the piped system? Does it freeze in winter?
16) How many zings are in this village? Are the zings still in use? If so, when?
17) Who maintains/repairs the zings? The yuras?
18) When does the agricultural season begin and end? What crops are grown here?
19) In what order do fields receive irrigation? How is the order determined?
20) How much water does each field receive? How is the quantity determined?