Chapter I

Introduction

1.1 Background

Bhutan is a small mountainous country in the eastern Himalayas, located between latitudes 26°45' N and 28°10' N and between longitudes 88°45' E and 92°10' E. The land rises from approximately 300 masl in the south to gigantic snow clad Himalayan mountains in the north of over 7000 masl covering a total area of 46,500 square kilometers. Physically, the country can be divided into three main landforms: the southern foothills, the inner Himalayas and the higher Himalayas (Central Statistical Organization, 2001). The country is drained by four major river systems (the Ammochu, the Wangchu, the Sankosh, and the Manas) rising from higher Himalayas and meandering down south through winding open valleys where people settle and do farming.

The country's economy is predominantly agrarian-based with 79% of the population dependent on small-scale mountain agriculture and livestock rearing for their livelihood. The primary sectors (agriculture, forest and livestock) contribute 35.39% to the GDP (Ministry of Agriculture, 2003). Bhutan has maintained 72% forest cover, rich biodiversity and plentiful water resources (Ministry of Agriculture, 1999). Mountainous terrain restricts agriculture only to 7.8% of the total area (Ministry of Agriculture, 2002a). The water from above mentioned rivers cannot be used for agriculture as they flow in deep gorges. As such seasonal streams form a principal source of irrigation water. The forest represents precious pool of natural resources for the people. The use of forest resource is an essential component of the livelihood system and is intricately woven into the Bhutanese culture (Ministry of Agriculture, 2002b).

In view of the fact that planned development started in 1961, the Royal Government under the dynamic and noble leadership, has always pursued people

centered and bottom up planning approach to development (Planning Commission Secretariat, 1993). Despite the limitations of physical and socio-economic situation, Bhutan emerged into the 21st century with an intact natural resource base and strong commitment to maintain it for future generations. This foundation has been possible only with the harmonious relationship between people and the environment, forged over centuries within moral, cultural and ecological boundaries (National Environment Commission, 1998). However, the rapid socio-economic development, commercialization and globalization could become a source of risk to destroy this pristine environment and harmonious relationship.

1.2 Common pool resources (CPRs)

As mentioned above, the dependence of Bhutanese society on natural resources is very high. Table 1 presents an overview of some of the common pool resources (CPRs) and quantities harvested in 2000. CPRs such as water, wood, fodder, and non-timber forest products are regularly used directly to increase productivity through transfer of organic matter, generate income, provide shelter, sustain farming systems through nutrient recycling (Sokshing system), energy to households, and effectively supplementing privately owned resources. As such, CPRs are an important component of household and community livelihood systems.

In Bhutan, the traditional norms and ingrained relationship among users constitute a broadly respected customary regime of natural resource management (NRM), which has resulted from appreciation for the value of natural resources and recognition of their dependence on these resources. One of the natural resources that are being principally managed by traditional institutions and norms is water (Litmus Consult, 2003; Ministry of Agriculture, 2002b). However, over the years the role and efficiency of these local norms and arrangements have weakened due to the influences of economic development, commercialization, and westernization through globalization.

Table 1. Annual harvest of CPRs (wood and non-wood forest products) in Bhutan, 2000.

CPR products	Unit	Volume
Firewood	('000) cft.	25,881
Bamboo	('000) Bundles	294
Fodder	('000) Bundles	4,753
Fern tops	('000) Bundles	441
Wild mushroom	ton	96
Cane shoot	ton	5
Edible oilseed	ton	150
Lemon grass	ton	102
Dyes	ton	19
Pipla (*Piper sp.*)[1]	ton	6
Resin	ton	72
Chirata (*Swertia chirata*)[1]	ton	2

(Source: Ministry of Agriculture, 2002a).
[1] Medicinal plant

A nationwide renewable natural resources census indicated that among 60,000 farmers interviewed, 20% reported a lack of irrigation water as a major constraint to agricultural production, second only to crop predation by wild animals (42%) (Ministry of Agriculture, 2002a). The shortage of water coupled with inequitable access among users cause conflict in many communities. With increasing demand and competition for water, frequent confrontation and abuse of resources have become a major concern (Renewable Natural Resources Research Center, 1998). Such conflicts can become severe and debilitating, resulting in violence, resource degradation, the undermining of livelihoods, and the uprooting of communities. According to Castro and Nielsen (2001), if such conflicts are left unattended, they may become causes for a breakdown in social institutions and even threaten society itself.

The ratification of the Forest Act in 1969, and Forest and Nature conservation Act of 1995, showed that Bhutan was already concerned about NRM problems. These two Acts put the government in full control over forest resources, including water bodies. The centralization of forest resource management in 1969 took away the responsibility from people to manage forest resources. Over the years, following this

disassociation from forest management, many of the indigenous knowledge systems and community-based regimes for natural resource management disappeared, as communities lost their customary rights and control over local forest resources (Gurung and Turkelboom, 2000; Messerschmidt et al., 2001; and Tshering, 2001). This has brought about an "open access" regime, as adequate administrative structure and resources were not in place to effectively and efficiently enforce the forest regulations (Ministry of Agriculture, 2002b). All natural resources within the bounds of forest area are considered to be under the purview of the Forest Act 1969. However, the specificity of the rules varies among the resources and in particular there is no specific policy and law concerning water resources. The water policy currently being formulated by Ministry of Agriculture is expected to address the policy, legal, and organizational framework for the fair sharing of water resources, and for effective participation, partnerships, and cooperation of stakeholders, as well as conflict avoidance (Bhutan Water Partnership, 2003). In the context of the people-centered development approach initiated by the government, Bhutan's nationalized forest management system has reoriented itself to provide people with incentives for sustainable management of forest (Dorji and Webb, 2001).

According to the decentralization policy, beneficiary participation is the primary driving force for development (Planning Commission Secretariat 1993). Further, with the ratification of Dzongkhag Yargey Tshogtshung (*District Development Committee* (DYT)) and Geog Yargey Tshogtshung (*Block Development Committee* (GYT)) governance acts, the responsibility for managing natural resources has been passed on to the communities and local institutions (Planning Commission Secretariat, 2002; Ministry of Home Affairs, 2002; and Royal Government of Bhutan, 2003a). This is specifically the devolution of decision making to the lowest level (Röling, 1999). To complement and support the devolution of NRM responsibilities, the Ministry of Agriculture formulated and released framework for community-based natural resource management in 2002 (Ministry of Agriculture, 2002b).

This brief statement of general development policies in Bhutan presents the rapidity at which changes are taking place. It is fortunate that the Royal Government

has always kept strict vigilance on the process and impact of development. However, it is no time to be complacent on the progress, rather strive to find approaches to ensure harmony between society and natural resources.

1.3 Rationale

Water is a critical input in agricultural production especially in rice farming. In the present day, it has become a highly contested natural resource in Bhutan. Almost all irrigation schemes in Bhutan have been built by farmers, and are still largely managed by them (Brand and Jamtsho, 2002). These schemes are managed based on traditional water sharing systems which were framed when water was plenty and user very few. The users have diversified, command areas have increased by expansion of rice cultivation, catchment areas have shrunk due to deforestation, and demand for water has increased by many folds. The government took the initiative to rehabilitate and construct small irrigation schemes, but ensured that beneficiaries were still responsible for their operation and maintenance. In 1993, the Ministry of Agriculture introduced the National Irrigation Policy, which explicitly emphasized on a sustainable approach to irrigation development through participation of users. Much of these past interventions were driven by the assumption that irrigation systems performances were not at an acceptable level. The cause of poor performance of irrigation systems have often been largely linked to issues ranging from inadequate design and management at the farm level to inefficient upstream supply facilities, or the lack of commitment to the success of the system by users (Walker, 1989; FAO 1996). Such poor performance is always a limitation to harness full benefit from the limited resource and the investment (Chamber 1989; Satranaryana and Srivastava 1989). As Peri and Skogerboe (1979) suggested, poor performance could lead to lower crop yields per unit area and lower yield per unit of water used as well as a lower total irrigated area, lower return from irrigated crop, and bring in negative environmental effects.

In a continuously changing environment as an outcome of the system dynamics, emergent changes often lead to competition and conflict. These conflicts will escalate

and increasingly surface in a society midst these changes. The scope and magnitude of change in resource management regimes and the societies of which they are part will only increase and incapacitate the development process by ripping off the community. In such a complex situation, decisions about the use of natural resources should be invariably based on interactions among stakeholders/users and their environment. More so, the exchanges of information on resource status, demand, use systems, socio-economic, and biophysical interactions should help in making such decisions.

The complexity of NRM, coordination, networking, and negotiation raises methodological questions. In the decentralized management setting, there is a need for tools to stimulate joint learning and integrating knowledge to establish shared understanding and coordination mechanisms in the context of multiple resource users and their conflicting relationships. Changes in resource use are considered to emerge from human learning, interactions and institutions (Röling, 1999), which often require considerable attention to create a common perspective of problems, diagnosis and possible solutions. As behaviour of stakeholders is determined by the goal and environment, modelling can form a stimulus-response framework, which can help in studying the system and its emergence. According to Holling (1978), integration of simulation models into collective decision-making in natural resource management (NRM) is one of the core points of adaptive management. Considering the complexity of the NRM issue, where stakeholder behaviour, actions and interactions determine much of the processes, any simulation models should have a capacity to capture the interactions through participatory means.

Since 1996, role-playing games (RPG) and multi-agents systems (MAS) platform have been used to study local land use management, water management, negotiation between foresters and breeders, and preservation of wild genetic resources by peasants (D'Aquino et al., 2002a). Among many modelling tools, multi-agent systems are increasingly used in the field of environmental and natural resource management (Barreteau et al., 2004; and Bousquet et al., 2002). MAS principally emphasize on interaction between agents and emergence from the interactions that makes it different from classical systems approaches (Ferber, 1999). Similar to any

abstract representation, MAS has been used to increase scientific knowledge about ecological and social processes (Bousquet et al., 1999). MAS models can be used for collective decision making as an outcome of interactions between agents who have differential objectives and strategies. Significant advances have been recently made in simulation of social interactions with environment to address complex interactions. Among many such innovative tools, MAS have been extensively tested in many countries as suitable tools for collective learning in NRM (Bousquet et al., 1998; Trébuil et al., 2000; Barreteau et al., 2001; Trébuil et al., 2002; D'Aquino et al., 2002b; Janssen, 2002; Etienne, 2003; and Purnomo et al., 2003). Role-playing game (RPG) is yet another interactive and participatory tool which is used in conjunction with MAS. It is often used to simplify the outputs of MAS modeling with a view to produce typology of management strategies, negotiation methods and to provide a teaching aid. It can also be used to understand the systems dynamics and generate information to design MAS model (Bousquet et al., 2002).

RPG and MAS have been used extensively to understand the management of irrigation water. The three steps together are termed as "companion modeling" (Bousquet et al., 2002). The support process, involving both tools simultaneously, is as follows:

1. Stakeholders are identified, as well as their perceptions of the environment.
2. Stakeholders are involved in RPG to validate hypotheses.
3. Finally, simulations are run to show the systems dynamics generated by interactions between agents and the environment.

In view of the multiplicity of users and prevailing conflicts in irrigation water sharing, companion modelling based on the association of RPG and agent based model can be a potential tool to collectively learn the state of affairs among concerned stakeholders (including researchers) and explore potential interactions to identify more acceptable alternative strategies to resource use. Therefore, the key research question is: Can the companion modeling (ComMod) approach based on the association of RPG and simple MAS simulation facilitate:

- The understanding of farmers' decision-making processes in sharing irrigation water?, and
- The mediation of the conflict among water users in the Bhutanese context?

1.4 Objectives

The objectives of the study are as follows:

1. To understand decision-making process in sharing irrigation water by farmers at household and community level.
2. To generate scenarios with users to assess impacts of their decision on water and land use.
3. To apply MAS to improve communication mechanism in irrigation water sharing.

1.5 Scope of the study

This study focuses on collective understanding process of sharing irrigation water and its impacts on the land use changes and water use in Lingmuteychu watershed. The understanding gained from the research can be simulated to improve communication for NRM among stakeholders. If successful, the approach can be replicated in management of other common property resources in Bhutanese condition.