# Companion modeling to examine water-sharing arrangements among rice-growing villages in west-central Bhutan: preliminary results

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Age-old traditions and interactions among users constituted a broadly respected customary regime of natural resource management that achieved social and environmental objectives. However, with the increased pressure of commercialization, the role and efficiency of local arrangements/institutions have weakened. During the past decade, a major policy drift of devolving control over natural resources from government agencies to user groups was observed.

Economic development has brought changes to environmental, social, and economic conditions and such changes are known to cause conflict. Consequently, this conflict can threaten to weaken the fabric of society. To understand these changes emerging from human learning, interactions, and institutions, an integrated approach is needed. Companion modeling in natural resource management is considered as an interactive approach for creating a shared perspective on a complex ecosystem and for generating scenarios as future options. These scenarios also seem to be relevant for negotiation or collective decision issues.

This study used role-playing games (RPG) and simple simulations on spreadsheets to collectively learn the current state of affairs and explore possible mitigation strategies. The study revealed that RPG can be used effectively as a learning tool to bring together two villages that are in a conflict situation so that they can discuss their problem and relate it to a broader perspective. Ultimately, this was seen as an approach for examining the emergence of complex macro phenomena from relatively simple micro activities to enhance people's perceptions of resource sharing and collective management, especially through knowledge sharing and learning.

There is ample scope to improve RPG and to build associated simulation tools that can be used in different situations to explore and assist in improving natural resource management situations. With the success of the present exercise, scaling-up of the games has been planned for 2004 to organize the community as a user group at the watershed level.

Bhutan is predominantly an agrarian nation, with some 80% of the population dependent on small-scale mountain agriculture and livestock rearing for their livelihood. Despite numerous hurdles, Bhutan has successfully maintained its 72% forest cover, rich biodiversity, and plentiful water resources (RGOB 2003a). In Bhutan, age-old traditions and well-established relationships among users constituted a broadly respected customary regime of natural resource management (NRM), which has resulted from the blending of appreciation for the dependence of people on natural resources and the value of these resources (NEC 1998). However, over the years, the role and efficiency of these local norms and arrangements have weakened because of the influence of development and commercialization (Turkelboom et al 2001).

One of the natural resources that has been principally managed by traditional institutions and norms is water (Litmus Consult 2002). Access to water and management is still governed by traditional rules that evolved during times when water demand was limited (MoA 2002a). A nationwide renewable natural resources census indicated that 21% of 60,000 farmers interviewed reported a lack of irrigation water as a major constraint to agricultural production, second only to crop predation by wild animals (42%) (MoA 2002b). Inequitable access to water is a major cause of conflict in many communities. With increasing demand and competition for water, frequent violent confrontations and abuse of resources have become a major concern (RNRRC 1998). Such conflicts can become severe and debilitating, resulting in violence, resource degradation, the undermining of livelihoods, and the uprooting of communities. If such conflicts are left unattended, they may become causes for a breakdown in social institutions and even threaten society itself (Castro and Nielsen 2001).

The ratification of the Forest Act 1969 showed that Bhutan was already concerned about NRM problems. However, Gurung and Turkelboom (2000), Messerschmidt et al (2001), and Tshering (2001) suggest that, since the centralization of forest resource management in 1969, 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. This has brought about an "open-access" regime, as adequate resources were not in place to effectively and efficiently implement the forest regulations (MoA 2002a). Many natural resources are considered to be under the purview of the Forest Act. However, the specificity of the rules varies among the resources. For instance, there is no specific policy and law for water resources; the MoA is currently drafting the Water Act. This act will address the policy, legal, and organizational framework for the fair sharing of resources, for property rights (including water rights), and for effective participation, partnerships, and cooperation of stakeholders, as well as conflict avoidance (Bhutan Water Partnership 2003).

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

The complexity of resource management, coordination, networking, and negotiation raises methodological questions, such as how to facilitate understanding and learning processes, mediation, and the development of management regimes that fulfill the aspirations of the majority of the stakeholders and yet ensure sustainability of the resource base. It is expected that enhancing knowledge and understanding through collective learning on the NRM regime can contribute to developing equitable and sustainable resource-sharing strategies.

As changes in resource use are supposed to emerge from human learning, interactions, and institutions, these changes often require considerable attention to create a common perspective on problems, diagnosis, and possible solutions (Röling 1999). Therefore, an integrated approach is needed to understand resource-use dynamics as this often involves multiple stakeholders and a series of decisions emerging from different behavioral patterns. Efforts in evolving multi-agent systems (MAS) for natural resource management are of recent development, and such an approach is gradually catching up as a versatile tool (Barreteau et al 2003, Etienne et al 2003, Trébuil et al 2002). MAS allow the examination of the emergence of complex macro phenomena from relatively simple micro activities. MAS are also considered efficient in expanding one's perceptions and ability to negotiate and collectively make decisions to manage a scarce resource in a conflict situation.

Role-playing games (RPG) and MAS have been used extensively to understand the management of irrigation water. The support process, involving both RPG and MAS simultaneously, is as follows:

1. Stakeholders are identified, as well as their perceptions of the environment.
2. Hypotheses are validated, and this is done by involving stakeholders in RPG.
3. Finally, simulations are run to show the systems dynamics generated by interactions between agents and the environment.

The three steps together can be termed "companion modeling" (Bousquet et al 2003). Considering that RPG and MAS simulations can integrate knowledge in a collective learning process on integrated natural resource management (Barreteau et al 2001, Bousquet et al 2003, D'Aquino et al 2002), this research proposes to use the companion modeling approach based on the association of RPG and simple MAS simulations to collectively learn the state of affairs of irrigation water sharing in Lingmuteychu, Bhutan. Accordingly, research questions can be formulated as follows:

1. Can companion modeling based on the combination of RPG and simple MAS simulations facilitate the emergence of a new set of rules, agreed upon by different parties in conflict?
2. Can it play a mitigation and mediation function in a context of conflict among common-pool resource (CPR) users in Bhutan?

The above research questions have been included in an M.Sc. student research activity, which is currently being conducted in Lingmuteychu. As a part of the fieldwork, RPG were conducted in April-May 2003 with two communities in Lingmuteychu.

This paper attempts to present the preliminary findings from the RPG conducted at the study site in April 2003 and draw certain conclusions to assess their usefulness as a tool to examine the research questions. The paper provides a general description of the study site, formulates the RPG, and discusses the results.

## Irrigation water sharing in Lingmuteychu

Lingmuteychu is a small watershed located at 27°33′N and 89°55′E on the east bank in Punatshang Chu in west-central Bhutan, occupying an area of 34 km2 (Fig. 1). It is drained by the 11-km-long Limti Chu stream that originates as a spring from a rock face at an altitude of 2,400 m north of Limbukha village (Fig. 1). It is a rainfed stream since the ranges that confine the watershed are below the snow line. The stream serves five irrigation systems supporting 11 irrigation canals that irrigate about 179 ha of terraced wetland belonging to 121 households of six villages (RNRRC 1998). These six villages share irrigation water within a broadly respected customary regime that evolved during times when water demand was lower.

The base flow during the dry months of April and May fluctuates at about 40 to 50 L $s^{-1}$. The flow produced by a widespread rain in the watershed can be more than 500 L $s^{-1}$. The rainfall-runoff response is quick and the stream returns to its base flow within a couple of days after the rainfall. The fluctuating nature of the stream mainly results from the steep gradient of the watershed. The watershed receives an average annual rainfall of 700 mm (RNRRC 1998). Regulations in terms of water diversion by different irrigation canals from the Limti Chu are based on two broad principles. The rule "first come, first served" applies, which means that existing schemes have an established water right and can prevent newcomers from using it. For instance, Nabche (one of the villages within the watershed) is a resettled community and it does not have water rights, which prevents it from constructing an irrigation canal. The second rule can be interpreted as "more water for upper-catchment communities." Conflicts arise particularly from these two rules. Under such a water-use regime, the community in the uppermost catchment (Limbukha), close to the intake point, has absolute control over the headwater.

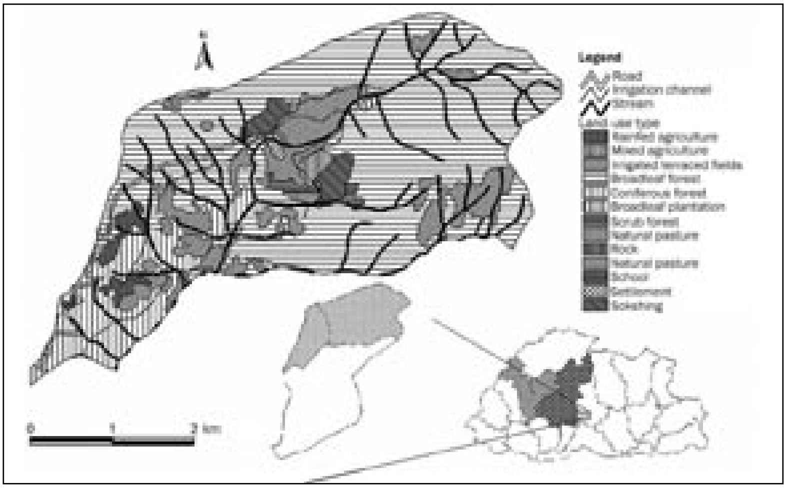

**Fig. 1. Map of study area (LUPP, 1997). Sokshing = forest for collecting litter.**

Dompola, a second village in the upper catchment located approximately 4 km downstream from the intake point, does not have direct access to the stream. As such, Dompola has to share water with Limbukha and the rules are stringently adhered to. As per the traditional arrangement, Dompola gets half of the stream flow only from the tenth day of the fifth Bhutanese month every year. As such, Dompola farmers really struggle to get their field transplanted. This indiscriminate use of water in the upper catchment produces conflicts and a chain of reactions from farmers in the lower catchment.

Within a village, water is shared on the basis of a rotation system locally known as "chukor." The rotation interval among different communities in the watershed varies from 3 to 13 days. In both communities, water is shared on the basis of three "relative" categories: "Thruelpa," Chhep," and "Chatho." The fourth category, "Lhangchu," has no entitlement to water.

- Thruelpa: entitled to half the flow in the canal (½ of canal flow)
- Chhep: entitled to half of Thruelpa (¼ of canal flow)
- Chatho: entitled to half of Chhep (⅛ of canal flow)
- Lhangchu: no entitlement (has to beg)

As shown above, existing water rights are not equitable. As the water resource becomes scarce, the current system has deficiencies. With differences in water rights, conflict can crop up within and between communities. It has also been shown that farmers use excessive water (MoA 2002a). This is aggravated by the introduction of multiple-cropping practices in upper villages, which have strong negative effects on water supply and rice productivity in the lower communities.

Within the present context of decentralization, whereby local institutions are given responsibilities over the management of natural resources (MoHA 2002), conflict could arise over boundaries. In particular, the Lingmuteychu catchment, occupying only 34 km$^2$, in extent falls within the administrative jurisdiction of the three districts of Thimphu, Punakha, and Wangdue, which invariably need to collaborate to sustain the resources and livelihoods of the people in the target area.

## Materials and methods

### Conception of the RPG

The problem was initially analyzed and existing knowledge synthesized through a review of the available secondary data on the Lingmuteychu watershed (RNRRC 1997, Duba and Swinkles 2001). Discussions with researchers and extension staff also helped in situational analysis and identification of a knowledge gap. To fill the information gap, a household survey using a structured questionnaire was conducted in two villages. Survey data helped in triangulating the information gathered from other sources. The study followed the conceptual framework shown in Figure 2.

Considering the problem of conflict in irrigation water sharing between two villages (Limbukha, upstream village, and Dompola, downstream village), the RPG method was conceived as a potential tool to initiate and facilitate dialogue between the two villages and for the research-extension team to enhance its understanding of the problem. With the onset of the transplanting season from the fourth Bhutanese month (end of May), Limbukha farmers started transplanting in the watershed. The game

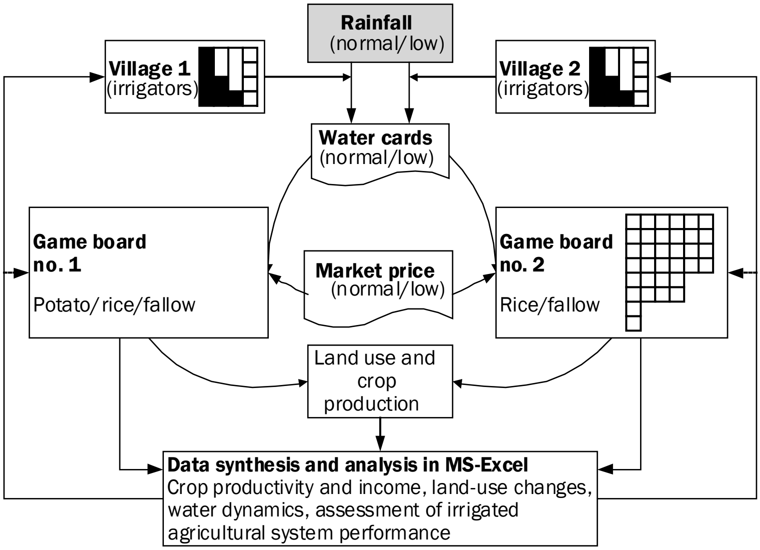


**Fig. 2. Conceptual framework for the RPG process.**

starts on the tenth day of the fifth month as Limbukha farmers will release 50% of the water to the Dompola canal. Six farmers of Limbukha village have yet to transplant rice, which means that what they do will still have an effect (on the quantity of water available for the next village, hence on the actions of the farmers in the next village). There will be two major chance factors: rainfall (normal and low) and market price (high and low). Rainfall will be declared after drawing a card at the start of the game, whereas the market price is declared after each game.

Six farmers each from two villages were categorized according to their water-right categories for the game. The game was played in three decision modes: village, collective, and swapped role. The first mode was played for 7 years (crop seasons); the second mode was played for 5 crop seasons with only 2 years for the swapped role (the third mode). Each crop year was divided into two cycles (first week of June to October and third week of June to October). Therefore, each successive time-step in a given season covered roughly two water-share cycles (12 days each) from the tenth day of the fifth month to the fourth day of the sixth month (= end of the rice transplanting season).

The game board

Two simple game boards (one for Limbukha and the other for Dompola) were drawn on a 0.5 m × 1 m poster paper representing the farmers in columns and their plots in rows (Fig. 3). On the game board, columns represented six farmers. For Limbukha, each column was divided into two subcolumns to represent potato (grown from March to June) and rice (grown from June to October). The game board for Dompola displayed just one column, implying that its farmers can grow only rice (June-October) and then fallow their fields (November-May).

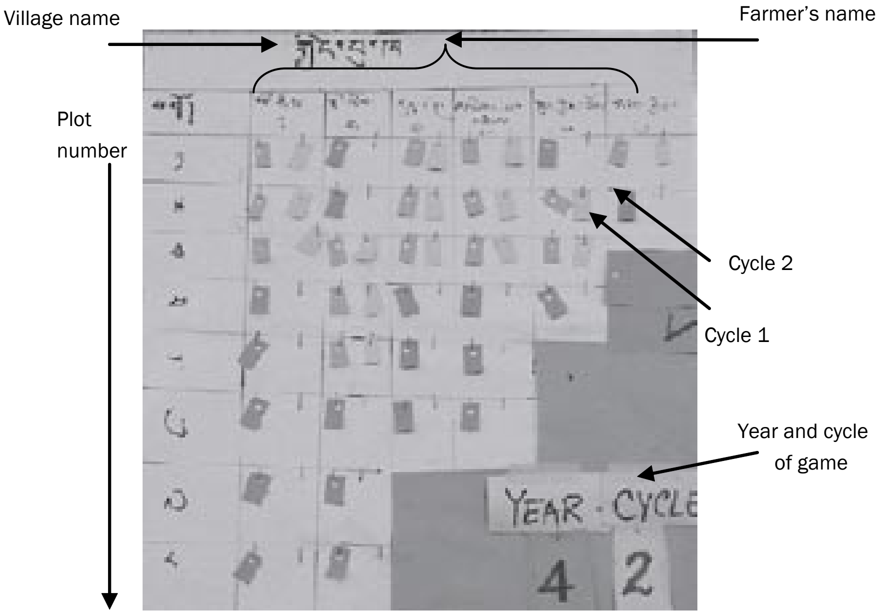


**Fig. 3. RPG game board.**

Rows represent plots that ranged from 1 to 8 (depending on the category of the farmer). Each plot is equivalent to 0.1 ha of paddy field. Only one crop can be grown at a time. However, in the actual game, players proposed that Limbukha villagers could grow a crop of potato before any rice field. The year and cycle of the game (e.g., 4/2: implying year 4 and cycle 2 ) were indicated in the lower left corner of the board.

The playing cards

Six types of cards were used as a medium in the game:

- *Name tag*. Each player was given a badge, which identified the bearer's social status and water-sharing category. The card carries the name of the type of farmer and a four-square box representing that person's share of irrigation water (Fig. 4A).
- *Cash.* Different denominations of local currency were used as cash to start farming and settle accounts after each cropping season (Fig. 4D). As the players introduced an exchange of labor, cash was also used for labor transactions. One could borrow and lend. The card was used as an indicator of performance in terms of income. Each player received initial cash to start farming at the following rates: Thruelpa = Nu. 20,000 (US$1 = Nu. 47.50), Chhep = Nu. 15,000, Chatho = Nu. 10,000, and Lhangchu = Nu. 5,000.
- *Rainfall.* Two cards, normal (N) and low (L) rainfall for each cycle, were used as chance cards to determine the volume of water available for sharing (Fig. 4B). Depending on the rainfall pattern, the units of water received by each player were regulated to induce dynamism. Before each cropping cycle, the card was randomly drawn and declared.

- *Potato card.* Limbukha farmers received yellow cards representing potato fields. One card was equivalent to 0.1 ha of potato grown before rice. Each player could use a maximum of three cards, and could also skip a season without growing potato.
- *Water cards.* Pink and light blue cards were used to represent water. One pink card was used as the equivalent to the volume of enough water to transplant and irrigate 0.1 ha of rice. Pink cards represented water used in the first cycle (first week of June to October) and light blue cards represented water used in the second cycle (third week of June to October). This means that farmers could place only one water card in one plot to indicate that that plot has been planted to rice. This card could be sold, exchanged, or used for transaction among villagers in a community or between farmers of the two communities. The game facilitator issued water cards in correspondence to the rainfall type. In the normal-rainfall season, Thruelpa received 5 water cards, Chhep 3 cards, Chatho 2 cards, and Lhangchu 1 card. During the low-rainfall pattern, the water provision was reduced by one unit, that is, 1 card less.
- *Market price.* Two cards representing a high and low price were used to indicate potato and rice prices. One of these cards was drawn randomly and declared after each cycle (Fig. 4C).

### The spreadsheet

A spreadsheet program (Microsoft Excel) was used to record all the data produced from the RPG and to run simulations. The data from the game board were transferred into a data-capturing spreadsheet (Fig. 5A) in codes (1 = rice, 2 = potato, and 3 = fallow). The data were linked to a simulation spreadsheet (Fig. 5B) on which gross margin is analyzed. This spreadsheet was used to calculate income from land-use


**Fig. 4. Cards used in the game.**

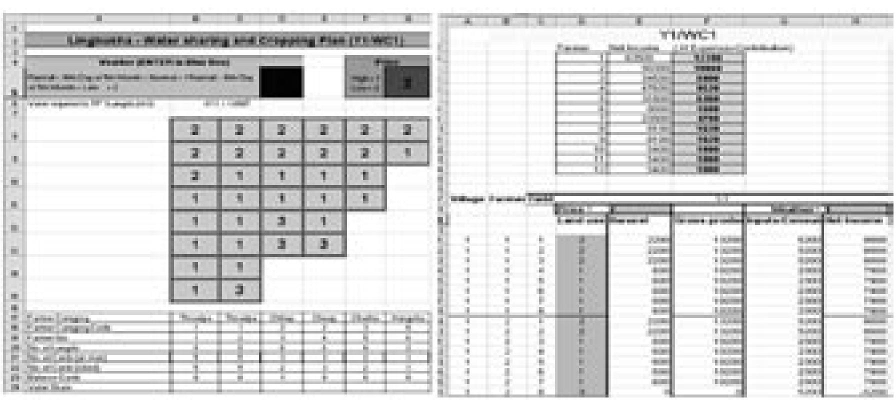

**Fig. 5. MS Excel Spreadsheet used in the RPG.**

decisions. Based on the simulated results, each player was paid an income at the end of each game. Other data such as water dynamics and land-use changes were analyzed after all the game sessions concluded. This actually facilitated the game session, thus enabling rapid calculations and year-wise comparisons if required.

## Pretest of RPG

The game was pretested at the RNR Research Center, Bajo, with researchers and trainees playing the role of farmers. Subsequent to the test, a few changes such as the number of plots and options for sharing water were incorporated into the actual game. This also helped to schedule the game in terms of time taken for each step. The game also served the purpose of training of the selected facilitators and assistants for the RPG in the field.

## Game sessions with villagers

In Dompola, RPG were used for 3 days. Six farmers from each of the two villages representing four water-share categories (Thruelpa, Chhep, Chatho, and Lhangchu) were selected to play the game. Players were given predefined numbers of rice fields (each field size was 1 langdo = 0.1 ha): Thruelpa got 8 plots, Chhep got 6, Chatho got 4, and Lhangchu only 2.

The first day was assigned for game (or RPG) sessions, which started with a briefing about the game, the purpose, the role of the players, and the expected outputs (Fig. 6A, B). The game sessions corresponded to three different modes of communication among villages: intravillage, intervillage (collective), and swapping roles. The first session represented the existing situation in which each village discussed water sharing independently at the village level and accordingly decided to grow different crops. Even the game boards were kept in distant places such that one village could not


**Fig. 6. (A) Linbukha farmers playing the game and (B) settling their accounts after each cycle of the game.**

see the actions of the other village. The game was played for seven cropping seasons. During the second session, farmers from both villages formed one group to discuss collectively water sharing between the two villages. The game boards were placed together side-by-side to allow the farmers to see and discuss them. This was necessary to demonstrate that two villages can freely discuss and share water to grow crops for five crop cycles in a collective decision mode. During the third session, roles were swapped between the two villages. We anticipated that this would provide a better understanding of other village situations, identify any unique decisions, and bring about new understanding from the swapping of the roles.

The second day was devoted to analyzing the RPG outputs and discussing them among the facilitators. On the third day, based on the preliminary analysis and observations, semistructured individual interviews with each player were conducted to collect views on the game and evaluate it. Following the individual interviews, a plenary session was organized to present the preliminary results of each RPG session to the players and to get their response to the proposed analysis in the form of simple graphs of land-use dynamics, water exchanges, and income.

## Results and discussion

Despite the concerns of many researchers about the simplicity of the game and the newness of the approach in the research field, the players adapted well to the game environment. After some initial confusion during the first time-step, which took almost 45 minutes to complete, subsequent time-steps took less than 20 minutes. The first game also generated new ideas and suggested that some rules needed to be changed. In view of the three RPG sessions in Dompola, a comparative analysis of the three modes of communication is presented in the following sections.

### Land-use dynamics

*Game 1: intravillage mode of communication.* The most critical effects of decisions on water use and sharing are land-use changes over the years. These changes are further influenced by the amount of rainfall, which in turn determines the stream discharge. For Limbukha farmers, when the rainfall pattern was low-low, 29% of the plots were left fallow (Fig. 7A). The number of fields planted with potato was highest (57%) when the rainfall pattern was low-low. Similarly, all the plots were planted with rice when both cycles received normal rainfall, thereby leaving no field fallow. In contrast, an average of 16% of the plots were left fallow in Dompola. Fallow plots existed in all rainfall patterns except in the normal-normal pattern. The highest rate (31%) of fallow plots was recorded during the low-low rainfall pattern (Fig. 7B). The fluctuation in number of plots transplanted with rice depended on the rainfall pattern and was higher than for Limbukha.

This indicates that rainfall amount and pattern strongly influence farmers' decisions to alter the cropping system. On average, 46% of the plots were planted with potato.

*Game 2: intervillage mode of communication (collective).* When both villages were grouped for collective discussion and decision-making on water use, farmers initially congregated to their individual village cluster and showed a passive expres-

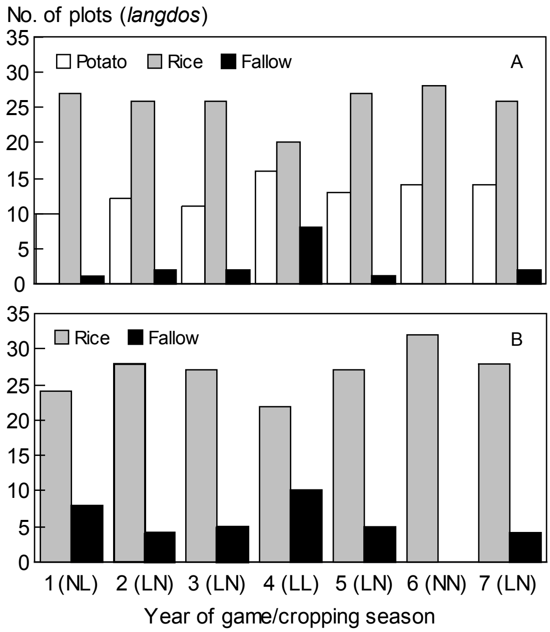


**Fig. 7. Land-use changes in (A) Limbukha and (B) Dompola over cropping seasons during the first gaming session. 1–7 on X-axis indicate year; letters in parentheses indicate rainfall pattern in two cycles, i.e., N = normal rainfall and L = low rainfall (e.g., NL means rainfall was normal in the first cycle and it was low in the second cycle).**

sion. This was the initial response, but it gradually turned into a very congenial environment featured by lots of exchange of views, water sharing, and discussions on cropping and other aspects of livelihood between the villages. There is no influence of communication mode on land use in Limbukha (Fig. 8). The percentage of plots planted to rice and fallowed was 91% and 9%, respectively, in both communication modes. However, in Dompola, there was a 4% increase in plots planted to rice and a decrease of 4% in fallow plots with the collective communication mode. This implies that, when farmers communicate collectively, the Dompola farmers seem to share water more efficiently. During the RPG session, players introduced water sharing between the two villages, which benefited Dompola farmers.

## Water management dynamics

Intravillage mode of communication. Water sharing is more prominent and systematic in Limbukha village, except when rainfall is low in both cycles. Sharing of water was a consistent feature among the villagers. It was interesting to note that 26% of the paddies are left fallow during the low-rainfall season, indicating a shortage of water. Throughout the years, Limbukha farmers shared on average 5% of the total water allocated, leaving behind 6% as excess water and 5% of the plots fallowed (Fig. 9A). Dompola farmers operate in a water-scarce situation, which can be seen from

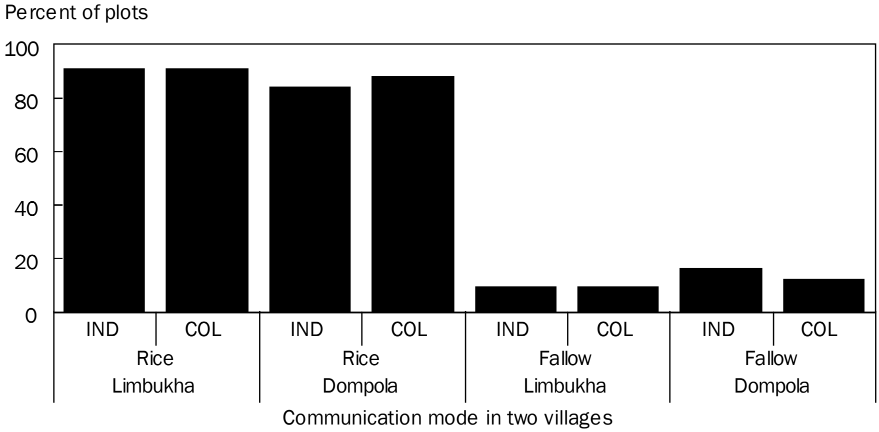


**Fig. 8. Comparison of land-use changes in two villages because of different modes of communication. IND = intravillage and COL = intervillage mode of communication.**

annual average fallow plots of 16%. Although Dompola farmers shared 2% of their water, they were left with 4% of the water share as excess water (Fig. 9B). Whenever there was excess water, it was shared within the village. Sharing was in the form of an exchange of water for labor. One water turn (12 hours of discharge) equates to 1 person-day of labor during the rice transplanting season.

In the game, the players introduced a charge of Nu. 100 per unit of water (equivalent to one day's wage). As this rule was not clearly documented, it was not included in the RPG rules initially. With the increasing competition and demand for water, the value was raised to Nu. 200 per unit of water. Figure 10B clearly indicates that Dompola farmers often have fallow plots because of a shortage of water. Fallow plots ranged from 1 to 10 (maximum of 31% of plots) except in the year of normal rainfall in both cycles. Players reiterated that exactly the same happens in reality.

*Intervillage mode of communication (collective).* The collective communication mode seems to ease the pressure on water management, as players exchanged water between the villages, thus introducing the collaborative approach in resource management. For Limbukha, farmers found that in the collaborative mode they could sell or exchange the excess water with Dompola farmers and earn more income. It can be seen that, on an annual average basis, while Limbukha farmers shared 5% of the water (the same as in the intravillage mode), they had 9% of the plots fallowed (4% higher than in the intravillage mode) (Fig. 9C). One player from Limbukha remarked, "If I did not share (exchange) excess water from my allocation with neighbors, it goes to waste as it will flow downstream without anyone making use of it." This statement highlights the satisfaction of Limbukha farmers when sharing water with Dompola farmers. This is valid as Dompola is located far from the stream and has neither provisions nor permission to construct a new channel to divert stream water. There was no difference whatsoever in water use between the two communication modes in Limbukha (Fig. 9C).

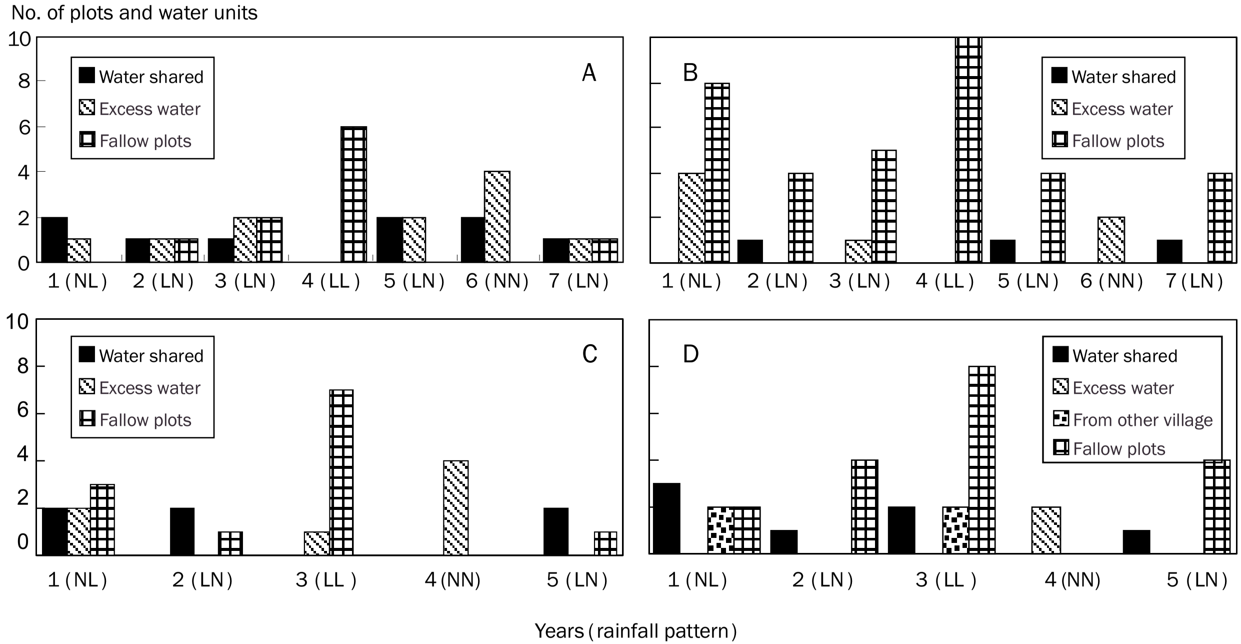


**Fig. 9. Water dynamics in two villages following two modes of communication. (A) Limbukha intravillage communication mode, (B) Dompola intravillage communication mode, (C) Linbukha intervillage communication mode, and (D) Dompola intervillage communication mode. 1–7 on X-axis indicate year; letters in parentheses indicate rainfall pattern in two cycles, i.e., N = normal rainfall and L = low rainfall (e.g., NL means rainfall was normal in the first cycle and low in the second cycle; "from other village" in D means water shared between villages.**

In the collective mode, Dompola farmers seem to benefit the most in terms of access to water. Throughout the years, the percentage of fallow plots declined from 16% in the intravillage mode to 11% in the intervillage mode in Dompola. In year 1 (NL) and year 3 (LL), Dompola farmers even received water from Limbukha farmers, an example of intervillage exchange. On an annual basis, this accounts for 3% of the water used coming from intervillage exchange (Fig. 9D). Particularly in the low-low rainfall pattern, the number of fallow plots decreased from 10 in the intravillage communication mode to 8 in the intervillage mode. It is evident that the number of fallow plots declines substantially in the collective mode. One of the reasons for this reduction is water sharing between the two villages.

## Income

All the players considered income as the immediate indicator of their actions in deciding water and land-use features and as a measurement of success. This was evident as all players, after each gaming session, took some time to assess the amount of cash accumulated (Fig. 10).

Income analysis showed that, overall, farmers' income was higher by 9% in the collective communication mode. Importantly, it can be seen that income is more stable in the collective communication mode than in the intravillage mode. When assessing the performance of different farmer categories, all categories except Lhangchu have more stable income over the years (rainfall types). For instance, the annual income of Thruelpa, Chhep, and Chatho was 4%, 13%, and 18% higher in the village-based communication mode than in the collective mode of communication (Fig. 11).

This implies that collective communication produces a more uniform distribution of income, based on the effective sharing of resources. It also indicates that sharing of water beyond the village boundary with other villagers provides an opportunity for the villagers to sustain their production and income. It also helped Dompola farmers

**Fig. 10. Players receiving their income and some players counting their cash accumulation.**

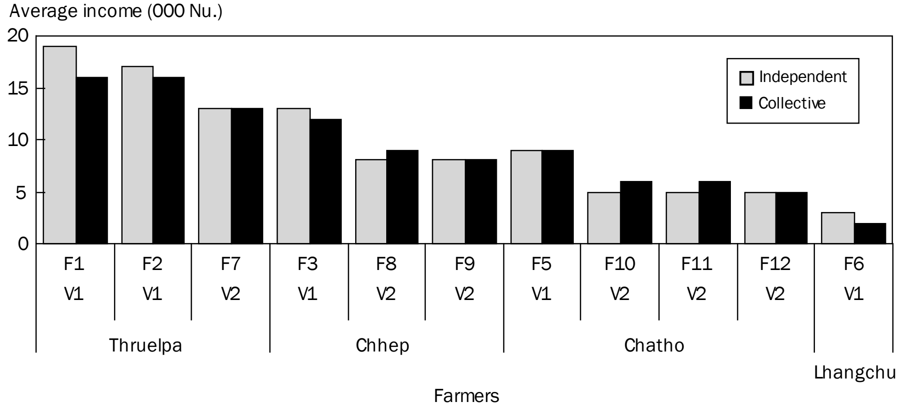


**Fig. 11. Income variation among farmer categories according to two modes of communication. F1–F12 imply farmers coded as 1–12; V1 = Limbukha; V2 = Dompola; and Thruelpa, Chhep, Chatho, and Lhangchu indicate farmer category based on water share.**

to become aware that income generation between two villages varies only because of potato cultivation in Limbukha. Consequently, this encouraged ideas such as trying out potato cultivation in Dompola and leasing land from Limbukha farmers to cultivate potato.

### Swapped role between two villages

As a third scenario, the role of each player was swapped with that of another village. It was swapped in the order of 1 taking the role of 7, 2 that of 8, 3 that of 9, and so on. Farmers easily swapped roles as they considered this a discovery, experiencing the condition of the other village. A comparison of annual income produced from three modes of communication clearly indicates the superiority of the collective mode for all categories of players. Income in the swapped mode was much lower for Dompola farmers playing the role of Limbukha farmers (Fig. 12). This further confirms that Dompola farmers were very cautious and that their perception of water resource scarcity dominated their actions.

Analogous to Barreteau et al (2003), the pertinent benefit of the swapped game was the learning experience for both teams (Table 1). One of the Limbukha players (Thruelpa) did not want to play the role of the Dompola farmer, as his major concern was low income. We presumed that his demotion in role from Thruelpa to Chhep made him discontented. The rest of the players considered the session as an opportunity to learn about the problem of Dompola farmers and the potentials of Limbukha farmers.

### Individual interviews

A majority of the farmers considered that the gaming parameters were precisely selected and laid out and they opined that all looked similar to reality. One farmer remarked, “It appeared like playing a game but recalling in the evening all appeared precisely real and stimulating.”

**Table 1. Farmers' response on swapping the role between two villages. Farmer 4 was not interviewed.**

| Response[a] | Percentage of respondents (n = 11) |
|---|---|
| Did not like swapping the role (2) | 9 |
| Comparison of income between two villages (1, 3, 8) | 27 |
| Understood the potential of potato in Limbukha and are motivated to try it out in Dompola (9 and 11) | 18 |
| Resource advantage of Limbukha farmers (10) | 9 |
| Understood the problems of Dompola farmers (12) | 9 |
| Possibility to grow potato in Limbukha (5, 6, 7) | 27 |

[a]Numbers in parentheses represent the number of the farmer, i.e., 2 = farmer 2.

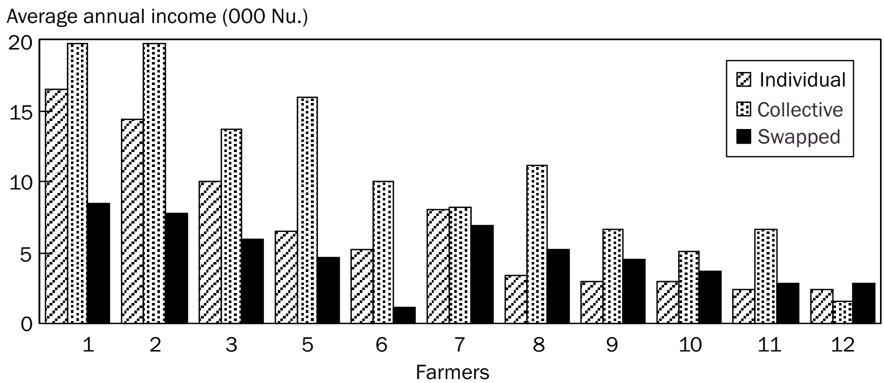


**Fig. 12. Annual income produced from three different modes of communication.**

As the game board was a poster paper with rows and columns representing plots, 82% of the respondents believed that the plots represented the actual spatial distribution. During the first game session, in which two villages played independently, definite patterns existed in choosing the crops and the plots in the first cycle. This revealed that, in the first cycle, potato is planted in central plots to facilitate protecting the crop from wild boar damage. However, the rest of the participants thought that the plots are more scattered and numerous in reality. All accepted the categorization of farmers in terms of access to water, number of field plots, and cash allocation: 27% (one each from Thruelpa, Chhep, and Chatho) of them thought that the cash allocation was too high, as farmers may not be in a position to gain access to that amount to start farming.

Initially, it was assumed that potato cultivation in Limbukha would have some effect on Dompola farmers in terms of access to irrigation water, but the interview revealed just the opposite. It was later clarified that potato is harvested before the rice-transplanting season in Dompola and its occupancy of the terraces will not influence the water-sharing system. Overall, all the players believed that the game results depicted the real-life situation.

Among the three gaming sessions, farmers preferred the second one as it allowed them to collectively share resources and work together. One participating member stated that "it is more fun and interesting to work together in a community, helping each other to pull along." This implies that both the villages would, given the opportunity, operate in a collective mode.

*RPG actual circumstances/reality linkages.* The components and rules used in the RPG were considered to represent the real-life situation. Water share, water units, and the influence of rainfall on water availability were the main features that players related to reality. Although water exchange depended on the demand from those who needed it, kinship played a dominating role in the exchange of water. Whenever there is excess water, it is given free of charge to relatives who need water. It was stated that it is shared on the mutual basis of helping each other in times of need. Only after satisfying the relatives' requirements would the players exchange water with whoever wants it for labor.

Although exchange of water between the two villages does not exist, 45% of the respondents answered that a water exchange could take place between the two villages. Further, they suggested that, when there is plenty of water at the source, it should be shared. With the increased dependence of Limbukha on farm labor from Dompola and other socioeconomic dependence, this should provide a platform for cooperation and the collective decision-making process in natural resource management, primarily for water.

*Possible improvements suggested.* It was evident from the game and individual interviews that the inclusion of labor in the game as a means for water exchange would improve the results of the RPG. As farm labor is the most limiting resource for Limbukha farmers, the inclusion of labor as one variable in the game could produce unique reactions. It was also suggested that the number of plots per farmer category and the initial capital provided to each player might have to be revised. Prior to the start of the gaming session, more elaborate briefings and discussions with the farmers (stakeholders) will help in enhancing the efficiency of the gaming process.

*Learning experiences.* As a learning experience from the game, 36% of the farmers reported that it helped them to understand the benefits of sharing water with a neighboring village, which enhanced their land-use system, productivity, and income. This was evident from the discussions they had on the preliminary results before the plenary session (Fig. 13). The game also helped in understanding the valuation of water share for 27% of the respondents and the facilitators. This implied that, given the opportunity, a water market will emerge in the system. Apart from the economic valuation of water, the game helped to open up new understanding of the social dependence between villages, particularly in terms of labor exchange and other services. The players also believed that the RPG helped them to understand the value of maintaining farm accounts, the problems of a neighboring village, and the importance of completing farm work on time. For Dompola farmers, the game gave them the idea to attempt potato cultivation either in Dompola or by leasing land in Limbukha to grow the crop.

*Possible use of RPG.* The responses of the players in the Dompola RPG on the possible use of RPG indicated that 36% would consider their use for crop production

**Fig. 13. Preliminary results and players discusssing the results.**

problems, followed by use in collective actions (27%). Others thought that RPG could be used for awareness and learning, and for weed management.

## Conclusions

The most important realization was the awareness of the ability of the RPG to bring two communities in conflict together to discuss and collectively develop options. RPG enabled two villages to cooperate for the betterment of both. The RPG also prompted a "sense of oneness" and interdependence that can expand the scope to look for alternative strategies to overcome water-sharing problems.

Since the RPG carried out in May 2003 began the process of discussion to seek a better management of resources, certain changes in resource-use decisions can be expected. One piece of vital information to substantiate the research findings will be to monitor behavioral patterns during the current cropping season. Even if sequential observation is not possible, interviewing the same players at the end of the 2003 paddy season could produce useful information to evaluate the influence of RPG. Accordingly, any changes in the rules of the game could be incorporated in a new version and the game could be played once again to see any pattern of change. In addition to the above use, RPG can also be used as a communication tool for awareness building by motivating stakeholders to participate in management actions.

In a situation in which irrigated agriculture is dominated by a small-farmer-managed irrigation scheme built on the traditional institutional platform passed down through generations, critical learning and understanding of the context and issues are the most important step in entering into the problem-solving phase.

We can conclude that Dompola RPG have helped in facilitating the emergence of new rules in resource sharing that could possibly be further tested and adapted in a situation of conflict. These games also have the potential to serve as a tool for a common platform for stakeholders in conflict, to initiate collective learning and negotiations.

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## Notes

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