Physics and Chemistry of the Earth 33 (2008) 873–880

Contents lists available at ScienceDirect

Physics and Chemistry of the Earth

journal homepage: www.elsevier.com/locate/pce

The river basin game as a tool for collective water management at community level in South Africa

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ARTICLE INFO

Available online 10 July 2008

Keywords:
Conflict resolution
Irrigation
River basin game
Water equity
Downstream user
Upstream user

ABSTRACT

Water scarcity in semi-arid catchments presents challenges on achieving equitable sharing of available water resources and avoiding social tensions among small-holder farmers. This paper explores the implementation of a river basin game as a tool to facilitate negotiations and rules of equal access among upstream and downstream irrigation water users in Ga-Sekororo, Olifants river basin in South Africa. The various stages of the game playing methodology are presented in a progressive manner and the outcomes are discussed. Through the application of this game, farmers were able to better relate to their catchment and accepted the board's schematic representation of their reality. They were able to understand top-tail inequities of water supply and to appreciate that solutions lie in the community. The coming together of the small-holder farmers to share knowledge and set agreements on equitable water sharing results in higher benefits such as community harmony, transparency, acceptance of operating rules and improved knowledge to the community as a whole. The collective negotiation exercise produces more acceptable water allocation rules, thereby improving the security of water supply to the irrigation schemes. The paper concludes that local level management of tensions and conflicts through participation as facilitated by the river basin games can be sustainable provided there is proactive support from higher level institutions such as water committees, government and research.

1. Introduction

About 60% of water resource is used for agriculture in the Olifants river basin, South Africa. Agriculture faces increasing competition from other water users and this trend is likely to drastically reduce water availability for agricultural uses. The increasing spatial and temporal water shortages for irrigation affect small-holder irrigation farmers in Ga-Sekororo, resulting in conflicts and social tensions on sharing the little water available (DWAF, 2004). These problems adversely affect efforts currently underway to reduce poverty and improve food security. The main competing uses in the catchment are large-scale and small-scale agriculture, domestic water supply, environment and the need to satisfy minimum in-stream flows into Mozambique. South Africa National Water Act of 1998 strives for equity within and outside the catchment for shared water courses (NWA, 1998).

The use of games to facilitate community negotiations is receiving greater attention in natural resources management and action research (Lenselink and Jurriëns, 1993; Bouwen and Taillieu, 2004). The games have winners, losers, and a motive for playing and competing. In the current study, it is the competition for irrigation water.

As the name suggests, role-playing is central to the experience. The fascinating effect that role-play games have on people participating is the high level of interaction involved in playing the game. War games (Auger, 1997) have little or nothing to do with role-play games, but the game boards and miniature pieces used became a foundation for the games played today. To role-play, all one has to do is take on a particular role and play it out especially as a part of understanding and learning a new skill. Another area where role-playing is often used is in training and/or teaching situations (Smith, 1989; McGrenere, 1996; Pahl-Wostl, 2002; Mayer and De Jong, 2004). Students are required to assume an individual role and to react appropriately to a hypothetical situation. Despite the increasing use of games, they sometimes face difficulties in acceptance by the players and the public. A vivid example is RPGs developed with the companion modelling approach. They confronted political disapproval and they had to be stopped (Perez et al., 2003). The river basin game (RBG) is one such role-play game to be discussed in this paper.

This paper reports on one of the thrusts of the on-going Waternet project (The Challenge of Integrated Water Resource

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1474-7065/$ - see front matter
doi:10.1016/j.pce.2008.06.045

Management for Improved Rural Livelihoods: Managing Risk, Mitigating Drought and Improving Water Productivity in the Water Scarce Limpopo Basin, Project Number 17) in the Olifants river catchment on training of farmers. The focus is on transforming local community stakeholders involved in the project into active partners, based on the viewpoint that people learn better, and are more willing to apply what they have learned when they are more involved themselves. For instance, local farmers set up trial plots in their fields which they monitored until harvest time in collaboration with researchers. Farmers were also involved in experimental field data collection.

The objective of the RBG described in this paper is to achieve a common representation of the issues and constraints of water management by all water users at the lowest level in the B72A quaternary catchment to ensure equity among various uses (nature, municipality and small-scale irrigation needs). Secondly, it facilitates discourse and negotiation among small-holder farmers for sustainable water and irrigation infrastructure management in the catchment.

2. Generalities on role-playing games

2.1. Overview of role-play games in water management

Improving scientific insights to address the complex interactions and feedbacks of natural and social systems is of essence for increasing the quality of decisions in a river catchment. Role-play games which belong to participatory action research are steadily being used to explore management strategies and policy making for natural resources such as water, fisheries and forests (Burton, 1994; Barreteau and Bousquet, 2000; Barreteau et al., 2001; Farolfi et al., 2004; Castella et al., 2005). Examples of games that addressed policy simulation exercises are Carton and Karstens (2002) in Netherlands and Hermans and Bots (2002) in Egypt. Role-playing games are increasingly adopted for educational purposes as well as for dealing with negotiation issues (Green, 2002; Barreteau, 2003; Lankford and Sokile, 2003). Role-play games have also found themselves being used as tools for conflict resolution and negotiation in sylvopastoral management planning (Etienne, 2003) and for collective awareness of reedbed wise use (Mathevet et al., in preparation). Some collaborative methods used role-playing games in negotiation (Ostrom, 1990; Ostrom et al., 1994; Heathcote, 1998; Daré and Barreteau, 2003; Elbakidze and Angelstam, in press), while Castella et al. (2005) combined use of an agent-based model and a role-playing game.

In Ngnith village, Senegal, games were played to resolve the conflict between farmers and herders in which farmers cultivated crops along the riverside and cattle had to cross the fields to access the river for drinking water (Barreteau et al., 2001). Several games have been devised for the management of irrigated systems (Burton, 1989; Barreteau et al., 2001) and irrigation planning as in the River Wadu role-playing game, played with agricultural economists (Carruthers, 1981). Farolfi et al. (2004) and Farolfi and Rowntree (2005) developed a role-play game to support multi-stakeholder negotiations related to water allocation in Olifants river basin, South Africa.

2.2. Background to the river basin game

The game in this study was first developed as a teaching tool for students in 2000 at the University of East Anglia, United Kingdom by Bruce Lankford (Lankford and Sokile, 2003; Lankford et al., 2004). Two years later, the game was introduced into Usangu sub-catchment, Tanzania under the project 'Raising Irrigation Productivity And Releasing Water for Intersectoral Needs (RIPARWIN)' and Nigeria. In both the cases, the sub-catchments were characterized by irrigation, domestic, livestock and environmental users. The objectives of the games were to negotiate for water equity and to resolve conflicts in the sub-catchments.

A board was used to represent a catchment with a gradient and glass marbles to show upstream–downstream flow of water. The RBG is actually a virtual river basin on which it is possible to conduct experiments according to scenarios defined by its user(s). Players call upon their own experiences to discuss issues and do not need prior training but are required to follow the rules of the game. The game thus offers a simplified understanding of the complex behaviour of human impacted ecosystems, for instance how individual behaviours and collective rules for water sharing interact with river hydrology. Furthermore, it gives the opportunity to test the sensitivity of the consequences of a given set of collective rules with respect to a set of assumptions on individual behaviours. The detailed game explanation is found in Lankford et al. (2004).

The current RBG was developed to understand how people coordinate their actions in an irrigated area to manage water and crop production. Experience shows that the main contribution of role-playing games, which enhances discussion among game session participants, is the way in which problems encountered in the field and known by each individual separately are translated into a common and collective knowledge. The RBG achieves understanding of the problem area through simplifying a large and complex system into a small and simple scale model, the board where every player can easily comprehend what is happening in the system and impacts of their actions on the system. Thus, the RBG has a dual commitment in action research: to study a system and for researchers to concurrently collaborate with the local members of the system (catchment) in changing the system to what is jointly reckoned as a desirable novel state. Satisfying these goals requires co-learning, supported by the active collaboration of researchers and local communities. The driving force of action research is the social dimension (Pahl-Wostl, 2002) to ascertain that the research takes place in real-world situations, and aims to solve real problems.

3. Case study – the river basin game in Ga-Sekororo, Olifants river basin

The Olifants river basin (Fig. 1) is located between 25° and 26.5° South Latitude, between 28.5° and 24.8° East Longitude and with altitude varying from 300 to 2300 m above the sea level. The catchment area is 54,475 km^2, with a mean annual rainfall of 630 mm per year (DWAF, 2004). The study was conducted in the quaternary catchment, B72A (Fig. 1) with an area of 534 km^2 and rural population of about 50,000 people (South Africa Census, 2001). The pilot area, Ga-Sekororo is located in the lower Olifants sub-catchment. A number of wildlife conservancies are located downstream of the catchment. The area experiences high spatial and temporal rainfall variability that leads to seasonal dry spells and water shortages, prompting water transfers into the catchment (DWAF, 2004). Population growth and agricultural changes are inevitable, exerting more pressure and competition on water supplies which prompts changes in water management, allocation, and use. Commercial, emerging and subsistence farmers exist within this catchment. Commercial farmers produce mainly for domestic and international market, while emerging farmers are those whom the government recently re-allocated sizeable land for agricultural purposes and are working towards commercialization. The emerging farmers came from former homelands[1].

[1] Homelands, a legacy of apartheid, were overcrowded black labour-reserve areas with high unemployment, mostly in the former Bantustans, with the *Subdivision of Agricultural Land Act, 70 of 1970*, being the main instrument to implement such zoning regulations.

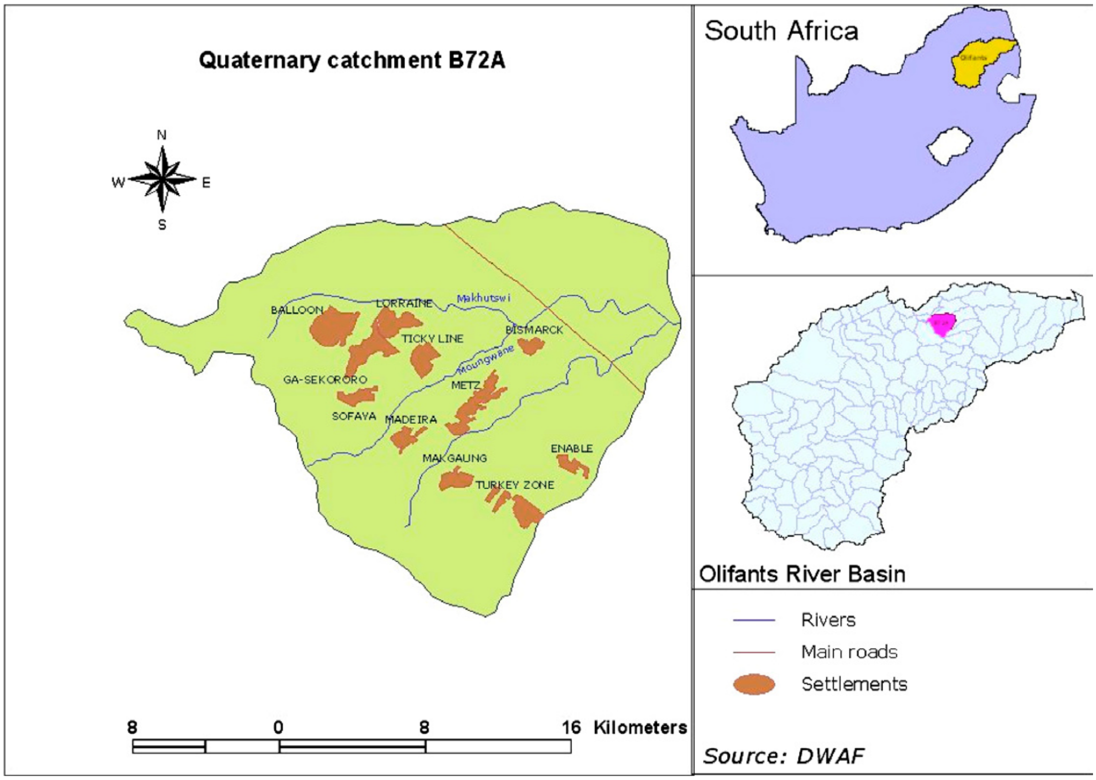

Fig. 1. Location of the B72A quaternary catchment in South Africa.

Subsistence farmers produce mainly for family food security. With more than half (60%) of the area falling under the former homelands (Liebrand, 2006), subsistence rainfed farming and small-scale irrigation schemes are the main livelihood strategies, complemented by social grants and remittances. More than 80% of the population relies on agriculture in the Ga-Sekororo area and Olifants river basin as a whole.

With the various water usages in the B72A catchment (drinking water, fishery, crop irrigation, conservancy, and the need to satisfy in-streamflow requirements into Mozambique), water has to be shared among various actors who do not have the same objectives and priorities. Thus, water sharing creates tensions or conflicts more so when addressing the past imbalances in South Africa.

There is currently tension among the small-holder farmers and between the disadvantaged local community and the commercial farmers stemming from the apartheid legacy. The local community is sometimes not allowed to use water for irrigation in the river, because it is committed to commercial farmers and municipality downstream. The commercial farmers argued that they are important as they provided jobs and food security to the country. One commercial farmer, growing fruits and vegetables claimed to employ 40–200 workers per season depending on the availability of water (Liebrand, 2006). In South Africa as a whole, commercial agriculture provides substantial employment especially in the rural areas, to about 940,000 seasonal and contract farm workers and the figure adds up to at least 1.3 million households depended on full or part-time farm employment (DA, 2001, 2005). Agriculture contributes about 8% to South Africa's total exports. On the other hand, recent government policies on black economic empowerment (BEE) encourage and support the emerging small-scale farmers to ensure food security in the country. Currently, about 900 families have been resettled in the Olifants (Nesamvuni et al., 2002). An example of such programs is the rehabilitation of small irrigation schemes (RESIS) program implemented by the Department of Agriculture to rehabilitate the small-scale irrigation schemes in Ga-Sekororo (DA, 2005). In addition, the Department of Water and Forestry Affairs (DWAF) has embarked on water re-allocation and verification of water abstraction permits in the entire Olifants catchment in an effort to ensure equity (DWAF, 2004). There is transformation of irrigation boards to water user associations under way in the B72A quaternary catchment. The new water user associations fall short of strategies for defined water allocation rules, maintenance of irrigation infrastructure, methods and resources to improve the irrigation service, which are precursors to water sharing conflicts.

Due to extensive groundwater use in the catchment, a groundwater component has been included in the RBG play, an addition from the original game form. There is extensive use of water boreholes by the commercial farmers in the study area.

4. Methodology

Pre-game preparation is very important and in this study it involved a two-day workshop on training of the trainers by one of the co-authors (Lankford), participant selection of local stakeholders and construction of a surface elevation catchment model (Fig. 2).

The elevation scale model was constructed for the farmers/community to easily identify the position of their irrigation schemes in the area and other areas of importance such as the conservancy areas, town and commercial farms.

The first game workshop was played with a sampled group of 40 small-holder farmers (males and females) from different irrigation schemes, students group (MSc and PhD students working in the catchment) and the senior expert group (senior researchers and lecturers). The second workshop consisted of 35 small-holder male and female farmers from one irrigation scheme. The total sample design was 75 players. The commercial farmers did

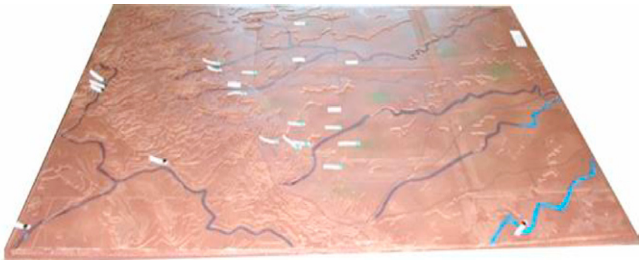

Fig. 2. Surface elevation model of the quaternary catchments (B72 A, E, F, and G) in the Olifants. The white tags show the names of irrigation schemes found in the area. The lines on the model board are rivers.

not participate in the first two games; only one farmer came as an observer. Commercial farmers will be our next target when expanding the RBG in the Olifants river basin with the help of agricultural extension officers.

The game commenced with an explanation of the overall game structure and its objectives by the coordinator/facilitator. The game board comprised a single channel with off-takes positioned at intervals from main channel to form a tree branch. The water channels were painted blue and the fields were painted green. Other land outside the river and fields was painted brown (Fig. 3). The glass marbles were used to represent units of water and holes in the fields to denote irrigation water requirement. Each release of marbles from the top of the board represented seasonal flow in the river. Hence, the RBG used a time scale of one season that allowed dynamics to be examined. The groundwater component was represented by an off-take channel from the stream to a sink, later connected to the irrigated field.

A review of the history of the catchment on land and water issues by the game players/farmers was done to place the current catchment development into context. This aspect was easily articulated because of the presence of the community leadership (chief and headman) among game players and their understanding of the built catchment scale model. The water users considered after consultation with the farmers were irrigation, domestic water supply (municipality) and environment at the downstream end of the catchment. The farmers were divided into groups according to the above uses.

The land allocation on the game board was exercised using three methods. Firstly, the farmers were divided into upper, middle and lower sub-groups during the game depending on the location of their farms/plots in the catchment. Secondly, the farmer sub-groups were allocated 10 min to discuss among themselves where they would like to farm on the game board. They chose representatives from each sub-group who competed to get to the field or position of choice on game board. At the start up signal (as in a race) by the facilitator, the representatives had to run to the board game, those who were not fast enough to get the fields or positions of their choice ended up on the fields or positions they disliked. Thirdly, later in the game, swapping of the advantageous and disadvantageous positions was arranged for each sub-group to give players alternative viewpoints of water security (what it is like not to have water).

Fig. 3. River basin game board.

The following stages of the game were tested: *wet and dry seasons* – large and small number of marbles were released in the river, respectively; *an increasing number and capacity of intakes to irrigation fields along the river* – players were instructed to use few intakes and intakes that block the whole river to divert water to their fields; *individual water-seeking strategies* – the players were to be selfish when abstracting water from the river; *individual money-seeking strategies* – players obtained the best plot in the game board in order to better satisfy their individual needs; and *community-based resolutions* – the players shared the available water fairly and were considerate to each other. Each stage involved group discussions and feedback within an allocated time frame of 35–45 min. This aspect is important for the successful facilitation of the game to ensure that participants have enough time to discuss their concerns and propose as much as possible their local solutions to hot issues found in the catchment.

The final component of the game required the farmer sub-groups to identify and rank water problems faced in the area, and proposed solutions through dialogue to overcome the problems according to the resources available to them. Feedback sessions of 7–10 min by each sub-group to all game participants followed the sub-groups discussions. The contributions by each sub-group were written on the board in front for everyone to see and synthesize. Through voting by the players the most important problems were selected. Each player was given three votes to select the most pressing problems in the area. The female farmers/players and male farmers worked in separate groups to elicit solutions as viewed by different genders. The other sub-groups (community leadership, student and expert groups) also worked separately.

The game workshop also involved a visit to Sofaya Irrigation Scheme (110 farmers on 200 ha) which has a committee consisting of five men and four women, elected every three years. An evaluation questionnaire of the impacts of the game was issued to all the participants at the end of the game to assess their understanding of the game and any improvements they would like to see in the future games. For a detailed methodology see Lankford et al. (2004) and Lankford (2006a,b).

5. Results and discussions

Community members use water for domestic purposes (cooking, cleaning, drinking, washing) and productive activities (livestock watering, beer brewing, house building, irrigation and brick making). Most of the farmers use the same source for all these uses namely the river. They identified irrigation as the largest consumer of water. Most farmers in the small-scale irrigation schemes have small plots (1–2 ha) and the land is communally owned. During the dry season, it is not easy to find water for them to use (in some cases it is even difficult to find it during the wet season). This creates uncertainty about their present and future livelihoods.

Water quality issues appeared to be worsening because of the increasing population and limited water and land resources. There is only one water treatment facility for the nearby Sekororo Hospital. The community mostly rely on the groundwater which is brackish in some areas for domestic water supply, whilst some villagers fetch water from polluted rivers. Furthermore, some community members wash cars and clothes in the rivers, livestock drink, graze and defecate in and around the watercourses and the polluted rainfall runoffs from the villages are discharged into the rivers without treatment, creating a potential health hazard.

5.1. Demonstration stage (phases 1 and 2)

At the end of the demonstration, all the players knew what the glass marbles represented, understood the difference between wet and dry seasons and were able to choose various locations and technologies for irrigation water abstraction.

5.2. Water-seeking strategies (phase 3)

Players tried to obtain the best plot by encouraging sub-group representatives to run as fast as they could to reach the game board first in order to get a position of their choice and satisfy their needs. The players abstracted water from the river selfishly and those downstream ended with little or no water. This resulted in water logging and low water application efficiency in the upper catchment, since excess water than required by the crops was held in the fields. Furthermore, high losses from open water evaporation could be experienced. The farmers realised the value of an upstream location, and all of them tried to get the plots upstream. The farmers made an interesting observation with the help from the facilitator that a single unit of water released from a wet upstream area had a high value to those short of water downstream, and yet those upstream might not even realise the absence of this unit of water. This follows the principle of marginal water productivity.

5.3. Money-seeking strategies (phase 4)

The players attempted to obtain the best plot in the game board to better satisfy their individual needs in terms of money. They also recognized the relationship between access to water and the access to money or livelihoods. Players that did not acquire water identified ways of feeding their families till the next rainy season. The identified alternatives for survival under water shortage were:

- Apply for loans to cover a financial shortfall or to invest and utilise the returns.
- Work for those who received enough water as cash labourers.
- Withdraw money from savings and/or use food from the previous harvest.
- Sell livestock such as cattle, goats and sheep.
- Hawking and selling small goods including crafts.
- Leasing land in wet areas.
- Migrate to big cities for full-time or part-time employment.
- Receive government handouts (chickens, food parcels, milk, and grants).
- Dagga (*Cannabis sativa*) trafficking.
- Stealing.
- Gambling.
- Picking firewood, sand and gravel for sale.

The last four options in the list indicated how a community can engage in illegal activities for survival and how unfriendly such actions are to society, the environs and the ecosystem. This behaviour is confirmed in the literature that the poor communities aggravate environmental degradation as their livelihoods depend much on natural resources (Adaman and Devine, 2000; Rockström and Falkenmark, 2001). Several reviews of the literature on environment–poverty interactions such as Duraiappah (1998), Horowitz (1998), Scherr (2000), and Grimble et al. (2002) pointed out that poverty–environment links are currently not well understood. Furthermore, Grimble et al. (2002) concluded that while poverty itself does not give rise to degradation, it can increase the vulnerability of the poor people to externally driven threats, and thus play a part in the process. Ellis (2000) pointed to a host of asset portfolios accessible to the poor, livelihoods alternatives they have, economic and institutional factors that vary enormously from place to place as bearing upon poverty impacts on the environment. Similarly, Rahman (2001) argued that a lack of strong resource base makes it difficult for the poor to opt out of the degraded environment and try to eke out a living with alternative sources of livelihoods which are less degrading. In that sense they are more victims rather than degraders of the environment. Thus, there is a linkage among water availability, food security, poverty and environmental degradation in the catchment. Poverty results in food insecurity and environmental degradation, and in turn, the degradations in environment exacerbate poverty as supported by Duraiappah (1998).

Some authors pinned the blame on poor farmers who intensify production with labour-led strategies, unable to afford such complementary capital inputs as fertilizers and conservation investments that might support sustainable intensification (Mink, 1993; Clay et al., 1998). This line of argument shifts the blame for environmental degradation from population to poverty. The farmers in the catchment had weaker social, financial, human and technology endowments to overcome liquidity barriers to recruit into skilled non-farm activities and so remain trapped in lower-return, and sometimes riskier farming livelihood strategies (Barrett and Reardon, 2000).

5.4. Community-based resolutions (phase 5)

For this phase, the players shared the available water fairly and were considerate to each other in order to get the maximum benefits for the community. Initially, there was resistance to the sharing water fairly by the upstream users previously advantaged by their location as they kept the use of large intake structures which traversed the river channel width. The large intakes almost diverted the total river flow to their fields. The downstream users did not get a fair share of the available water. Hence, they negotiated with the upstream farmers to utilise smaller intake structures that did not span across the whole river channel width. As one group, both upstream and downstream water users adjusted all intakes in the river to achieve reasonable water sharing and every member had an idea how much each user/ farmer abstracted. The players interpreted this phase as a positive approach towards water equity in the catchment.

5.5. Discussions on the game and its value

The questions and answers to elicit the value of the game are shown in the sections that follow.

5.5.1. How does the game relate to the community?

The game was viewed as an essential and important tool for consensus building on equitable sharing of water, especially with the widespread water shortage and competition in the Ga-Sekororo quaternary catchment. Secondly, the game revealed that water was not shared equally within the community, and selfish water use created mistrusts that led to hatred and fights. Thirdly, it created a sense of awareness about water management, water productivity and the need for a management committee to resolve conflicts should they arise.

5.5.2. What does the game mean to the community?

To the farmers, sharing water meant more production, survival and peace in the community, and knowing water available to each farmer per season/year was a plus. The farmers were not comfortable to interact or visit other irrigation schemes and share experiences due to the concealment of the amount of water one farmer used and social tension caused by water shortages. The farmers realised that nothing prevented them to act conjointly; they had not made an effort to initiate interaction. However, it was agreed that water productivity by tail end farmers was high because of the little water they receive, which propels them to use it sparingly. The farmers acknowledged the impacts of not managing water that included conflicts and bound in poverty cycle. However, household incomes, social capital, private assets, natural assets such as fertile soils, forests among others should compliment better water management as they also hamper escape from poverty. In addition, the game showed that to benefit the poor most, better water management must be coupled with economic growth, institutional factors, policies that reduce inequalities (Jodha, 1986) and improve income distribution in a society through payment of environmental services.

5.6. Community water-related problems

The contributions from the sub-groups (Table 1) in identifying water-related problems currently confronted by the community are presented. Each group shared with the others the three most important problems because of time constraint. The most agitating problems selected by voting and proposed solutions are shown in Table 2.

The improvement of water productivity by communities is envisaged through forming groups (to have plots in one big field) rather than having small patches of irrigation plots scattered all over the area, by growing crops with a high water conversion factor and high value crops for selling on the market, using tested/hybrid seeds for their crops, supplying nutrients to the soil, crop rotation, supplementary irrigation and protecting crops from diseases. This could be done by combining appropriate indigenous (already in use in the catchment) technology such as mulching, organic farming and technology from outside the catchment to maximize the productivity of available water.

The outputs from the two workshops indicated the importance of dynamic interaction among different stakeholders in negotiation for the limited water allocation and the timely maintenance of the irrigation infrastructures. Farmers cannot always get the water they need. When a water crisis situation arises, stakeholders had to start negotiating on the basis of their agreed fair rules. The 'coming together' of the community empowered them to speak with one voice and to specify management ideas compatible with the values of the community. However, in the presence of political figures the power might be clouded, that is why we separated the farmers from the local leadership during discussions. The lowest local water management institutions such as irrigation committees were to be renewed and strengthened for transparent communication, with the community involvement in all steps of water management (to include infrastructure operation and maintenance) to ensure equitable sharing of the available water for the effective development of agriculture and improved rural livelihoods in the area.

5.7. Future river basin games

The community agreed that all the stakeholders should be represented in future games. These included commercial, small-scale and emerging farmers, municipal managers, water managers, tribal leaders, pastors, research institutions, Department of Water Affairs and Forestry (DWAF), Provincial Government and Non-governmental Organisations (NGOs). They indicated that the workshop helped them to improve their water management skills and should be an activity done on a regular basis by agricultural extension officers until the whole Olifants river basin is covered.

5.8. Improvements to the river basin game

The farmers were able to relate the game to their scheme very well on the second workshop in Sofaya irrigation scheme. However, they noted that the way their scheme operates is different from that of the river basin game. In their scheme, the first farmer/user to access irrigation water is the user downstream and the sequence goes up to the last upstream user. They defended this arrangement as a means of saving water because it always keeps water in their night storage dam.

One of the game improvements suggested was to have storage in the stream to capture excess water and release it slowly later during the dry part of the season. The other improvement was on finding an optimal slope of the board to avoid excessive velocity of the marbles. In terms of facilitation of the game, the need for translations to be coordinated and synchronised well with the pace of the game was underlined.

5.9. Evaluation of the river basin game

The farmers demonstrated a good understanding of the game and that it was important in their irrigation schemes. They agreed to use the new knowledge and to spread it to other farmers who were not present. More interesting was their realisation that small problems that they faced could be resolved by themselves if they come together and share information without the government's help. Government's help would be reserved for larger and complex projects. These findings mirror very closely the outcomes of the game played in Tanzania (Lankford et al., 2004).

Table 1
Water-related problems from each group for the two workshops

Female farmers	Male farmers	Community leadership	Student group	Senior expert group	Other problems
Pipes up in the mountain get washed away by rain	Lack of water – no job creation	Lack of committee skills, ownership and supervision	Deficiency of water monitoring for domestic and irrigation use	Lack of water for domestic use during the dry season	Perceptions of water quality (river versus. boreholes)
The government provides water pumps but not fuel	Diseases outbreaks on crops and livestock Livestock mortality and low crop and animal yields	Little research with consultation – knowledge	Lack of water infrastructure maintenance	Deficiency of planning for storage	Rivalry between communities: sabotage and breakages of water pipes
Some government pipes are not functional		Unable to share water	Inadequacy of structure for day to day water management	Lack of water and land management institutions	
People rely on river water resources					Erosion and siltation: blocking pipes Under utilised potential of land/water/people Building on agriculture based livelihoods is risk

Table 2
Solutions to the main identified problems in order of importance

Problems in the catchment	Envisaged solutions
Some government pipes are not functional, people rely on river water resources	Identify affected areas, families and costs
	Come together, contribute money for repairs
	Delegate a representative to speak to the government to carry out repairs
	Management and supervision of water supply system by a ward/village committee
Lack of skills, supervision by committee, and community ownership	Training on how to manage water, finance and co-finance and supervision skills
	Awareness to target community ownership and responsibility
Lack of planning for water storage in wet periods	Elect task team (to plan flow from source, work with relevant consultants, where to build and size of storage, number of people supplied)
	Committee elected from all stakeholders to implement storage dams. Consult community for contribution and other aspects
Lack of water, low crop yields, hence no job creation	Construct small dams/weirs in their plots
	Dams to be protected from livestock and children
	Local-level resource monitoring and evaluation with regular maintenance of infrastructures such as regular cleaning of furrows and irrigation intakes
	Establish supervising committee and skills development
	Fair distribution through water user associations
High livestock mortality	Regular dipping, vaccination, and management of herd at pasture carrying capacity
Lack of land management institutions	Strengthen existing water and land structures
	Security of tenure and regulations that evolve and are enforced locally (enforce the rights of community to manage their resources through granting legal recognition, can be changed by alterations in policy an institutional arrangements)
Rivalry between communities resulting in sabotage and breakages of water conveyances	Encourage free discourse and transparency among water users, smallest social organisation above household
	Meet regularly to decide management issues
	Put conflict management arrangements in place
No markets to sell their produce	Markets should be build in the village so that farmers can be able sell their produce
Inputs suppliers are far away hence high transportation costs	Team up as a group to buy inputs
	Have mobile input sale stations in the area towards rainy season
The extension officer is very busy and does not have time to organise training and workshops for them	Rely on NGOs and researchers working in the area

An interesting testimony the farmers raised during our recent follow up workshop was that there was evidence on the ground that people had improved operation and maintenance of their irrigation schemes since the RBG was played. We have to confirm this claim through a survey.

The results from the evaluation questionnaire showed that the game can act as a tool for reducing water use conflicts, because it had the capacity for role reversal between head-enders and tail-enders, and vice-versa, making it easier for the parties to reach a compromise thereby reducing water conflicts. It made the users understand how water is allocated between up and downstream users. Bringing farmers together helped them to plan together, encouraged transparency, hence, reduced the conflicts.

6. Conclusions

The implementation of the RBG game to small-holder farmers was explored to facilitate negotiations/discourses on maintenance of irrigation infrastructure and rules for equal access among upstream and downstream users to irrigation water supply in Ga-Sekororo. The game also aimed to broaden the perspectives of the participants on how the catchment functions. The current version of the game incorporates the groundwater component.

The farmers acknowledged that the problems they were facing were created upstream, but could not discern that because their irrigation schemes are far from each other and in some cases located along different water courses. Nonetheless, conflicts were addressed when stakeholders become open to each other, shared information such as quantity of water one abstracted, and came together regularly. The participation of farmers at the lowest level coupled with optimal institutional organisations such as irrigation committees supported by policies for water management remained paramount in preventing future conflicts. With the transformation of irrigation boards to water user associations under way in the B72A quaternary catchment, the new water user associations still fall short of defined water allocation rules, methods and resources to improve water productivity to address the poor technical quality of the irrigation service, which is the main cause of conflicts. Hence, there is a dire need to strengthen their knowledge and organisation through such tools as the river basin game.

Our aim was to bring the farmers together to realise their problems in a different way and to demonstrate that the solutions exist within the local communities rather than with researchers who might know little about the area and community desires. Integrating local requirements, advices and expertises are recipes for conflict prevention. The farmers discovered the importance of doing things by themselves before seeking assistance from the government. The RBG workshop emphasised pro-active communities that would only approach the government when their resources cannot match the required project.

The use of the RBG in the two workshops produced interesting results. Players understood the RBG reasonably well, found ways to initiate discussions of their real systems and conceived of the possibility of out-scaling the game to the entire river basin. The farmers had fun, which is a pre-condition of the RBG playability.

In the RBG, farmers/players were placed in a virtual world where roles were allotted and rules defined. In this approach, a question arises: did players adhere to the rules given by the game or did they bring in their own reality? Although the answer is likely to be both, there is a need to focus on a methodology to link the game play and reality in conflict resolution processes as argued in Daré (2005).

As the game is generic enough to be used in different contexts in different catchments/countries and with different people that face the same type of problems, more opportunities exist for the implementation of the RBG under (Integrated Water Resources Management (IWRM)).

Acknowledgements

This study was financed by Waternet under the Challenge Program Water and Food Project Number 17. We would like to extend our great appreciation to IWMI, World Vision, students doing research in Ga-Sekororo and the Ga-Sekororo community.

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