WAT-A-GAME: sharing water and policies in your own basin

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Summary

After having designed and used various games for learning and supporting water management and governance, many similarities appear. However, the components, topologies, and social and political setting of the basins are different. Therefore we have started designing and validating a new generic game platform, *WAT-A-GAME*, alias *AMANZI*.
This new game aims at facilitating exploration and transformation of water management and water use at the small catchment scale. It gives a simple but enlightening view of the various consequences of individual and collective choices, including regulation policies.
After comparing it with some previous games, we discuss its main rationales and features. We show how it can be adapted to very different settings, how players can usefully contribute to designing an instance, and how it can especially address dialogue between multi-level stakeholders.
We describe an application in South-Africa, in the Inkomati basin and the preliminary results of this instance.

Introduction: background for this development

WAT-A-GAME has been designed as a follow-up of series of applied projects (Barreteau et al., 2001; Ferrand, Nancarrow, 2005; Cavailles et al, 2005; Farolfi, Rowntree, 2007; Daniell, 2008) dealing with water management and governance, using games as educational, exploratory and transformative processes.
Between 2003 and 2007 we have had played more than 30 times a first educational river basin game. Designed to be used during half-day sessions with non trained teachers in classes of pupils age 8 to 15, it was to be simple and with no preparation. It had also to contribute to the learning of integrated water management and its main concept. Therefore in a first stage, the young participants, gathered in groups of 3 to 5, had to draw a scheme of their overall water system, on a large white page showing only the sky on top and the sea at the bottom, and based on series of stickers showing the names of key concepts or entities ("river", "pump", "spring", "farmer", "pollution", "forests"…). They could also add new ones on post-it. The form of the drawing was an hybrid spatial and functional map, and it could be done either on paper boards, or on computer, using tools like Cmap (IHMC, 2007). This scheme was

showing the transfer of water from the sky to the sea, passing through all uses and processes. Some corrections and additions could be made at the end by the teacher. Then in a second phase, the facilitator or teacher put a large bunch of water tokens (usually paper binders or flat marbles) in the "sky" and step by step flew it through the system, splitting it and moving throughout the graph. This qualitative "hand ran" simulation led to simply demonstrate evaporation, run-off, infiltration, and sharing water among the different uses. Eventually not enough water was still flowing downstream the basin and left for these users. In some cases pupils could play the role of some of the users (farmers, dam managers, mayors, river ecologists) and had to argue about the water.

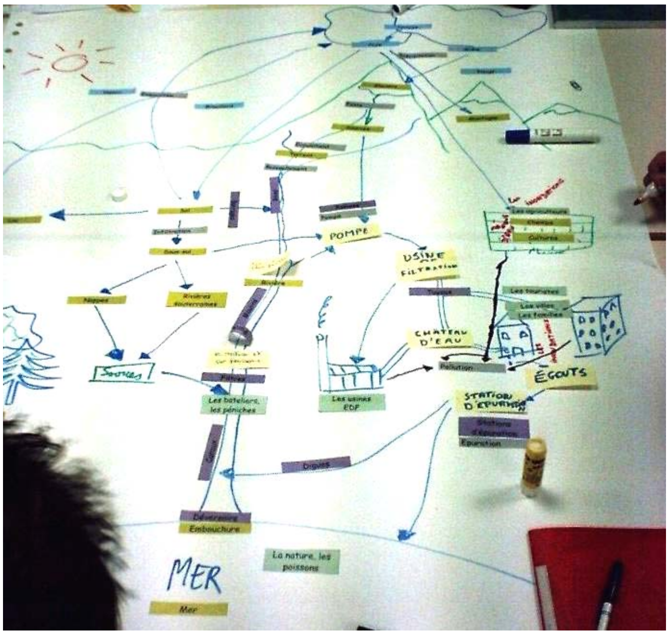

Figure 1 : A scheme produced (2004) by pupils age 11-12. Water tokens are flown on this graph.

However, teachers not experts themselves in water management felt uneasy with running manually this simulation. To improve this, we have started designing a new version (Cavailles et al, 2005), including more prepared materials, and especially transfer or consumption functions for the different activities. But we wanted to keep the participatory design phase, critical for learning, and the tuning of the support scheme to the known, sensible, water system of participants. A trade-off between preparation, calibration and appropriation had to be found.

Meanwhile we have pursued operational games where many features appeared to be common and some repetitions were experienced in the development. Still, both in terms of scientific issues addressed and in terms of tuning to the specific cases, differences exist, especially in the settings of the targeted river system, and in the complexity of the management process. Again, a trade-off between genericity and adaptation was to be sought.

More recently, looking for strategies toward "upscaling" the "Companion Modeling Approaches" (Commod, 2003), one of the options for bringing these processes to higher and wider decision levels has appeared to be their generalization and the capacity given to non expert facilitators to adapt and repeat games at lower cost.

Following these various rationales, we have started assessing the needs for a generic infrastructure, called WAT-A-GAME, and which could facilitate and speed up development of new applications. In a second step, we have designed, built and tested two versions, through experiments in educational context in France, and operational context in South – Africa – where it's been renamed as "Amanzi", *water* in the local dialect xhozi.

Rationales and key features of Wat-A-Game / Amanzi design

The requirements for the design of Wat-A-Game have been based on the experiences described above, and tried to concentrate on genericity and reusability. The target features for the game are:

- Representing any water basin with the right compromise between accuracy and playability;
- Being flexible and adaptable to the real structure of the basin, and to various resources use including water, land, labour, money;
- Being repeatable and transposable to various contexts, countries and players
- Providing measurable results
- Being scalable in terms of basin size and number of players
- Being easy to set and teach to new games organizers
- Having an adaptation time for a new case not longer than 2 man-days.
- Being cheap and easy to set in poor countries
- Nor requiring any computer for the game session
- Having and average session duration of a half day
- Possibility to calibrate it with real data or to use gross qualitative figures
- Interesting, funny, and attractive for many kinds and levels of participants.
- It can be used to test and compare different policies.
- Sessions can be self-designed by the players.

Wat-a-Game vs. other role playing games applied to water management

The literature about Role Playing Games (RPGs) dealing with water management and governance is quite rich. We will try here to present a simple framework based on a review of the most relevant RPGs about water management developed in the last 25 years and to position Wat-a-game within it.

Although RPGs can be used for many purposes in social sciences and common pool resource management, we propose to adapt the typology suggested by Dionnet et al. (2006) and consider four main types of RPGs applied to water management issues: Educational and training games, Common-pool resource management games, Experimental games, and Policy simulation exercises.

Educational and training games

Educational games became popular in the 80's with the development of the communicative approach in field education (Dionnet et al., 2006). They are often backed with computerized support and can be used with children or students as much as with adults for professional purposes. In the field of water management, games have been used as training tools for long time. Carruthers applied for the first time this type of RPGs to the water domain creating the River Wadu RPG, an educational game dealing with irrigation planning issues used for post-graduate agricultural economists (Carruthers, 1981). Burton (1989) developed the Irrigation Management Game to demonstrate the interdependence between crop growth, farm localization within the irrigation system, work performed by staff of the irrigation department and water supply. The game was generic enough to be played in different countries, context and with different players. It was used for instance in Australia, Nigeria, UK with players ranging from students to irrigation officials. Close to the previous one, the Rehab Irrigation Game (Steehuis, Oaks et al., 1989) was presented as a learning tool for irrigation system rehabilitation. It is a scenario-oriented virtual tool, where engineers, social scientists, planners and other actors can practice rehabilitation plans for a hypothetical irrigation system in a sort of non threatening environment. Several RPGs used in Latin America for educational purposes related to water management were reviewed in a recent article by Camargo et al. (2007).

Common pool-resources management games

Some RPGs originally developed as purely educational proved useful at a second stage when applied to real-life contexts. The Riparwin River Basin Game (Lankford and Sokile, 2003) was originally developed as a teaching tool for undergraduate students in the UK. Its transposition into real-life contexts in Tanzania first and then in other African countries proved useful to elicit farmers' suggestions regarding real-life solutions and allowed them to understand their crucial role in the management of the resource. The MEDTER Game (Le Bars, Le Grusse et al., 2004) has a similar history to the Riparwin RBG, as it was designed to be a teaching support, and then was used to build a game used in the South West of France with farmers. This game is based on a computerized simulation tool (OLYMPE) developed to assist farm management. Players manage virtual farms that share the same water sources and must develop collective water management rules.
The Just Game (Ferrand et al., 2005) is based on a survey about principles of fair allocation of water expressed by a small population of Australian farmers. It first aims at improving researchers' knowledge about justice and secondly to promote different and fairer management protocols.

A wide group of RPGs related to water management were developed by a community of researchers called Companion Modelling or "ComMod" (Bousquet, Barreteau et al., 1999). ComMod combines the use of computerized models, mainly multi-agent systems (MAS), and RPGs in a participatory posture that aims at involving stakeholders and final users in the process of development of the artifacts (models and RPGs) that are then used for the social interactions. The Njoobaari Linoowo Game (Barreteau, Bousquet et al., 2001) was the first RPG constructed under the ComMod approach. It dealt with the question of the viability of irrigation water schemes in Senegal and the objective was to explore whether this viability was in relation to the coordination modes between farmers and, if so, the way this coordination could be improved. KatAWARE (Farolfi et al, 2008) was developed to facilitate discussions and negotiations within a South African Water User Association in order to prepare a catchment business plan for water management. The process went on for two years and a half and produced two versions of a RPG based on a MAS representing the dynamics of water availability and consumption in the catchment.

Experimental games

This type of games places players in a very controlled situation in order to analyze and understand the collective and individual behavior that it causes (Dionnet et al, 2006). Experimental exercises in social sciences can be used to test a new theory or hypothesis, or as a prospecting tool fro better knowledge of human behavior (Friedman & Sunder, 1994). Players usually are students, but field experiments with professionals or local stakeholders have been progressively undertaken in the last years. In experimental games players are remunerated in order to stimulate "rational" behaviours.
Bachta and Bchir (2008) conducted field and lab experiments in France and Tunisia to test the behavior of farmers in order to verify the hypothesis that water access in irrigation schemes is a club good and that the level of adhesion to the club increases the performance of the irrigation scheme. Desolé et al. (2008) used experiments to test in a water-related context the

cooperative game theory assumption that, in a super additive game, players of the grand coalition would share its payoff according to the Shapley Value.

Policy simulation exercises

Policy simulation exercises are widely used to think about the way to manage potential situations in all kind of fields (Duke and Geurts, 2004). The main part of a policy exercise is the development and analysis of scenarios. These games create virtual dimensions and are particularly good to improve the management of a possible problem that have to face different types of stakeholders (Dionnet et al., 2006).

Many policy simulation games are connected with large-scale water management policies concerns, such as the Nile management policy in Egypt, but they are not restricted to this scale.

The Water for Space Game (W4S) (Carton et al., 2002) aimed at enabling the players to visually experience the space that water can provide in the Netherlands and to illustrate how social and economic uncertainties affect the way space and water are organized. The FIRMA Watergame was designed by Hare et al. (2001) in order to support the emergence of a new way of managing the water supplying system in Zurich. It relies on a dilemma regarding stakeholders' conflicting goals of maintaining water security and quality, saving money and preserving the resource.

Position of Wat-A-Game in this framework

Following the proposed framework, Wat-a-game is a common-pool resources management game that originates from the need to combine a participatory process with the willingness to upscale the level of intervention (geographically, institutionally) and reach a higher genericity of the artifact than the one obtained through the ComMod approach. Wat-a-game represents a hybrid between a common pool resources management game and a policy simulation exercise. With the first group of RPGs it shares participation aims and description of real issues, and a policy simulation exercise. The proximity of Wat-a-game with a policy simulation exercise relates mainly to its scale of intervention and its objective of genericity / abstraction with respect to strongly contextualized and specific RPGs as those developed though the ComMod approach.

On top of that, Wat-A-Game has been designed to allow for full flexibility in the game settings and adaptation to a local case. This follows the original and traditional leisure role playing games, where a scenario was initially designed by the game master. To our knowledge, outside computer based tools, very few water or resources related games allow for shaping a new specific case tuned to reality. Furthermore this game gives space for the players themselves to contribute – and learn- to the game design. Finally players can be associated to the decision about the game's objectives and the rules for winning.

Game's description

General features

WATaGAME represents a water catchment including different land plots which are managed by individual players. The players have to decide how they exploit their land, the water they use, and optionally other resources. The can be confronted to new policies to which they must react. They have to maintain their land activity and livelihood to a viable level.

The game itself can be competitive or cooperative. Players pay-off or win / lose state can be defined according to some pre-chosen indicators or play objectives.

Game topology

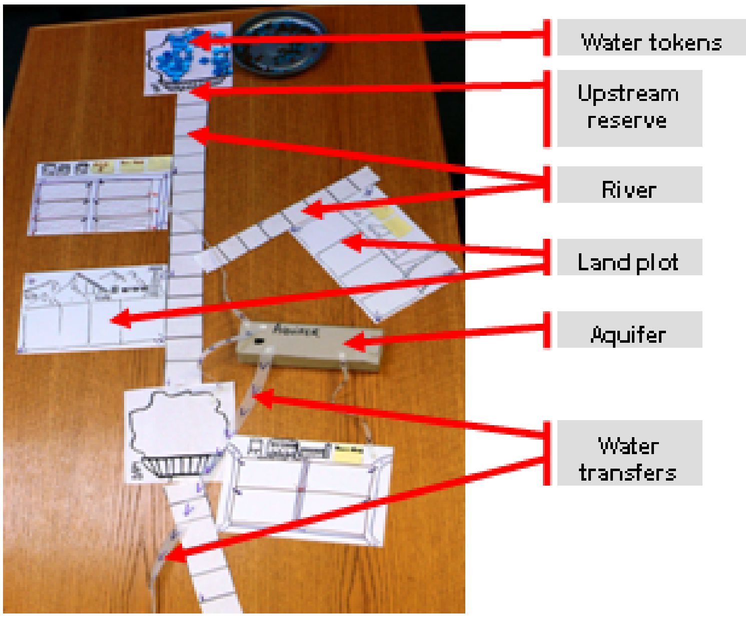

Figure 2 : components setting a custom basin structure

The game spatial structure can be organized at will for a given use. Any catchment structure can be set. Basic components are:

- river parts
- reservoirs, lakes
- land plots
- aquifers
- water transfers via pipes or other physical transport including infiltration or run off outside rivers
- pumps

With these elements an overall basin can be chosen for a game session. Components are easily printed or copied on paper.

Figure 3 : 2 different organization for a basin

Game cards and tokens

- **River stripes:** they are only used for showing the flow direction and the network topology. They can be removed if the structure is simple and explicit enough.
- **Land plots cards (LPCs):** land plots cards are managed each by one player. They can represent all kinds of activities. Basic land cards are village farming, commercial farms, emergent schemes, mines, industry,

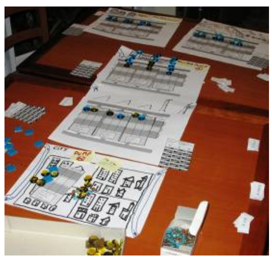

Figure 4 : A basin without river stripes

and cities. Other cards can be designed for specific needs. All land plots cards can be connected to the water network, receiving water and returning some. They can be drawn by hand or use pictures.

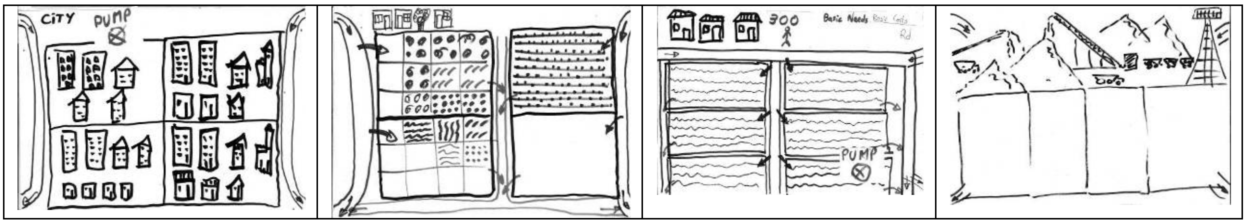

Figure 5 : 4 types of land plots cards

When setting the game with calibrated data, LPCs can be automatically generated using data sheets and pre-formatted cards.

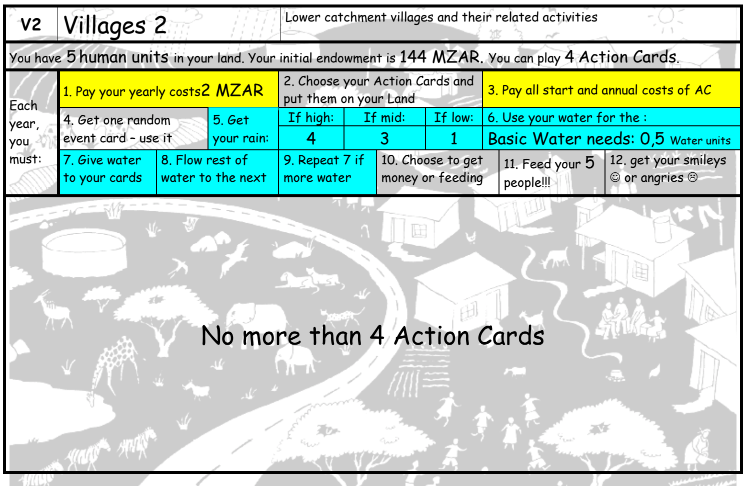

Figure 6 : An automatic LPC generated from data

On a LPC one can read the basic action (s)he has to do, the resources (s)he can use and the basic needs (s)he has to fulfil.

- **Action cards**: these cards show one action of a player for one round. (S)he must choose which actions are played. These cards receive the water tokens and keep track of the results in money, return flow and other dimensions played. Different kinds of action cards can be used. Some action cards are land based. Only a limited number of them can be played on each LPC. Other action cards are "technological" cards. They represent changes or addition in the technologies used on the land, like new irrigation system, or water saving technologies.

S5	**Cabbage**		
LU yearly	grow irrigated cabbage		
COST	4,9 MZAR	Start delay : 0 y	
Happy people	0 ☺		
Annual cost	MZAR		
	Water needs	Gain	Fed persons
Max	4,2	7,	
Low	2,1	3,5	0,0
Min	1,1	1,8	0,0

C1	**W saving methods**		
tech perm	Saving water in the network		
COST	0,5 MZAR	Start delay : 1 y	
Happy people	0 ☺		
Annual cost	0,3 MZAR		
	Water needs	Gain	Fed persons
Max			
Low	0,0	0,0	0,0
Min	0,0	0,0	0,0

Figure 7 : simplified action cards

An action card is put on the LPC by the player to show that it is applied for the current year. When water flows in the system, the player must, as much as possible, fill the blue boxes either with values or ***tokens***, and (s)he obtains the equivalent money according to the relevant column.

In previous versions of the game, we used **production abacus** which are information cards given to players to inform them on the water needs for a given action, on the expected profit and on the return flow (optionally on the labour required). Production abacus must be designed and provided for all possible activities of the players.

Name :	Citrus	
Starting cost :	300	kRand
Land type :	Farm	
0	100	50
P1	P2	P3
0 / 0 / 0	100 / 300 / 30	50 / 200 / 20
0 / 0 / 0	70 / 250 / 20	40 / 150 / 10
0 / 0 / 0	50 / 150 / 15	20 / 100 / 10
0 / 0 / 0	20 / 50 / 10	10 / 50 / 0
0 / 0 / 0	0 / 0 / 0	0 / 0 / 0

Name :	Cabbage	
Starting cost :	50	kRand
Land type :	FARM	
20	10	0
P1	P2	P3
20 / 20 / 5	10 / 10 / 5	0 / 0 / 0
15 / 15 / 5	7 / 7 / 5	0 / 0 / 0
10 / 10 / 0	5 / 5 / 0	0 / 0 / 0
5 / 5 / 0	2 / 2 / 0	0 / 0 / 0
0 / 0 / 0	0 / 0 / 0	0 / 0 / 0

Name :	INDUSTRY	
Starting cost :	4000	kRand
Land type :	INDUSTRY	
10	10	10
P1	P2	P3
10 / 1000 / 8	10 / 1000 / 8	10 / 1000 / 8
7 / 700 / 6	7 / 700 / 6	7 / 700 / 6
5 / 500 / 4	5 / 500 / 4	5 / 500 / 4
2 / 200 / 2	2 / 200 / 2	2 / 200 / 2
0 / 0 / 0	0 / 0 / 0	0 / 0 / 0

Figure 8 : 3 samples of production abacus

- **Water tokens**: some tokens are used to represent water. Two kinds can be used: clean and reclaimed (return) water. Various quantities must be represented and easily moved and counted. We use blue and brown flat marbles of different sizes.

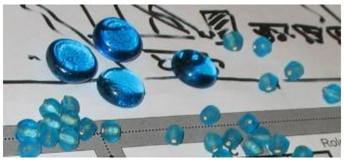

Figure 9 : clean water tokens

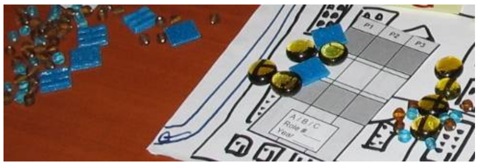

Figure 10: mix of water tokens

- **Reservoirs, lakes:** they can store water and are usually managed by the authority. They are included in the water network.
- **Aquifers**: a "black box" of which content is not visible to the players. Water can enter it and some water can be abstracted on demand by the game manager.

Figure 11 : an aquifer "black box" connected with water transfers

- **Water transfer stripes:** stripes connecting two parts of the system, directed, and showing water transfer. They can be connected to "pump" cards also and reverse natural flow.
- **Pump cards:** small cards showing the setting of a pump somewhere. Usually connected with a water transfer stripe.
- **Indicators table**: this table is used to show the target and current value of some indicators. It is visible to all players and is updated yearly by the game animator.

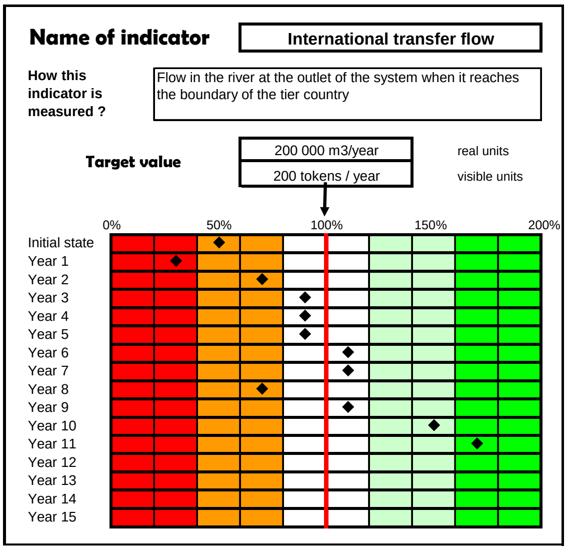

Figure 12 : sample of indicator table

There is one indicator table per indicator.

- **Events cards:** these cards are designed to bring unexpected events to the players. Usually one card can be drowned per year and per player. Event cards can be invented and proposed for each specific session of the game, or they can be taken from the basic set of cards.

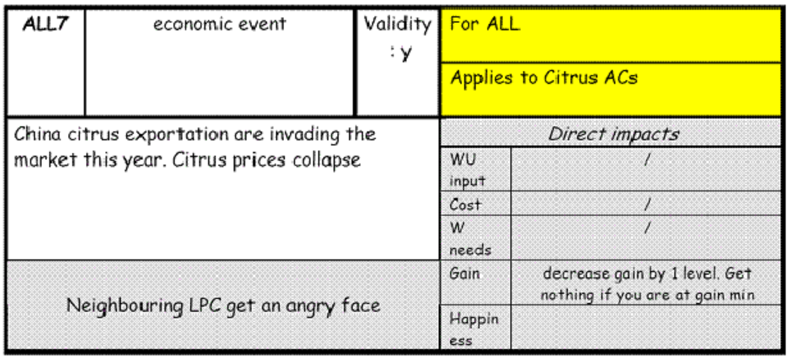

Figure 13 : an event card

Game settings

Playing the game requires a large room with a very large table where the basin model will be organized. Players will seat around the table, each close enough to her / his land plot card. Players should normally stay seated all the game long, except when they want (and are allowed) to discuss separately.

The game animator (cf. “Participants, players and roles”) will circulate around the table to distribute the water tokens.

Participants, players and roles

Categories of roles in the game design, setting, play and evaluation are:

- **Game manager GM** : proposes the game to the policy maker, manages the whole process, coordinates all activities. Speaking local language is not mandatory if a game animator is provided. (S)he must be able to train all participants with the game.

- **Policy maker PM** : person in charge locally of designing specific policies or action plans and who wants to test them or trigger some change in the practices.
- **Local process manager LM** : person in charge locally of supporting the whole process, to organize the logistics, invite players, provide equipment and prepare the coffee.
- **Game animator GA** : will be in charge of animating the game session itself and facilitate the process with the players. Must speak local language and be used to the cultural and social habits. Must be trained.
- **Local expert LE** : the local expert is required to provide information about the local case (water basin) targeted by the game. (S)he must know the activities and have access to the relevant data to calibrate the game.
- **Players PL**: they can be of any kind. Access to the game is not restricted. They must be chosen according to the goal of the game session.
- **Observer OB**: they observe and evaluate the game to extract some additional results outside the direct impact on the players.

Some of these roles (GM+GA+OB, PM+LE…) can be shared by the same person. But ideally and for workload reasons they must be split. Most of the roles can be shared by different persons.

In the game itself, the possible roles are directly linked to the land plots cards which are used (small and large farms, cities, industries, mines, etc). Each card must have a player, although some cards can be played by the game animator. Outside land based roles, some roles can allocated to policy makers or regulators who then control some session parameters or the water distribution. Other roles can be invented according to the specific needs of a session.

Game process

ID	Step	Description	Participants	Requirements - Process
P1	Start	Start the process and establish the partnership.	GM → PM ?	GM has identified the need and can contact the PM. Can be also mediated by a LE or LPM.
P2	Select management group	Select the main actors of the process: choose LPM and GA.	GM, PM → LPM, GA ?	LPM should know the people locally. (S)He should be able to organize the whole process. The GA should be trained for the game and know the local habits for groups dynamics.
P3	Choose experts	Select the local expert(s) LE	PM, LPM, GM → LE ?	The LE is chosen to establish the fundamentals for the game and calibrate the session.
P4	Select case	Select the local case (zone, topics) represented and addressed in the game. Decide goal of the game.	PM + GM + LE → case ?	The case is decided either by the PM directly or by the LE if sampling is required.
P5	Select players	Players' categories are defined and the actual players are chosen in the available population.	LPM, GA, GM → PL ?	Players should be available, representative and accept to participate.
P6	Design basin	Design the game structure based on the basin structure.	GM, PM, LE, GA (PL) → game ?	Have the relevant cards for this basin. Assembly them. This can be done optionally with the players themselves.
P7	Collect data	Collect data for calibrating the game	LE, GM, GA → data ?	Data about the hydrology, the water use, the production functions, the ratio of activities.
P8	Calibrate hydrology	Decide input-output quantities, aquifer features.	LE, GM, GA → hydrology ?	
P9	Decide scenarios	Decide external scenarios including climate variability and other economic or political factors	LE, GM, GA → scenarios ?	Scenarios are chosen to trigger the main issues related to the game's goal. They can be "extremized".
P10	Allocate resources	Roles are allocated the various resources like soil, water and money	LE, GM, GA → resources ?	Some stress can / must be introduced according to the target scenarios.
P11	Organize session	The game's room is chosen. Players are invited. All material logistics is prepared.	LPM → room, logistics.?	
P12	Select observer	The game's observer is chosen.	GM → OB ?	The game observer can be an expert or anyone. Some support and methods must be provided.
P13	Check equipment	All the game equipment is prepared and checked.	GA, LPM → material ?	
I1	Prepare	The room is organized for the game. Table and	GA, LPM, OB	

	room	seats. Observation / recording equipment.	→ room ?	
I2	Set game	The game is installed on the table. Cards are distributed. Tokens prepared;	GA, LPM → game board ?	
I3	Welcome	Welcome players. Ice breaking. Round table.	GA → PL welcome.	
I4	Distribute roles	Roles are allocated to players. They are given the role cards.	GA → PL	
I5	Explain game	The game is explained to the players.	GA → PL	Players receive some basic rules. The process is explained on a board with a slideshow or equivalent.
I6	Distribute action cards	Action cards are distributed and explained.	GA → PL	
I7	Distribute money	Initial money is given to players	GA → PL	
I8	Fake round	A fake round is played to explain the whole process	GA → PL	GA shows the principle only for one player and for simplified settings.
(I9)	Decide indicators	(Optional) Players discuss to choose a set of goals based on the indicators	PL → goals?	The goal which is decided must be measurable with the existing set of indicators.
I10	Explain scenario	The overall global scenario is explained to the players	GA → PL	Some figures can be shown.
I11	Questions	Players can ask questions	PL → GA, LPM, LE	
		YEARLY		
Y1	Inform players	Some information about the yearly situation (projected climate, economy, etc) is given to players.	GA → PL	
Y2	Policy info	Inform players about the current policy, regulations, objectives. Messages can be passed.	PM, GA → PL	This could be based on a separate discussion by a group of PMs.
Y3	Events cards	Events' cards are distributed to the players.	GA → PL	
(Y4)	Group discussion	(Optional) Local players groups can discuss between themselves.	PL → PL	Can discuss water sharing, other resources, activities, problems, regulations…
Y5	Add actions	Players choose some new action cards, put them and pay if required.	PL → actions ?	
Y6	Pay fix cost	All players pay the fix cost related to their activities.	PL → bank	

PER PERIOD / ROUND / SEASON				
R1	Put water	The input water is provided	GA → input water	Based on the climate scenario, the GA introduces the amount of water required, at different input points.
R2	Inform water	The quantity of water available is communicated to everybody	GA → inform water	
R3	Distribute water	Following the network from up to down, water is given for the action cards	GA → water for action cards	All land plot cards at the same level are allocated at the same time for the current period (season). Water tokens are put on the action cards.
R4	Record water	On each action card, the quantity of water is written directly.	PL → record water	
R5	Get return flow	For each action card where water is allocated at input, the return flow is collected using “polluted” water tokens	GA → return flow	
R6	Iterate downstream	Repeat R3 for the next downstream land plot cards using the mix of fresh and return water.		
R7	Put money tokens	All players put the corresponding money on their cards.	PL → money	
R8	Visualize return flow	The final flow in the river or downstream the basin is shown to everybody, including pollution.	PL → final flow	
R9	Evaluate indicators	All indicators’ values are assessed and shown to the players.	GA, OB → indicators ?	
END of YEAR				
E1	Get money	All players collect the money they got during the year.	PL → money	
E2	Store cards	All action cards are cleared and kept aside for record.	PL → GA	
E3	Borrow money	Players can get loans from the bank.	Bank → PL	
E4	Debrieff	Debrieffing between all players and animator	GA+PL	Optional – Can start only after some years.
E5	Feedback	Information about yearly management is given by PM	PM → PL	According to Pm’s goal

Adaptations of the game

Wat-A-Game has been designed to be adaptable to various settings. We have tested four different implementations of the game: one pre-test in South-Africa, two tests in the south of France, and one validation session in South-Africa. In these different cases, various basin topologies, land plot cards and action cards have been tested and used. We have developed variations tuned to the needs and cases' features.

The scale has been changing from small or medium scale basins in the first tests, to large basins (500000 inhabitants) in the last.

In the first free cases, land plot cards were representing scaled activities, which results had to be extrapolated to the entire basin, whereas in the Inkomati case, the land plot cards represented the entire sector of this kind, for the whole basin.

Another key variation in the game is between cases where water flows from the top to the bottom of the basin, and cases where water is allocated to the LPCs as from direct rainfall.

In the last implementation, we dropped the polluted return water, but we included satisfaction indices ("smileys") and feeding capacity as a substitute to money.

In the initial versions, water was flown step by step in the river stripes whereas in the last only the stock of water was distributed to the different parts of the system, with a priority order.

Application in South-Africa

In South-Africa we have started developing a specific version devoted to the Sand River catchment. This development has been based on the previous assessments and interventions of the NGO AWARD in the same basin . An implementation has been adapted locally. The main settings are:

- The basin is very large which brought us to include an entire sector of activity in a single LPC
- Local rainfall is critical for water balance, hence represented directly and used for consumption
- Time step has been expanded to the year - not the season – as no decision is really taken under this horizon.
- The game has been organized around the key notions, included in the South-African National Water Act (1998), of human reserve, ecological reserve and strategic reserve. The objective is to manage water while respecting these constraints.
- A preliminary water allocation exercise is organized to establish the boundaries of management to be respected by the players.

Results of the validation test

We have organized a validation test with five players, all researchers. Results and feedbacks show that:

- Calibration has to be improved to allow for smoother initiation of the game
- Game has still to be simplified, maybe removing the satisfaction indices (smileys)
- Markets and exchanges among players have to be included to account for dependencies like provision of food by local producers

Figure 14 : Test of the Wat-A-Game Sand version

Follow-up in South-Africa

In the next months, sessions are planned with local stakeholders to finalize validation and adaptation of the game. At their end, we expect to organize sectorial games followed by a joint session. In these games we aim at exploring both river classification and water allocation, with players at different levels, from local communities to the catchment management agency.

Conclusion

We have presented the origins and the development of the Wat-A-Game / Amanzi game set. It has been designed to facilitate education, exploration and management of water systems. Its main features are adaptability and scalability. We have tested it four times and we start now an operational process which should bring it to an application for local water management in the Sand river catchment in South-Africa. Another application is planned soon for wet zone management.

We intend to finalize development and disseminate freely the game set before the end of 2009 after an educative session planned in Mozambique.

References

Bachta, M.S. and Bchir, M.A. (2008). Associations d'irrigants et bien club : cas d'étude de la plaine de Kairouan (Tunisie) In : IWRA. 13 ème congrès mondial de l'eau, Montpellier, 1-4 septembre 2008 . Montpellier : IWRA, 14 p. Congrès mondial de l'eau. 13, 2008-09-01/2008-09-04, Montpellier, France.

Barreteau, O., F. Bousquet, *et al.* (2001). "Role-playing games for opening the black box of multi-agent systems: method and lessons of its application to Senegal River Valley irrigated systems." Journal of Artificial Societies and Social Simulation [online] 4(2): \url{http://jasss.soc.surrey.ac.uk/4/2/5.html}.

Bousquet, F., O. Barreteau, *et al.* (1999). An environnemental modelling approach : the use of multi-agent simulations. Advances in environmental modelling. F. Blasco and A. Weill, Elsevier: 113-122.

Burton, M. A. (1989). "Experiences with Irrigation Management Game." Irrigation & Drainage Systems 3: 271-228.

Camargo, M.A., Jacobi, P.R., and Ducrot, R. (2007). Role-playing games for capacity building in water and land management: some Brazilian experiences, Simulation and Gaming, 34 (4): 472-493.

Carruthers, I. D. (1981). A role-playing game for training river basin planning. River basin planning: theory and practice. S. K. Saha and C. J. Barrow. Wiley: 265-283.

Cavailles, M., Commande, B., Deschamps, M., Dieng, B., Migairou, F. (2005) Développement, réalisation et test d'un jeu pédagogique sur la gestion intégrée de bassins versants. Rapport étude DIFED. Cemagref.

ComMod Group (2003). Our Companion Modelling Approach. Journal of Artificial Societies and Social Simulation 6 (1), http://jasss.soc.surrey.ac.uk/6/2/1.html

Daniell, K. (2008). Co-engineering participatory modelling processes for water planning and management. Phd dissertation. AgroParisTech & Australian National University.

Désolé M., Farolfi S., Patrone F., Rio P., Thoyer S., Tidball M. 2008. From experience to experiments in water management. In : IWRA. *13 ème congrès mondial de l'eau, Montpellier, 1-4 septembre 2008* . Montpellier : IWRA, 10 p. Congrès mondial de l'eau. 13, 2008-09-01/2008-09-04, Montpellier, France.

Dionnet, M. et al. (2006). Survey on past experiences and practices on the use of Role Playing Games in the field of water management. Report of the Aquastress Project, 35 p.

Duke, R. D. and J. L. A. Geurts (2004). Policy Games for Strategic Management. Amsterdam.

Farolfi S, Rowntree K (2007) "Accompanying local stakeholders in negotiation processes related to water allocation through simulation models and role-playing games: an experience from South Africa", Empowers Insights, 1 (2): 5-7.

Farolfi S., Gumede H., Rowntree K., Jones N.A. 2008. Local water governance in South Africa: To which extent participatory approches facilitate multi-stakeholder negotiations ? The Kat River Valley experience. In : IWRA. *13 ème congrès mondial de l'eau, Montpellier, 1-4 septembre 2008* . Montpellier : IWRA, 14 p. Congrès mondial de l'eau. 13, 2008-09-01/2008-09-04, Montpellier, France.

Ferrand, N., B. Nancarrow, *et al.* (2005). Simulation and role-playing games for social justice research. CABMHEMA- SMAGET, Bourg St-Maurice, France.

Friedman, D. and S. Sunder (1994). Experimental methods, a primer for economists. Cambridge.

Hare, M., N. Gilbert, *et al.* (2001). The development of an internet forum for long-term participatory group learning about problems and solutions to sustainable urban water supply management. Zürich, Online Mediation Workshop, ETH: 8.

IHMC (2007). CMapTools, knowledge modeling kit. Institute for Human and Machine Cognition. http://cmap.ihmc.us

Lankford, B. A. and C. Sokile (2003). Reflections on the river basin game: Role-playing facilitation of surface water allocation in contested environments. ICID European Regional Conference "Consensus to resolve irrigation and water use conflicts in the Euromediterranean Region", Montpellier, France.

Le Bars, M., P. Le Grusse, *et al.* (2004). NECC: un jeu de simulation pour l'aide à la décision collective. Application à une région méditerranéenne "virtuelle". Acte du Séminaire Modernisation de l'Agriculture Irriguée, Rabat.

Steenhuis, T., R. Oaks, *et al.* (1989). "Irrigation Rehab: A computer aided learning tool for system rehabilitation." Irrigation & Drainage Systems 3: 241-253.