The French Agricultural Research Centre for International Development

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DEVELOPING AND PLAYING A ROLE-PLAYING GAME IN THE KAT RIVER VALLEY: KATAWARE. REFLEXIONS ON THE PROCESS

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A STAKEHOLDER DRIVEN PROCESS TO DEVELOP A CATCHMENT MANAGEMENT PLAN FOR THE KAT RIVER VALLEY

WRC Project no. K5/1496

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A USER'S GUIDE FOR THE KATAWARE ROLE-PLAYING GAME

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Terminology and Acronyms

CGT	Cooperative Game Theory
CMP	Catchment Management Plan
ComMod	Companion Modelling
DWAF	Department of Water Affairs and Forestry
IS	Insurance of Supply
KatAWARE	The Multi-Agent model developed in the Kat River Catchment
LS	Lower Sub-Catchment
MS	Middle Sub-Catchment
RPG	Role-Playing Game
US	Upper Sub-Catchment
WRC	Water Research Commission
WUA	Water User Association

PREFACE

Within the Water Research Commission (WRC) project: "A stakeholder driven process to develop a catchment management plan for the Kat River Valley", the Companion Modeling (ComMod) approach (Barreteau et al, 2003) was adopted to help the local Water Users Association (WUA) in the task of defining a Catchment Management Plan (CMP) for the Kat River Valley.

Two platforms, a multi-agent model named KatAWARE (Farolfi and Bonté, 2005; 2006) and a Role-Playing Game (Farolfi, 2006), were constructed in conjunction with local stakeholders through the ComMod approach.

This document reports on the use of the Role-Playing Game (RPG) KatAWARE developed through the ComMod process. *It must be underlined that this report does not provide guidelines on how to play the KatAWARE RPG, as this information is contained in Farolfi (2006). Rather, more general considerations on the opportunity to use a RPG within the studied context and more in general the importance of RPG in participatory research and Companion Modelling projects is discussed.* T he following chapters refer to the Kat River ComMod experience; nevertheless some lessons learned during the described case study could be generalized to other possible applications in South Africa or elsewhere.

The document is organized as follows: Chapter one recaps quickly the main characteristics of the KatAWARE RPG in its two versions; Chapter two illustrates the outcomes of the second session of the RPG played with the Kat River WUA in March 2006; whilst chapter three concludes and provides recommendations. The appendix provides some technical information on how to install and operate the KatAWARE model that backs the RPG.

1. THE DEVELOPMENT OF THE KATAWARE RPG

As indicated in Figure 1, the two versions of the KatAWARE RPG were developed within the ComMod process in the Kat River Valley following the construction and discussion of the KAtAWARE multi-agent model version 1 (Farolfi and Bonte, 2006). The information gathered through playing the game enabled the development of a second version of the model (V2). Two sessions of the RPG were played with the Kat River WUA, the first in November 2005 and the second in March 2006.

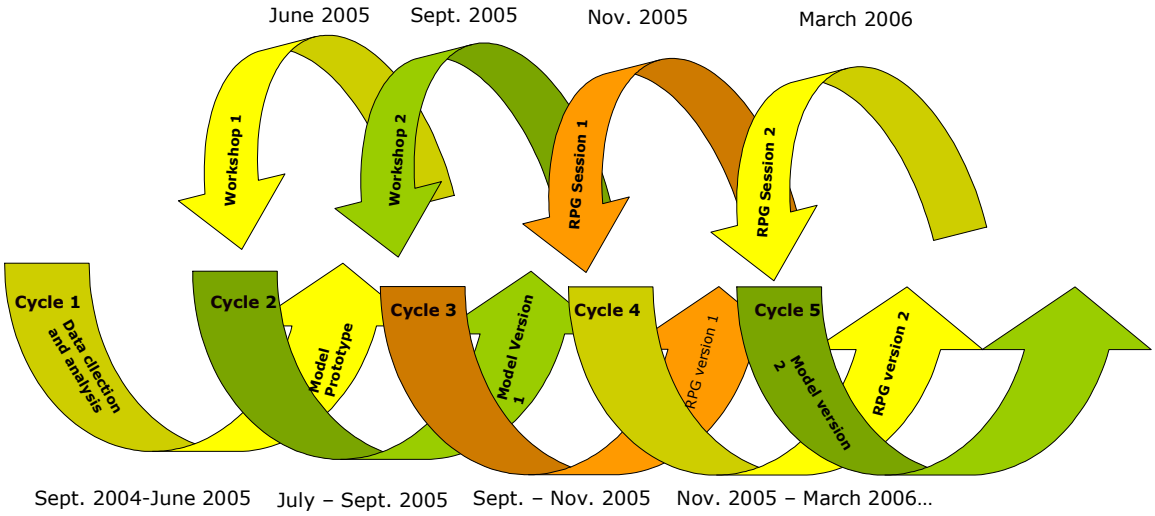

Figure 1 ComMod cycles in the development of KatAWARE with the Kat River WUA

The characteristics of the version 1 of the RPG are thoroughly described in Farolfi (2006). Some changes were introduced in the second version of the game after the first session was played. These changes were either suggested by the players or introduced by the researchers in view of the experience of session 1.

The main new features of version 2 are:

- Water availability lower than in the previous session (< rainfall);
- Costs for domestic water provision are higher than in the previous session;
- Some information is available on request for players on rainfall series and market prices;

- Users are represented in the WUA by one representative per sector (the chairman is also representing a sector) = WUA composed by 3 committee members;
- WUA sessions were held in English for one year and in Xhosa the following year: translation was provided;
- Water demand from different sectors was calibrated closer to reality;
- One village (village 2) was withdrawn from the set up of session 2;
- A Department of Water Affairs and Forestry (DWAF) representative participated to the RPG playing his own role.

2. OUTCOMES FROM RPG SESSION 2 AND THEIR RELAVANCE TO THE COMMOD PROCESS

This chapter reports on the outcomes of the second session of the RPG KatAWARE that took place in Fort Beaufort in March 2006. The outcomes from the first session are described in Farolfi (2006).

The session was attended by all WUA members (most of them participating also in the first session), a DWAF representative, and a representative of the Nkonkobe Municipality. The Research Team from Rhodes University and the Cirad modellers facilitated the session.

2.1 RPG Outcomes from Session 2

Table 1 shows the initial and final values of the exogenous factors controlled by the game operators. Rainfall values in session 2 start off (year 1) lower then previously occurred in the first session of the game. In this way the game facilitators introduced a general trend of increasing water scarcity through a reduced rainfall. Very marginal changes affected crop prices in session 2. As in session 1, a relatively low level of uncertainty was introduced in the session, corresponding to a small difference between expected (forecasted) and actual exogenous factors to which stakeholders were confronted.

	Initial	Final	Difference %	Average
Rainfall Upper (m3)	1,700,000	600,000	-65	1,150,000
Rainfall Middle (m3)	850,000	250,000	-71	550,000
Rainfall Lower (m3)	850,000	250,000	-71	550,000
Population Upper (hab.)	5,000	5,000	0	5,000
Population Middle (hab.)	0	0	0	0
Population Lower (hab.)	5,000	6,000	20	5,500
Market Price Citrus (R/ton)	2,000	2,000	0	2,000
Market Price Cabbage (R/bag)	6.00	6.00	0	6

Table 1 Exogenous factors in the RPD session 2: initial and final values

Water demand in the three sub-catchments increases at year 3, but then players put in place strategies for regulation of water demand (control of irrigated surfaces, less cycles of cabbage), resulting in a lower water demand, particularly at year 6[1]. Tables 2 and 3 synthesise players' individual behaviour and strategies all along the session. In the upper sub-catchment (US) the two irrigation schemes opted for two different strategies: irrigation scheme 1 intensified its cabbage productions (from 2 to 3 cycles per year), whereas irrigation scheme 2 reduced it (apart from year 5). The two irrigation schemes were very sensitive to water availability in the catchment and were willing to reduce their surfaces and water demand if the WUA indicated a water shortage in the catchment. This is why they reduce by 50 their surfaces and the number of cycles at year 6.

In the middle sub-catchment (MS), the two citrus farmers adopted this time to take a similar strategy oriented towards a progressive substitution of citrus old technology with citrus new technology. A slight reduction of the total citrus surface was observed in the two farms, where conversely some cabbage was introduced to produce cash every year and cover investment costs for citrus new plantations. In the lower sub-catchment (LS), the large citrus farm adopted a strategy oriented towards a stiff reduction of citrus surfaces, only in the first three years compensated by some cabbage production.

All new citrus planters in the three farms were equipped with innovative irrigation technologies, consisting in drip systems, more costly in terms of investment, but water saving.

Table 3 shows the dynamics in the village managers' decisions regarding water services and tariffs for their households. As a general trend, better water provision was introduced in all villages, and this was accompanied in village 1 by an increase of water tariffs to be paid by local households. Nevertheless, the higher costs for domestic water provision introduced in this version of the RPG prevented village managers from investing

[1] It is worthwhile noticing that the lower water consumption in the catchment at the end of session 2 was due to a commonly decided reduction of irrigated surfaces, whereas in session 1 it was provoked by the sudden decision by the WUA of stopping releases from the dam.

massively as happened during session 1. This resulted in low increases or even decreases in the satisfaction indexes. The higher costs for water provision put the village managers in front of a clear trade-off between residents' satisfaction on one side and manager's profit on the other. The manager of village 1 increased water tariff finding a fair equilibrium, whilst the manager of village 3, not increasing water tariffs, struggled the whole session with their budget. Village 1 opted also for a de-investment at a certain stage in order to reduce the costs for water provision.

As in session 1, the WUA gave priority to the domestic uses of water, not hampering any initiative of water provision improvement by the local managers. Priority was given, by the WUA, to an ecological Reserve of 500,000 cubic meters/year in years of drought and 750,000 in normal years. Agricultural uses were more controlled and during this session it was clear that the WUA had an influence on the choice of farmers' strategies and consequently on the irrigate surfaces, particularly during the last years of game.

	Initial	Final	Difference %	Annual average
Irrigation scheme 1 (US)				
Ha citrus old technology	0	0	0.0	_
Ha citrus new technology	0	0	0.0	_
Ha cabbage	20	10	-50.0	_
Cycles cabbage	2	1	-50.0	_
Tot Ha	20	10	-50.0	_
Employment (n)	51	12.7	-75.1	49
Cumulated Profit (ZAR)	64,208	397,000	518.3	66,300*
Irrigation Scheme 2 (US)				
Ha citrus old technology	0	0	0.0	_
Ha citrus new technology	0	0	0.0	_
Ha cabbage	20	10	-50.0	_
Cycles cabbage	2	1	-50.0	_
Tot Ha	20	10	-50.0	_
Employment (n)	51	12.7	-75.1	30
Cumulated Profit (ZAR)	64,208	254,000	295.6	42,270
Citrus Farm 1 (MS)				
Ha citrus old technology	30	0	-100.0	_
Ha citrus new technology	0	25	_	_
Ha cabbage	0	5	_	_
Cycles cabbage	0	1	_	_
Tot Ha	30	30	0.0	_
Employment (n)	46	44.2	-3.9	65
Cumulated Profit (ZAR)	829,300	3,360,000	305.2	561,000
Citrus Farm 2 (MS)				
Ha citrus old technology	30	0	-100.0	_
Ha citrus new technology	0	20	_	_
Ha cabbage	0	10	_	_
Cycles cabbage	0	2	_	_
Tot Ha	30	30	0.0	_
Employment (n)	46	63	37.0	73
Cumulated Profit (ZAR)	829,300	3,340,000	302.7	556,500
Citrus Farm 3 (LS)				
Ha citrus old technology	40	0	-100.0	_
Ha citrus new technology	0	10	_	_
Ha cabbage	0	0	0.0	_
Cycles cabbage	0	0	0.0	_
Tot Ha	40	10	-75.0	_
Employment (n)	62	17	-72.6	71.2
Cumulated Profit (ZAR)	1,105,700	3,540,000	220.2	591,400

* Annual profit is the net financial result of a specific year. It is not cumulated.

Table 2 **Strategies and outcomes for the five farms during the RPG session 2: initial and final values.**

	Initial	Final	Difference %	Annual average
Village 1 (US)				
Population (hab.)	5,000	5,000	0.0	_
% river	0.8	0.7	-10.0	_
% collective tap	0.2	0.2	0.0	_
% indwelling tap	0.0	0.1	10.0	_
Water tariff (ZAR/m3)	1	2.15	115.0	1.91
Satisfaction index	40.6	40.3	-0.6	40.5
Manager's cum. Profit (ZAR)	27,180	161,700	494.9	26,950*
Village 3 (LS)				
Population (hab.)	5,000	6,000	20.0	_
% river	0.1	0	-10.0	_
% collective tap	0.4	0.3	-10.0	_
% indwelling tap	0.5	0.7	20.0	_
Water tariff (ZAR/m3)	2.5	2.5	0.0	2.33
Satisfaction index	41.2	41.57	1.0	41.74
Manager's cum. Profit (ZAR)	11,000	-334,200	-3,138.2	-55,960

* Annual profit is the net financial result of a specific year. It is not cumulated.

Table 3 **Strategies and outcomes for the three villages during the RPG session 2: initial and final values.**

Job creation was positive for farms in the MS and negative for all the other. This is a direct consequence of the strategy adopted by the farmers in this region. In fact, the two irrigation schemes and the large-scale citrus farm of the LS opted for a reduction of irrigated surfaces during the last years of game.

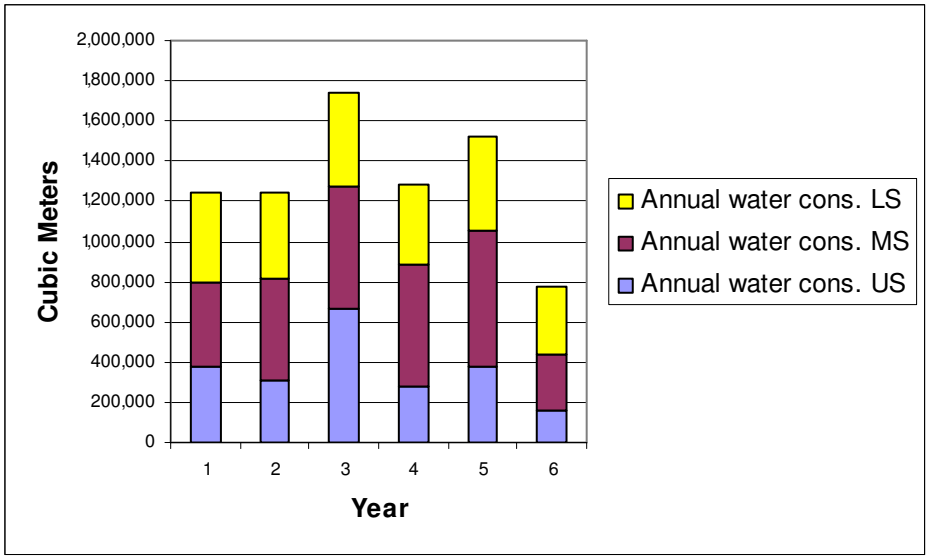

Figure 2 **Water consumption in the three sub-catchments in session 2.**

Figure 2 shows the dynamics of water consumption in the three sub-catchments over the game time frame. At years 1 and 2 the three sub-catchments consume approximately the same amount of water then, at year three, when an increase in US consumption occurs

due to the intensification of cabbage production followed by a progressive decrease in the following years. The reduction in irrigation water consumption in the LS is compensated by the increase of domestic uses (higher population + better water provision). In the MS a clear reduction of water consumption, due to the farmers' strategies, is observable in year 6.

Figure 3 indicates the water level in the Dam. The WUA opted for a use of the water in the Dam to satisfy users' water demand and to provide water flow in the river to preserve ecological requirements (the ecological Reserve). The WUA and DWAF set a limit threshold of 500 000m^3 (12.5% of the total storage capacity) as the minimum amount of water to be present in the dam every year. Below this level, no more water releases for uses other than domestic would be allowed. The limit was respected for the whole duration of the game (555 000m^3 at year 6).

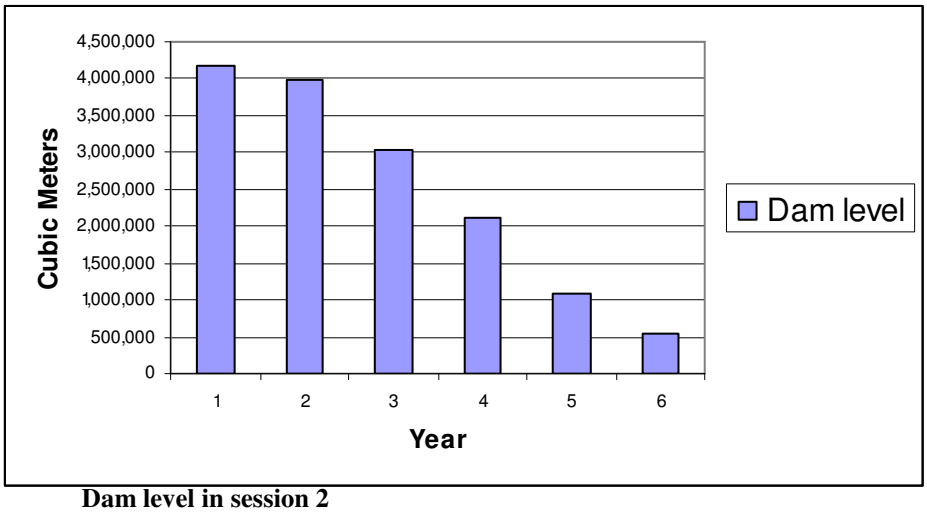

Figure 3 **Dam level in session 2**

Figures 4 and 5 show the impact of water use and management on profit and employment in the three sub-catchments.

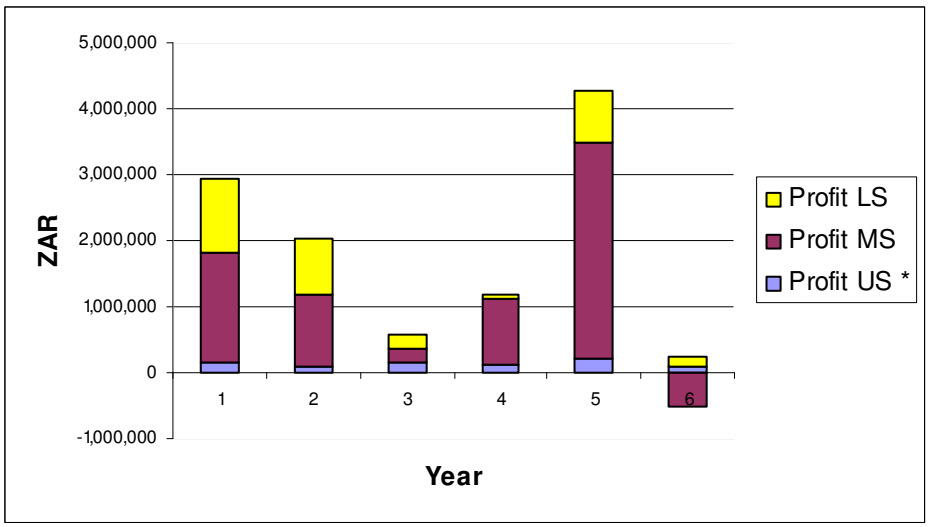

Figure 4 **Profit generation in the three sub-catchments in session 2**

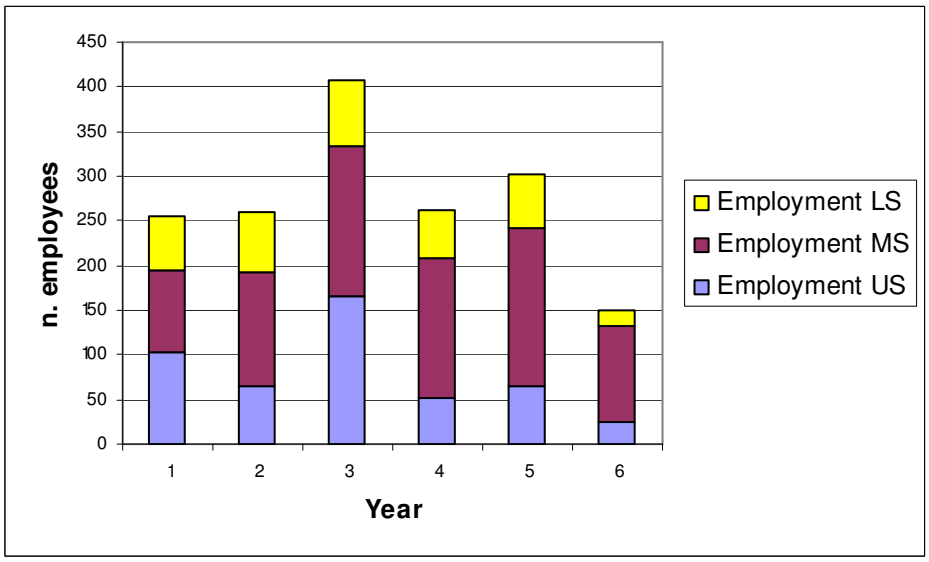

Figure 5 **Job creation in the three sub-catchments in session 2**

Job creation is directly linked to the surfaces cropped and to the intensity of production (cycles of cabbages on the same surface); it therefore, follows the dynamics of water consumption. Profit is more sensitive to water availability and farmers' and village managers' strategies. In session 2 the distribution of profits overtime is more regular than in session 1. Better water management at the WUA level implies that year 6 only had a negative profit in the MS[2]; this is due to the new investments in citrus made during

[2] But largely compensated by the high profits during the previous years.

this period. The US and LS have positive, though limited, profits in year 6 unlike in session 1.

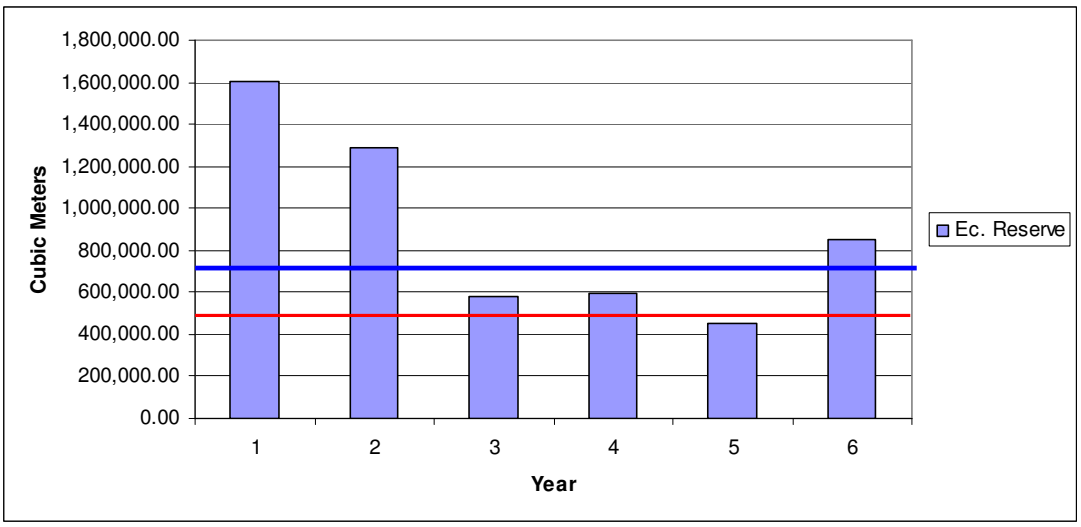

Figure 6 Water flowing out of the catchment annually in session 2

It is worthwhile noticing, finally, that better water management during the whole of session 2 had a positive effect on the ecological Reserve. Figure 6 shows that the 500 000m^3 set as the annual amount of water that must flow downstream in dry years is always respected (apart from a small deficit in year 5).

2.2 Observable differences in the two RPG Sessions

A comparison of the two RPG session results facilitates the generation of several conclusions, and for the interpretation elements relative to the individual and global strategies of players.

The main differences observed in session 2 with respect to session 1 can be listed as follows:

- A lower water availability;
- A higher global cumulated profit;
- A higher cumulated profit for each farmer;

- Higher difficulties for village managers in coping with profits and residents' satisfaction due to increased costs for water provision;
- A higher use of water from the dam, but in respect to the defined minimum amount of water which must remain in the dam;
- A better respect of the ecological Reserve.

These observations lead to the following conclusions:

- The WUA had more influence this time on the individual strategies. A process of arbitration took place at each WUA meeting and, if needed, it resulted in a reduction of irrigated surfaces and therefore, a lower water demand from agriculture;
- No long-term planning was observed in the WUA decision-making process: decisions were taken year by year;
- Long term planning was clearly observed in the individual strategies of large-scale farmers. No planning was observed in village managers' and smallholders' strategies.
- A clear objective of profit maximization was observed in all players and all players played for 'real' (as a result, in session 2 the total cumulated profit from agriculture was +49% than in session 1).
- Apprenticeship (from session 1) was observed in the way players played: a typical example is the way large-scale farmers managed citrus re-planting, covering some surfaces in cabbage to generate available annual cash to cover investment costs.
- A real DWAF representative playing his role resulted in enforcement of DWAF control relative to set standards i.e. the Reserve and the minimum amount of water in the dam).
- Irrigators (large and small scale) were willing to reduce their surfaces if the WUA warned for water scarcity, but always kept an eye at their personal benefits (almost never negative on an annual basis and globally much better that in session 1 on a cumulated basis).

- Water from the dam was used in an efficient way (no fear in reducing the level of the dam) but respecting the limits.

2.3 Individual and WUA observed behaviours

From observing the outcomes of the two RPG sessions, the following elements were introduced in the methods of the KatAWARE model V2 to represent agents' behaviours.

Smallholding irrigation schemes:

- Profit maximization (> surface; >cycles), but when water is scarce, willingness to reduce surfaces and cycles of cabbage;
- No interest in citrus production;
- No long-term planning; decisions year by year.

Large-scale farmers:

- Profit maximization (>surfaces) but when water is scarce, willingness to reduce surfaces;
- New technologies of irrigation (water saving);
- Interest in planting annual crops (cabbage);
- Long-term planning

Village managers:

- Profit maximization (>tariffs) but interest in increasing the satisfaction of residents;
- Better water provision (>indwelling; >collective) but in function of costs.

WUA:

- Definition and respect of standards for ecological Reserve and water in the dam;
- Efficient use of water from the dam if this implies an improvement of socio-economic conditions of the catchment;

- No long-term planning (more year after year) => it has to change into a catchment plan (5 years);
- Has the power of influencing individual strategies (reduction of irrigated surfaces) -> introduction of a licensing system?

3. CONCLUSIONS AND RECOMMENDATIONS ON THE USE OF THE KATAWARE RPG

This report focused on the use of a Role-Playing Game (RPG) called KatAWARE within a project aimed at facilitating discussions and the negotiations amongst the Kat River WUA members in order to develop a CMP for the area.

After having recapped briefly the main steps of the development of the model, the adoption of the version 2 of the RPG during a game session with the WUA was presented and discussed.

Some considerations can be drawn from this experience in terms of "lessons" and "perspectives" on the use of the RPG in a context of negotiation-support and participatory methods to capacitate the recently-created WUA in setting-up their water allocation strategies.

1) The RPG was adopted to support the development of the KatAWARE multi-agent model within a Companion Modelling process. The RPG proved useful for the stakeholders, who reached a much deeper knowledge about the multi-agent model from which the RPG derives. As indicated in Fox (2005 and 2006) all stakeholders involved in the two RPG sessions indicated that they enjoyed playing and had the impression of move from a "passive" into an "active" phase of the project. They started discussing among themselves about water allocation strategies and initiated a real process of common decision-making around water management. Figure 7 presents a diagramatic representation of the ComMod process in the Kat over the three main cycles. Through the implementation of the RPG sessions, the process moves from a phase of 'understanding' into one of 'exploring', which prepares it and its participants for the more operational activity of 'applying' and from this construct the Catchment Management Plan.

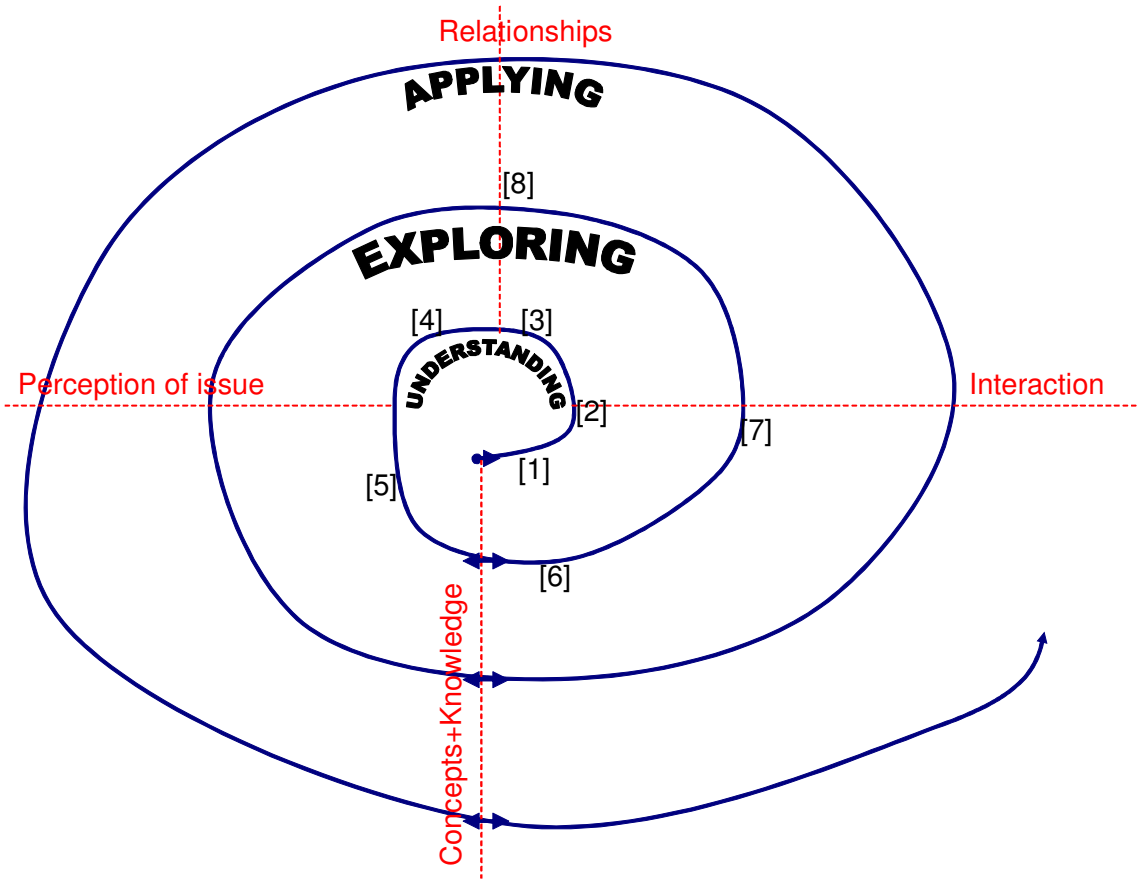

Figure 7 Action research and learning loops in the ComMod process in the Kat. Numbers between brackets indicate the processes main phases, [6] and [7[are the two RPG sessions.

2) At the same time, the RPG was instrumental for the researchers in order to improve the model (version 2 – not yet implemented). The information and observations obtained during the two RPG sessions was used to conceptualise a new version of the multi-agent model for adoption in the next phases of the project. Unfortunately, software problems prevented the construction and implementation of a V2 of the model, however, the observed behaviours and trends during the RPG sessions still allowed researchers to propose realistic scenarios to be built through the KatAWARE model V1 and discussed with the WUA in a follow up workshop.

3) It was clear that in the Kat the RPG was crucial for the development of the ComMod process (Fox, 2005; 2006). Without the RPG sessions, most stakeholders would have 'given-up', not being able to follow the modelling component of the process. This fact raises questions about participatory modelling projects in the South African water sector: can they be implemented without intermediate artefacts, such as RPG, that capacitate local stakeholders in their ability of following and become active members of the process? RPGs, when associated with models, imply long and costly sequences of activities. The cost of these exercises must be carefully compared with the benefits of the outcomes.

4) The RPG, once constructed, can be used for pedagogic purposes. For instance, a simplified version of the KatAWARE RPG is adopted to train students at the University of Pretoria.

5) Questions remain open about the possibility to use the RPG for negotiation purposes in other catchments without adapting it to the new reality. Only experience will provide an answers.

6) The RPG can be used for laboratory experiments. A project is underway at the University of Pretoria which looks at comparing negotiation results (from the RPG) with virtual equilibriums calculated by a Cooperative Game Theory (CGT) model calibrated on the same reality as the Kat River. A first comparison has already been made between a CGT model and the first session of the KatAWARE RPG in the Kat (Dinar et al, 2006). Further experiments adopting simplified versions of the RPG will be conducted with local stakeholders and with candid players such as university students to explore more in-depth similarities/differences between real and virtual negotiation in different contexts.

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Appendix

Installing KatAWARE RPG and downloading/installing Stella (demo version)

The RPG KatAWARE (Farolfi, 2006) is backed by a model developed in HPS Stella ©. A free Demo version of Stella © is downloadable at the web site: http://www.iseesystems.com/community/downloads/STELLA/STELLADemo.aspx

After having installed on your computer the Stella Demo Software, copy on your computer the folder called KatAWARE MARCH 2006 available in the CD.

Then open it and click on "Full Model". The user's interface of the KatAWARE model that supports the RPG will then appear on your screen.

For further help an Email can be sent to: Stefano.farolfi@up.ac.za