Role-Playing Games and Agent-Based Models in Lower Amudarya

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NeWater

ROLE-PLAYING GAMES AND AGENT-BASED MODELS IN LOWER AMUDARYA

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1 Overviews of the objectives and of the activities settings and outputs

Cemagref is participating in Newater WP3 & WP2.5 by providing modelling support for the Uzbekistan test case. This work has been carried on in collaboration with the coordinator of Uzbekistan case study Maja Schlueter, from UFZ, and Neela Matin, from York University. The idea was to use a companion modelling approach both to gain understanding on Water User Associations (WUAs) ability to cope with water stress and to set up a collaborative working context in these WUAs in Khorezm (irrigation) and Karakalpakstan (fishing).

1.1 Role-playing games

The fist step of this intervention was to design 2 role-playing games (RPG), one for farming and one for fishing, based on conceptual models issued from interviews and expertise. These 2 RPG were meant to: 1a) feedback, through the underlying conceptual model, researchers' understanding to stakeholders 1b) bring insights (on stakeholders practices and collective rules) to the model, underline and discuss knowledge gaps; 2) stimulate interactions and discussions between and with stakeholders; 3) generate some input to the following activities of the workshops; 4) serve as a test bench on the use of RPG and companion modelling approaches in Uzbekistan.

1.1.1 Design and implementation

First step was to select focus issues on irrigation and fishing WUAs, and then to gather knowledge and hypotheses on these issues through reading and discussions within the internal team (MS + NM + GA). This resulted in a first draft conceptual model. This model was used as a baseline for discussions with uzbek NeWater partners in Tachkent in November 2007. From this discussion more knowledge and hypotheses were gathered. Then, the process of choosing the elements and the hypothesis of the RPG conceptual model according to the most pressing issue was conducted during a 3 days internal workshop. The final refinement of the RPG conceptual model and rules was done shortly before the gaming sessions in Tachkent, by presenting the RPG to the uzbek partners.

These RPG were played 2 times each during the first week of April 2008, with 2 communities of farmers and 2 communities of fishermen. They were the opening part of the community restitution workshops of N. Matin's community based research in WP2.4. As a consequence, the participants had all been implied in N. Matin social study and were recruited by local relays. This series of joint workshops in local communities was organized so that: 1) RPG can be experimented in the morning and motivate participants discussions through a different way of interacting 2) N. Matin findings can be feedback and hold focus groups on options and strategies can be held in the afternoon. Women are growing crops (in tomorkas) but they are not fishing at all. So they did take part in farmers game, but not in fishers game (see list of participants in Appendix 10).

Informal interviews with some of the participants of the game could be held 1 month after, focusing on "awkward" outputs of the game, what was learned from the game, relation of the game to reality, and possible use of the game in real decision-making process.

1.1.2 Outputs

The main constraint on the implementation of these RPG sessions was time shortage, both in the preparation of the sessions, including training of the facilitators, and during the sessions. This lead to strong weaknesses in the experimental protocol, resulting in poor observation data and poor reframing from debriefing discussions. However the RPG sessions were successful in terms of stakeholders participation and satisfaction and they are an encouraging experiment for more thorough use of companion modelling in Uzbekistan.

1.1.2.1 Informational outputs

For the irrigation WUAs, an interesting output of the farmers RPG is that the 4 groups displayed several differentiated management styles corresponding to different levels of collective control and authority, from very centralised management to a completely chaotic one with no kind of control through a "self-organised" one with management emerging from collective control. And supposingf participants were exhibiting "best practices", we could observe behaviours attached to a range of institutional settings, from formal official one (the rules from the manuals) to very informal ones (bribing).

For the fishermen WUAs, the game just made it obvious that the water inflow in lakes in so scarce and so irregular that fishermen use lakes de facto as open access resources. It also showed that there is no solidarity between fishermen on the fish resource which is logical when main incomes come from other activities. Finally it raised questioned about the reasons why fishermen would work for lake owners instead of poaching.

Several other scarce pieces of knowledge emerged from the RPG sessions. They are detailed thereafter. The RPG design, implementation and discussions were definitely a very good "alibi" for having uzbek scientists, managers and participants talking about knowledge gaps and inconsistencies we western scientists had on the system. So they prove very useful to build an externalized knowledge of the system.

Uzbek scientist feedback is that they did not get new information from the sessions. Otherwise, those who knew the participants acknowleged getting new insights on participants personalities and relationships.

Participants may not have been able to get new knowledge neither. They could experiment mid-term issues but everybody is doubting their means and skills to do some accouting. However the game sessions and the few debriefings that could be done 1 month later were resented as a good media to talk and express pressing issues and fight falsehoods.

1.1.2.2 Procedural outputs

In terms of methodological outputs, the positive points are that :

- participants enjoyed and exchanged a lot, between each other and with the uzbek research team. Farmers acknowledged the potential benefit of increasing interactions and discussions with each other. Managers playing farmers acknowledged having learned from getting the perspective of a farmer role.
- participants could easily play the game and make parallels with their reality
- the RPG experiment was still very vivid in participant memories 1 month after.

However it is very difficult to make more hypotheses on the appropriateness of the method in the uzbek context because :

- there was no time and no understanding for the debriefings, because of language issues combined with the poor training of the uzbek moderators and the poor knowledge of uzbek context of the RPG specialist. This means that no reframing and no critical feedback has been achieved from the game sessions with the players. The absence of reframing in particular is problematic because in RPG, most often people might not display the strategies and behaviors they have in reality, but those they would like to have, or those they think are "good" strategies and behaviors. So in the farmers' game, there was a very low level of conflict, and in the fishermen's game, there was no poaching. Bribing – towards each other and towards facilitators - however has been used by participants in all sessions. Does it mean that bribing is considered as a standard practice by everybody? These interrogations show how it is very important to be able to allow enough time during a debriefing to come back on what happen during the game and why. Another consequence of this lack of time and preparation is that no link could be made between the RPG activities in the morning and the strategic choice activities in the afternoon.
- Issues raised by the games were not completely relevant for the players. In the case of the fisher's game, the issue of water management is highly impacting the livelihood of participants, but it is completely out of their possible levels of control. In the case of the farmer's game, it seems that people do not consider that much agricultural water management as an issue. From Neela's Matin livelihoods work, water appears only as the 5th important constraint on farmers and fishermen decisions, after knowledge, financial resource, production means, and markets, but before institutional.
- This leads to a 3rd limit of a possible critical assessment of the methodology which is that companion modelling RPG should be built through an iterative process with regular critical feedbacks of

stakeholders so that addressed issues are relevant. And then a RPG session should lead to new investigations and interactions with the stakeholders.

To be able to make a proper assessment of the methodology it would be necessary to be able to conduct a proper companion modelling cycle, allowing enough time to conduct fieldwork and proper training of the facilitation team.

In particular it would be good to be able to question the evolutions of our posture and of the posture of the uzbek researchers. Care should be taken concerning the uses and objectives that could be made of the RPG tool considering we had a lot of feedback from uzbek people of type "it is a good tool to have people understand that they should..". In 2 of the 4 game sessions, the game was interrupted by the hakim or hakimiat people. In Elikhala it seems that the Hakim just did want to show up, but in Muynak, the hakimiat person asked to the fishermen to get quiet and behave and pushed them to lunch right after the game, leaving no chance for debriefing. However when interviewed 1 month after, 1 deputy hakim asserted the activity would be good for joint measures crafting. This testifies how difficult it would be to build trust and to take all the precautions concerning the difficult uzbek political context, notably in terms of not raising hopeless expectations from participants, and not harming them by revealing their strategies or making them some problems with officials.

How is it possible to work in a context where stakeholders have a very low level of control on resource availability? There is a crucial issue of choosing and appropriate scale and issue, where participants have an acceptable level of control on the resource, while the questioning of the control of the resource at this scale is politically acceptable.

1.2 Short- term perspective: Agent-Based Model

Then a second step of the intervention was to design a new refined conceptual model of irrigation WUAs and implement in an ABM. This ABM is focusing on water allocation and distribution in WUA with a yearly time step (distribution should be taken in the sense of allocation implementation, not in the sense of scheduling). The objective of this model is to question different possible management rules and their possible enforcement levels. It is using both field and literature results on formal and informal institutions rules that may impact on Central Asia WUAs functioning. It is now in an early implementation stage and need further testing and development to deliver some results.

For obvious reasons of available time, the problematic around fishing WUAs institutions has been put aside for the moment.

2 Role-playing games

The principle of RPG is to have stakeholders acting in an abstract and stylized situation that would raise some issues that are similar to theirs concerning water scarcity and WUAs. So the game is a way to feedback some knowledge and is expected, from a well prepared debriefing, to bring more information on farmers and WUAs practices and to initiate discussion on possible forms of WUA management.

Concretely, RPG are interactive simulations of the uses and dynamics of a resource within a community. In a RPG session, each participant is playing the role of a user or manager of the resource. The resource is represented through artefacts (pebbles, papers…) that can be distributed over a schematic representation of the territory. A game session is divided in several rounds. At each round, the participants must use or manage the resource, and the resource dynamics evolves consequently to their actions and to climatic constraints, following abacuses or a computer model. Settings and rules of a RPG consist in a simplified version of the socio-ecological system surrounding the resource.

RPG focus on action, coordination, interaction, not on technical aspects.

2.1 Fishermen game – Balikshinar Oyeni

2.1.1 Issues and context

Very few was known about management rules and organisation of fishermen and lake owners. Knowing that, we were curious to learn more about fishermen hiring practices, and also what kind of collective management of lakes fishermen and lake owners could perform at their level.

The game focus on fish catches organisation and sharing: between lake owners and fishermen through the negotiation of contracts; and between fishermen through the constraint of fishing by teams.

Because we wanted to work on common pool resources, we abandoned the idea of focusing on livelihoods with a game where fishermen get a time budget to share between fishing and other activities at the different crucial periods of the year. In such a game the nets and the interactions with lake owner would be a useless level of detail.

2.1.2 Game global description

In the fishermen game, fishermen have to team up to catch fishes and make a living, and lake owners have to contract fishermen to get a share of their catches and pay their lease.

Fishing is done by drawing beds in a bag representing a lake zone. Each draw represents a catch and different colour beads represent different catch sizes. There are 2 kinds of nets: big nets allow more catches but need more people in a team; small nets allow less catches but need only 2 people in a team.

At the beginning of each round, fishermen have to team up and negotiate a contract with a lake owner. It is also possible for a fisherman to choose not to fish but get a minimum livelihood from an external activity.

Fishing teams can choose not to get a contract and poach but they risk being caught by NPA and pay a fine.

When everybody has fished, catches have to be shared between the teams and the lake owners, and then between the members of a team.

More details can be found in appendix 1

2.1.3 Underlying conceptual model

The underlying ecological model is a simple logistic equation.

The calibration was done considering broad proportionality between mean fishermen incomes and nets prices so that in mean year everybody should be able to make a living. For the ecological model it is necessary to tune a catch probability parameter to set up the proportion between the 2 types of beads. More details can be found in appendix 2

2.1.4 Game sessions progress and result

In each session, there was about 12 participants. In the first session there was 2 managers but they played fishermen. In the first session the participants were mainly elders who are poaching in real life. The way game was presented is detailed in appendix 3.

In the second session, there was more diversity. The second session was very lively but was interrupted by hakimiat people before it was possible to do a debriefing. Then most of the outputs come from debriefings with moderators and observators, not from debriefing with participants.

A prominent characteristic was that fishermen did not exhibit any kind of collective management of the lakes or sharing of the fishes. This is the case in reality were lakes poor ecological state leaves no room for management at this scale.

Another characteristic of the 2 session was that fishermen were dominant in contracts negotiation, whereas it is not the case in real life. 3 possible and probably combined reasons for that : a calibration problem, most people reckoned that leases were too high compared to fishermen livelihoods, or maybe also because of a structural problem of the game, and also because lake owners were played by fishermen who may not be skilled for accounting.

An unexpected rule that emerged in the 2 sessions is that when possible, teams were buying as much nets as they can.

The game sessions are described in appendix 4 and 5. Hypotheses and results are synthesized in the following table.

		Knwoledge and Hypotheses before	Hypotheses included in the conceptual model	Observed from game (observation + debriefing)	From "cold debriefing"
Upper levels				BUIS give priority to agriculture in water allocation Lease money is partly used for hatcheries and NPA Ministry has not enough money to monitor correctly from pasportisation data Nukus Balek = fishermen association or company doing hatchery and joint venture with Russian company. Most fishing companies are member. No lobbying role to upper authorities. No trust in fishermen behaviour and water availability for establishing sustainable hatcheries in the lakes.	(There are some contradictory infos…) If no water, lake owners talk to hakim, and hakim talks to upper levels
Lake owners	Economic aspects	Lake owners get money from fish caught fishermen they hire. They have to pay yearly lease. A year lease is about 1M soms	Lake owner have lease to pay. They pay lease with fishes they get from contracted fishermen. Contract fixes the proportion of fish kept by fisherman and fish given to lake owner	(observed) contract ratios were about 30% for lake owner, 70% for fishermen In reality lake owner take about 2/3 of fishermen catches and it might rise during the year Lake owners may be big companies or small guys. Leases are fixed by tenders: the higher the bid, the higher the lease. Sometimes the lease is higher than lake productive capacity. This is one reason for lake owners getting bankrupted. The other one is bad management: no up keeping of the lake, bad relationships with fishermen..)	Lease is not much and lake owners can get rich easily 1/3 leases are payed only Lake owner get bankrupted also because they have no storage facilities 1 lake owner do not give salary and maks 50/50. Some other lake owners give salary but take all fish..Some buy fish with a price they fix Contracting is often done on basis of pre-existing reputation or relationships ("dynasties of fishermen"). But sometimes lake owners have to prospect.

	Practices and strategies	Lake owners may be former directors of state fish farms or kholkoze. They also may be rich investors who are new to the fish business. This case exists in Shege and this lake owner has very bad reputation with fishermen	In the story presenting the setting we mentioned wether the lake owner was rich and new, or coming from state farm time.	Controls are done by locals, they are easily bribed "good" and "bad" lake owners practices : - good : give salary and support fishermen; monitor and clean lakes; launch hatchery projects - bad : hire as many fishermen as possible to make as much profit as possible	Lake owners also poach! In general lake owners o not give nets to fishermen
	Water scarcity rules				No much lake owner do stocking and maintenance
	Information available		Lake owner know basic characteristic of lake : mean catch, mean yearly production	lake owners do "pasportisation" = document where they fill up some indicators and have abacus to monitor lakes state	
	Long term adaptive capacity		Possible actions : clean lake or buy young fishes		Hatcheries projects
Fishermen	Practices	Fishermen get money from complementary activities (construction …) and also from jingil collection They have different types of nets – jilim and chinese nets. They use jilim in fishing season and chinese nets when fishing is forbidden They team up to go fishing	Complementary activities are kept by the possibility to choose to get just enough money without fishing. Fishermen can choose between small and big net	Lake are open access resources even in scarce time. (observed) There is no solidarity on catches within villagers Management by mesh size – small mesh only if no big fishes Jilims only left from soviet times, people buy chinese net (they don't want to share anymore) (observed) no poaching – it was not necessary to get rich	30 years ago lake were common pool resources and there was management rules – deputy hakim said it would have been good to have "veterans" in the game Some fishermen get fined even if they have contract Everybody tries to cheat in Sarbas Most fish also in closed season

Economy	Jilim cost 1.5 M soms – catch 500 kg / day 5 people household livelihood = 200.000 soms / months A good fishing season : 5000-6000 soms a day during 20 days With contract income is 30.000 to 150.000 a soms / month With poaching income is 20.00/30.000 a month	Roughly reproduced through calibration	Chinesr net cost 10.000 soums in Nukus and 20.000 sioums in Muynak	Nets cost between 40.000 and 150.000 soums In general fishermen don't buy nets together Fishermen cannot invest in stocking as in the game The market is very influencial – when possible fishermen sell to traders who come and give attractive price
Collective rules				Chinese nets are forbidden – they ahev very small mesh Seasons where fishing is closed (in may and june)
Water scarcity rules				
Information available			fisherment have experience only for information	Water color indicator of water quality : white good, green worse, yellow bad Deeper areas are better for fishing
Long term adaptive capacity				
Bio-physical dynamics	There are parts of lakes which are more fishy Fishing activity is highly seasonal Lakes have silt problems and water provision problems (upper dam fall) If not much water, it is silty and fish don't grow well.	Only on fishing zone for each owner. 1 time step representing the high fishing seasons. Lake capacity and growing rate changes roughly with low or high water availability	Bad calibration in the game on catches size and return	Stocking is in October In sarbas there is a zone in the lake with o inflow very bad for fishing. But not as separate to the "good" zone as in the game Lakes need freshwater inflow. If drainwater inflow, reeds don't grow. If low inflow, water quality change from white (clay, good) to green and then yellow.

				When water is yellow it is salted, fishes are smaller and taste different Worst factor for the lake : siltation (when inflow is too low) and inflow fluctuation
Other users within WUA				Lake water is also drinking water Reeds and other vegetation of the lake are much used
Inter-levels influences	Fishermen can poach or get contract with lake owners Through contracts, lake owners either get all fish and give fishermen a salary, either leave them a portion of their caughtss	Fishermen may poach but they may get caught by NPA	There is no interactions between lake owners (observed and confirmed through debriefings) Most lakes have several lake owners	If much water upstream, lake owner claims “his” fishes who have migrated downstream

2.1.5 Conclusions

The game was focused on teams' organisation and interaction with lake owners. Discussions during ad after the game demonstrated a variety of situations regarding relationships and contracting between fishermen and lake owners, depending on lake owners' good willing, but also on stocking and market possibilities around the lake. Game issues made sense for the participants but revealed irrelevant with respects to their main issue that was scarce and irregular inflow in the lakes. The game could just underlie the helplessness of fishermen and lake owners regarding water scarcity and their only left strategy of fishing as much as possible before fishes die from lake water scarcity. It was confirmed in debriefing that when water inflow were not so irregular, different kind of collective management strategies were used. A prominent output was also individualistic behaviour of fishermen who have never display any kind of collective management practices, and never shared their caught between teams.

It means that in the present state of lakes and fish resources, the lake scale is not appropriate to raise collective management issues. It would make more sense – if feasible regarding the local and national political context - to bring activities to an higher scale of lake networks with lake owners and district level stakeholders participants. Hakimiat people could just confirm how fishing WUA stakes were unconsidered by BUIS compared to agricultural WUA stakes. Our Uzbek partners in Tachkent are making some lobbying for the lakes needs to be included in BUIS water allocation planning.

More generally than with the Uzbek context, the game raised questions on how to have the players getting a feeling of lake sustainability dynamics in a few time steps. There is much more fishes left than fishes caught even when the lake is getting unsustainable. We played with constant mean catch value. It should somehow vary with number of fishes in the lake: if there are less fishes, they should get more difficult to catch. The idea could be to have a mean catch value for the equilibrium state of the lake (when catches = MSY) and to have this value varying linearly with number of fishes in the lake.

2.2 Farmers game – Fermerlarning o'yini

2.2.1 Issues and hypotheses

The issues we wanted to focus on wit the farmers game were :

- "normal management"
  - What rules are WUA using for water allocation and distribution among their members? How can farmers influence WUA decisions and actions?
  - How do farmers allocate water for different purposes (state order crops, "cash" crops, gardens)
  - Information availability
- Response options in case of water scarcity
  - How is WUA organisation dealing with water scarcity?
  - How do farmers deal with water scarcity – do they use any kind of social networks or neighbourhood relations?
- Adaptation to change in water availability in the long term (to be tackled during debriefing)

The different elements of knowledge and the hypotheses that were selected to be represented in the RPG conceptual model are displayed in the table below.

The game focus on the articulation of decision-making between water allocation planning and water distribution for agricultural use, without considering physical constraints on distribution scheduling, which is a technical issue. Free-riding issues are not included in the game neither.

2.2.2 Game global description

The farmers game simulates water allocation planning and implementation in a WUA constituted by a single canal. Farmers from the same village have fields along this canal. They can crop cotton or wheat and are constrained by state orders on cotton. A WUA manager is taking decisions on WUA water allocation, and a mirab is distributing water to the farmers. The time step of the game is a whole irrigation season

At the beginning of a time step, farmers get state orders and choose crops and WUA manager get WUA water allocation planning and decides allocation rules within the WUA.

Then water is given to WUAs and mirab distributes water to farmers following WUA manager indications.

After that farmers get production depending on water they had and they get money from private crops. Finally WUA can collect a tax and participants must pay for they livelihood.

The originality of the game lies in the dissociation of decision-making between planning and distribution between two separate roles of WUA manager and mirab. Moreover, WUA office, village and fields are situated in different areas of the room so that the different actions of decision and distribution happen in different places. By this way players have to move to the proper area if they want to take part in the action.

A detailed description of the game can be found in appendix 6.

2.2.3 Underlying conceptual model

The agronomic production function is a very simple abacus table relating production to water level and soil quality. The calibration was done very roughly respecting broad proportional relationships between state order area and total crops area, cotton and wheat production functions relatively to water, and cotton and wheat market price, and so that people are able to make a living in mean years. More details can be found in appendix 7.

2.2.4 Games sessions progress and result

In each session, there was about 30 participants. They were divided in 2 groups (2 WUAs) and a farmer was played by a pair of players. The way the game was presented is detailed in appendix 8.

In the 1st session, participants were mainly farmers and in 1 group and there was not any real WUA manager. In this session, the management style was chaotic or self-organised. In one group, some solidarity and concertation emerged and led to some kind of self organized management style. In the other one, no solidarity emerged and people even tried to steal water from each other.

In the 2nd session, participants were mainly managers. This session was very organized and the management style was very centralized.

The main difference in the rules between the 2 sessions is that in the second session, farmers had to go to the manager to tell which crop they choose.

The sessions are described in appendix 8 and 9. The hypotheses and the results are synthesized in the following table.

		Knwoledge and Hypotheses before	Hypotheses included in the conceptual model	Observed from game (observation + debriefing)	From "cold debriefing"
Upper levels	Allocation rules	BUIS allocate water to WUA depending on salinity levels and state orders. State orders are fixed depending on soil quality	Allocation and state orders are roughly calibrated so that needs can be met in mean years		BUIS get WUAs requests and make water use plans. If there is not enough water, they reduce allocations without consultation
	Distribution rules	Allocation is distributed through a given flow during specific irrigation periods During irrigation periods, water flow is irregular and might end up before the end of the period. Outside irrigation periods, there is only a marginal amount of water for households.	The time step represents a whole season.	WUA may give excess water to each other in the frame of negotiations led by hakimiat	
WUA	Structure	A WUA is typically managing a main canal with a few outlets and there might be 1 to 10 fields on an outlet. Generally villages are upstream on the outlet. In a village there might be a significant amount of households that are not member of the WUA (no fields). An household can have fields on different outlets	1 village (1 makhalla) for 1 canal in 1 WUA	Soil quality is worse for downstream fields and those that are far from canal (they do not get enough water for leaching?)	
	Allocation		up to manager	(observed) WUA allocates water according to soil quality	
	Distribution	Outlets are operated by a mirab who is implementing WUA decisions	Up to mirab – he is supposed to follow manager's rules	(observed) Water is given according to requests and exceeding water is given to worse soils for leeching	

		Distribution is constrained by physical constraints on flow in canals Distribution in done with “oral queues” Downstream users are disadvantaged	It is mentioned that fields are arranged upstream-downstream but it has no impact in the game other than when the mirab arrives at the table he is closer to upstream players..		
	Water scarcity rules			water selling inter and intra WUA : talked about but not done (observed) request of downstream / bad soils are fullfiled first	
	Information available	Water allocation forecast from BUIS No measure instruments of flows in the WUAs	During planning : water allocation planning from BUIS; crops of farmers	(observed) WUA technicians do centralize information about water availability and needs for farrmers	
	Long term adaptive capacity	WUA needs financing from users fees to be sustainable		(observed) Some got same fees for everybody some got fees proportional to fields area	
Farmers	Structure	Farms differ in number and size of fields, and on fields soil quality Main crops are cotton (state order) and wheat. Rice is cash crop but is not much allowed	A field : size big/small; soil quality bad / good Crops : cotton / wheat No cost for crops	Rice is not allowed but everybody wants to grow rice	
	Allocation rules		Up to farmers	(observed) crops allocation : state orders go on good soils. good soils use water more efficiently, bad soils need water for leaching	In the game, the only driver for getting money was getting as more water as possible. There was few of such “gaming” strategies from participants who understood the game before the others
	Distribution rules			State order get water first. (observed) downstream farmers bribe mirab to get water	
	Water scarcity rules			(observed) farmers negotiate water between each other, with or without counter part. Among others, there was a temptative water for crop exchange. Water selling is forbidden but they	

			would like it. (observed) If water previsions are scarce not all fields get crops	In reality water for crop exchanges can be agreed with manager (??)
Information available Long term adaptive capacity	If state order is not reach, farmer is bankrupted. If it happens several years, farm might be taken	Maximum yields and water needs of crops. Sanction for not reaching state order is exclusion from the game after several times.		
Bio-physical dynamics	4 main irrigation periods with different water needs and different importance ; leeching, sowing, growing, flowering Fields like water with clay, it makes it less salty. Some people prefer less water but clay water	1 time step representing a whole season No water quality		
Other users within WUA	Households and tomorkas are free-riders for planning and distribution. Water for households (and tomorka) is informal sharing, managed by mahalla Use is marginal until water is scarce or until when they cultivate rice on tomorkas Other free-riders upstream?	No households, no tomorkas – *for debriefing*	Makhallas were never needed in the game	In each WUA there is a Dekhan association who centralizes tomorkas needs at WUA level People don't know when they will get drinking water Makhallas would like to be part of WUAs
Inter-levels influences	WUA decides water allocation and water turns during assemblies, or autoritarly looking at fields salinisation, or friendship relations might be important It happens that outlets are broken during the night Makhalla is dealing with households coordination. It can organize maintenance works	Makhalla is not represented but farmers sit in a "village" table different from the one with their fields – *for debriefing*…	negotiations with mirab : - mirab bribe no water if no WUA tax money - downstream give money to mirab to get water	In reality there are more interactions with mirab cos he goes on fields

2.2.5 Conclusion

Because of the poor reframing, the informational output of the game relies essentially in a number of scattered hypotheses and questions on water allocation and distribution organisation within WUA and at upper scales. These include more interestingly:

- the central role of WUA technicians, including mirabs in term of information centralization
- depending on the level of control of participants playing WUA manager or mirab, but also on the farmers groups, 3 management styles were displayed :
    - Chaotic (1st arrived, 1st served, only bilateral agreements on water sharing were reached, of any)
    - Collective (farmers discussed water allocation among each other, came to common agreement, set norms at the beginning of the game)
    - Centralized (the authorities /mirab distributed the water to the farmers according to "rational" plan - - agreements may be made between individuals and authorities/mirab)

However, in the context of constraining state orders and inexistent access to any kind of financial resource and market, the sessions left the feeling that insufficient water may not a central issue for farmers and WUAs

2.3 Agent-Based Model

The main question this model will study is : how does the system react when, starting from an "ideal" situation where all actors use best practices of formal institutions as described in manuals, we gradually relax the assumption that these actors play according to the best practices? This assumption will get relaxed by introducing informal rules as taken from literature on the field. As to keep the model as minimal as possible, it is build "from scratch". Social simulation examples and references to social theories will be introduced in a second time for comparison and discussion purposes. 2 dimensions of "good governance" will be used as indicators of the simulations : social dimension (equity in water allocation) and economic dimension (water efficiency). As the focus is not on agronomic decisions but on practices and institutions dynamics, we are using a yearly time step.

We have jointly developed with MS a UML of the reference version of our model (the "perfect" case). This UML is now implemented as an agent-based model with the platform Netlogo.

We will present the result of this work in an international conference concerning modelling and simulation for social sciences or natural resources management.

Appendix 1: Karakalpakstan Fishermen Game – Detailled Game Description

Game settings

Animation team needed

1 moderator + 1 or 2 other persons at resource table

2 or 3 assistants for observing and helping players

Material needed

1 small table for each lake owner, 1 small table for each lake, 1 big table for each village

1 opaque bag or envelop for each lake zone

marbles, beads or little rocks of 2 different colors for fishes

Cards :

- contract sheets
- nets (with price and characteristics)
- alternative income activity
- lake owners info : lease, lake mean productivity

Board or white sheet where the following information should be written as memo for people while explaining the game :

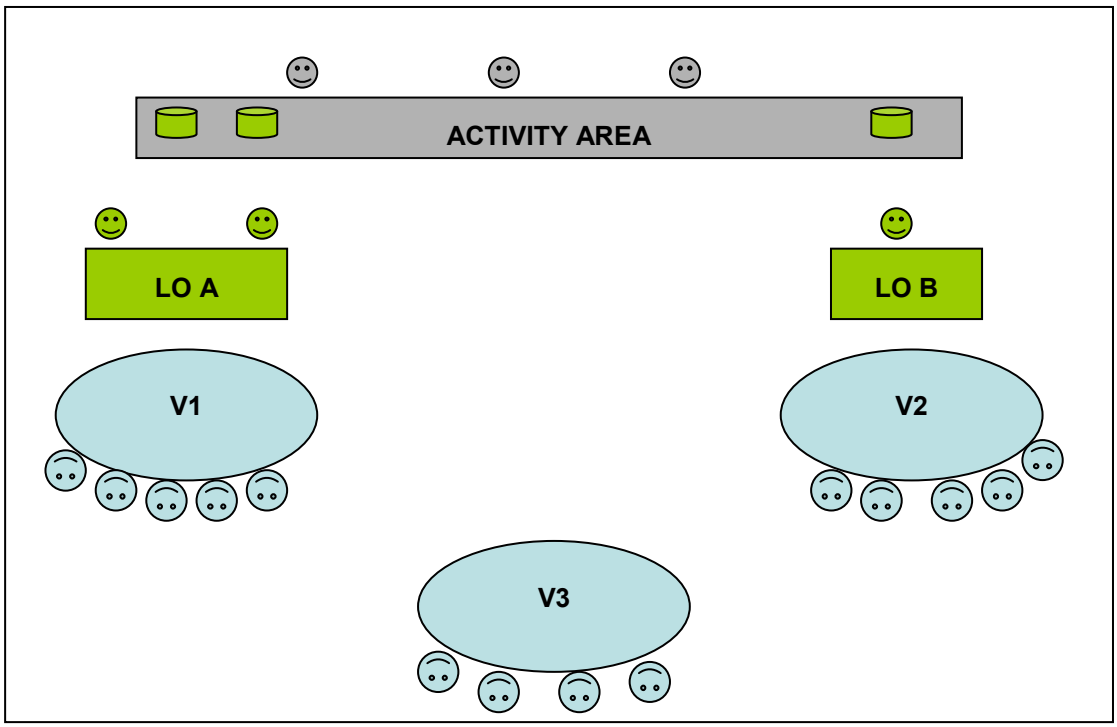
- lakes and villages map
- nets prices and characteristics
- fishermen livelihood needs
- lakes mean productivity
- lakes mean quantity of fish you get in a catch
- actions for improving lake

Space configuration

Ideally the game space should be arranged with the following areas :

- each village should have a big table to sit and talk
- each lake owner should have a small table representing his office. It should be next the village their lake is closer to
- a separate big table should represent the lakes area where fishermen go and fish

The drawing shows a possible configuration for 15 to 20 players with 3 villages, 2 lakes and 3 lake owners.



Then the idea is to have contrasted situation between the lakes :

- 1 should be small and fishy. It could have been part of a kholkoze, and the fishermen could go there and fish for free. Its lake owner could be the former kholkoze director.
- 1 should be big and less fishy. It could have been part of a state farm where villagers were employees. It could have 2 owners : the former state farm director and a rich person new in fish business.

The different roles

For each lake zone, there is a lake owner. His objective is to hire enough fishermen to pay his lease and keep his lake fishy enough to be sustainable. At their office, they have some initial money and possessions, a sheet with information on their lake and contract sheets.

Lake owners can volunteer or be chosen by everybody.

All the other players are fishermen. If there is several villagers, fishermen must sit so that all villages have about the same number of fishermen, unless we want special villages (e.g. only lake owners). In front of him, each villager should have an envelop with his initial possessions (money and nets).

Fishes and fishing

Each lakes zone is figured by 1 bag, one for each zone.

In these bags there are beads of different colors. White ones represent small quantities of fish, blue ones represent big quantities of fish (to be adjusted depending on calibration).

Fishing is figured out by drawing beads in the bags. Drawing a bead is like making a catch.

Different kind of nets can be used by fishermen, that allow a different number of catches.

The quantity of fishes in bags changes every year according to inflow arriving in lake and also fishermen catches.

Nets

Fishermen need a net to go fishing.

There is 2 kind of nets : big nets (jilim) and small ones.

Big nets are very expensive and they can be used forever. They allow more catch but they need a big team (to be calibrated with number of players)

Small nets are cheap but they have to be bought every year. They allow less catches but they need only 2 people. Every fishermen start the game with enough money to be able to buy a small net.

Contracts and lease

Lake owners have to pay a lease at the end of each year for their lake part. They have to hire fishermen and get a part of their caught so that they can pay their lease. The part of the caught they get from their fishermen should be negotiated in a yearly contract. Former state farm directors have big nets they can provide to fishermen. The new lake owner has an initial amount of money he can use however he wants.

1 Contract for each lake owner is pre-filled with reasonable values.

Playing a season

A time step represents what happens during the high fishing season

Choosing what to do during the year

When the game starts, it is the beginning of a new fishing season. Fishermen can go fishing but they can also decide to get a job somewhere else that they are sure will bring them just enough money for making a living.

Fishermen who make this choice get their money now and can rest for the rest of the year.

Recruiting fishermen / getting contracts

Fishermen should get a contract for the part of lake they want to go fishing to. If they fish in an area they don't have contract for, they might get caught by NPA and have their nets taken.

Lake owners have to recruit enough fishermen so that they can pay their lease but be careful that their zone does not get overfished. Lake owners can choose wether they provide nets to fishermen or not. Then they have to define which amount of fishermen catch they ask. This should be written on contract they make with fishermen on an individual basis.

When a contract is signed, lake owners have to fill a contract sheet they give to the fisherman and complete their own playing sheet.

Making teams and getting fishing nets

Fishermen have to make teams, buy a net if necessary and get a contract or not.

When a team is ready, it can go to the activity table and start fishing.

Contracting and making teams should not last more than 10 minutes.

Catching fish

Fishing team come the lakes table with their net and their contract. They can fish anywhere they want but after each serie of catches, the assistant has to draw NPA control. In case of NPA control, fishermen must show their net, their contract and their catches. If something is wrong, they must give everything to NPA.

Fishing is done by drawing beads in the bags representing the lakes. Fishermen have as many tries as catches authorized by their net. However they don't have to use all their catches and can stop fishing if they are happy with what they got.

Assistants should monitor how much fish each team did get.

Sharing fish

The fishing team should go to lake owners and fill their contract.

Finally fishermen can share their catch within the team.

Paying for yearly expenses

Fishermen pay for livelihood, lake owners pay for lease.

If money is left, lake owners can make actions on the lake.

Possible actions are :

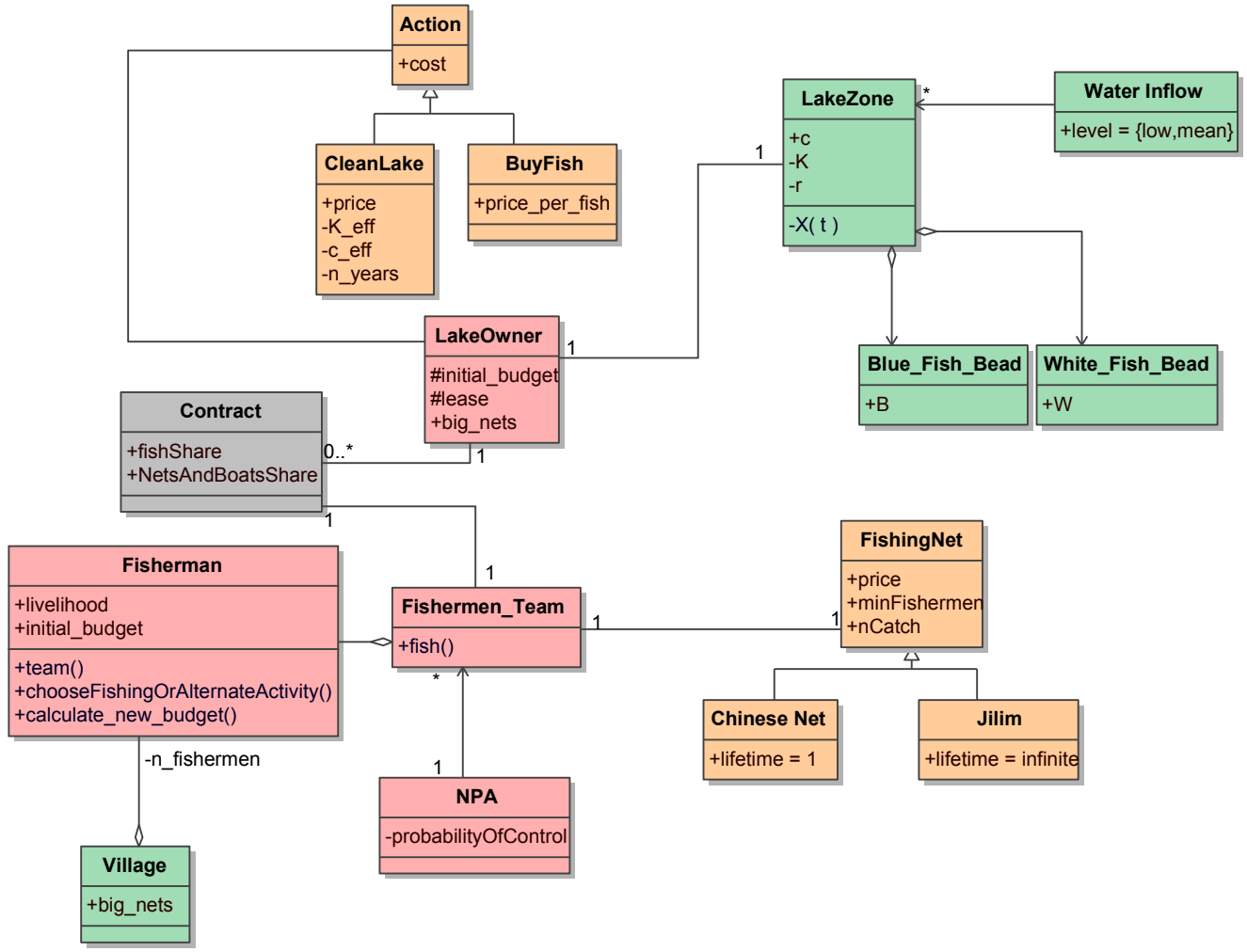
- clean lake : this is done by hiring fishermen. It makes the lake more productive
- buy young fishes : this is increasing fish population for the following year

Simulating ecological dynamics.

When fishing season is over, assistants must count how much fishes are left in each bag. There is a computer program that generates the new fish population of the lake depending on how many fishes were left, wether an action is done, and next year inflow (scenario). The underlying model is a simple logistic equation associated with a probability of catching fish.

Appendix 2: Fishers' Game Detailed Underlying Model and Calibration

Fishers game entities and parameters



Ecological model

The fish population model is a simple logistic equation.

$X(t+1) = (X(t) - H) + r*X(t)(1-X(t)/K)$

with X(t) fish population at step t

K carrying capacity

R growing rate

H harvest

For this model, the maximum sustainable harvest is given by $MSY = r*K / 4$

Then the number of each type of beads is fixed by the mean catch value

X(t) = nB(t)*B + nW(t)*W	with	nB(t)	number of blue beads at t
		nW(t)	number of white beads at t
		B	value (numb of fishes) of blue bead
		W	value (numb of fishes) of white bead
c = (nB(t)*B+nW(t)*W)/(nB(t)+nW(t))		c	mean catch probability
resolves in			
nB(t) =(X(t) / c) * (c - W) / (B - W)			
nW(t) =(X(t) / c) * (B - c) / (B - W)			

There is an Excel routine implementing the model.

Actions effect

Buy Fish

Adds as many fishes as bought in the lake. This is propagated in the whole lake if there are several zones

Clean Lake

Increase K and c respectively by K_eff and c_eff. Applies only in the zone where the action is done. The effect decreases linearly in n_years

Calibration

Ecological parameters

This calibration defines ecological parameters in relation to mean catch value. It should be done so that in mean years the expected catches are equal to MSY. However downstream lake should be disadvantaged towards the other.

- Non sustainable : it is not possible to find a situation where lakes are sustainable and fishermen make a living
- Just sustainable : there is a few situations where lakes are sustainable and fishermen make a living
- Very sustainable : there is a lot of situations where lakes are sustainable and fishermen make a living

For a sustainable situation we should have

*MSY_total > c * n_fishermen_total*

Economical parameters

This calibration defines leases and fishermen livelihoods.

For a sustainable situation, the total of livelihood and lease needs should not be bigger than the expected catches

*c * n_fishermen_total > Lease_total + n_fishermen_total * (livelihood + fishNetPrice_fisherman)*

And the ratio between livelihoods and leases should be set up so that

*Lease_total < Expected_lakeOwner_share * c* n_fishermen_total*

Initial budgets : fishermen should have enough to buy a small net. Lake owner A.2 should have enough money to buy a big net and a big boat.

Nets parameters

This calibration defines number of catches per fishermen in relation with ecological and economical parameters.

The nets should be calibrated so that with mean catches, each team fisherman gets at least enough fish for livelihood.

Number of fishermen per net should be adjusted with the number of players.

One net could be more efficient than the other

*c * nCatch > min_fishermen * livelihood (+ price for small nets)*

Appendix 3: Presentation of the Fishers Game

This is the way the game was presented, just before a tea break

General presentation of the activity

- We want to bring new input on water management issues with a new type of activity. This activity might be different from what you are used to.
- In my institute we study how people make decisions together. For this we work together with fishermen and managers so that everybody understand the way things function and understand each other, and then it is possible to work on making rules and decisions better. We know your world and your decisions are complex so we design a simple game like theatre where you have to play and manage lakes.
- The objectives of this activity :
    - 1. you discuss and exchange ideas
    - 2. we understand better your decisions
- After the game, we discuss and we will be happy to get your ideas. Some of these ideas, you can use it with Neela this afternoon.
- Back in France we will work with other Newater researchers to make model looking for better management
- First we explain you short the different moments of the game. Then we have tea break and after we explain more detail and we play.

General presentation of the game

- In this game you will have to play your own role, or the role of people you are used to interact with. Some of you will be fishermen, some of you will be lake owners
- Fishes are figured by beads. White beads are small amount of fish, blue ones are big amount of fish
    - *Show fish beads*
- Each fisherman needs a certain quantity of fish for his livelihood. For this they can fish, or they can go work on building site so that they are sure they make a living.
    - *Show happy faces – show building site card*
- Lakes are figured by bags. Fishes are in the bags, but you don't know how much. You fish by drawing beads in the bag
- But for fishing you need nets. There is 2 different kind of nets : big nets like jilims and small nets.
    - *Show nets cards*
- Small nets are cheap but you need to buy a new one every year. Big nets are very expensive but they last forever.
- With a big net you can draw more beads from lake than with small one.
- You need to team to use the nets. You can be only 2 for using the small net, but you need to be a bigger team to use the big net.
- Each lake zone belong to a lake owner. You need a contract from the lake owner to fish in is lake. If no contract you can get caught by NPA. If NPA catch you, it takes your fishes and your net.

- Lake owners need enough fishes to pay lease for their lake zone. They get fishes from contracted fishermen. So they need to hire enough fishermen, but they also have to take care of the sustainability of their lake.
    - *Show lease card – show contract sheets*
- Contracts tell how much fish on a catch fishermen must give to lake owners. This amount is fixed by lake owners or might be negotiated.
- If there is fishes left at the end of a season, it is possible to buy actions to improve the lake :
    - Cleaning the lakes results in increasing lake productive parameters
    - Buying new stocks results in increasing the number of fishes in the lake
- There is more information on the lakes on a paper that will stay during all the game :
    - Mean quantity of fish in a catch for each lake
    - Mean yearly fish production for each lake.

Game installation

- Pre fill lake bags with initial amount of fishes
- Ask for lake owners
- Have lake owners sitting on 1 table and fishermen sitting in another one.

Game step organisation

- Everybody gets an amount of money for starting :
- Fishermen choose to fish or not
- (5 minutes) Lake owners and fishermen think how they team/ how they contract
- Fishermen and Lake owners make contracts
- Teams ready can fish. After they have fished, there might be NPA control
    - *Don't forget*
        - *Checking net*
        - *After they finish with a bag, draw NPA and then check contract and catch*
- Teams who have fished give fishes to lake owners depending on their contracts
- Fishermen and lake owners Give money for livelihood and lease
- Lake owners take actions if possible and if they want
- *Count fishes, and enter number and actions in computer – refill bags*

Appendix 4: Shege Game session description canvas

GAME	Fisher's Game
SESSION	1 – Shege
	GENERAL INFORMATION
Date	4/4/08
Location	Shege School
Participants	10 old men, 8 fishermen mostly poachers
	SETTINGS
Calibration	Not enough players to have 2 villages 1 Fish Unit (FU) = 100 kg of fish Livelihood = 10 FU Big net : 4 people, 16 catches, price 100 FU Small net : 2 people, 5 catches, price 2 FU Mean catch : 5 FU
Setting	1 villages and 2 lakes with 1 owner each. 1 lake owner with a big net
Roles assignement	Lake owners were decided by the group. There was a real lake owner but played a fisherman
Other	
	ANIMATION AND OBSERVATION (WHO, HOW, HOW LONG)
Game presentation	Live translation by Shuhat
Game animation	Shuhat and Madina
Observation	Nizom, Ablatyn and Joldasova
Debriefing	/
	GAME EVENTS

1 fisherman (real life big poacher) bought several small nets (which was not supposed to happen but we let him), got very rich and emptied the lake. Nobody did get angry at him

Fishermen teamed according to their status in real life (1 team of managers, 1 or 2 team of real fishermen)

All teams get small net

Only 1 poached at 1st round

Fishermen with money gave it to the lake owner for him to make actions

Some had contract with the 2 lakes at the end of the game

Lake owner had to decrease their share to get fishermen

DEBRIEFING POINTS AND GAME SIDE DISCUSSIONS

The lake in reality is dry so there is nothing to manage. When there are fishes we get them before they die.

In reality they let small fishes go.

In reality there nobody has contracts with different lake owners

Control is easily bribe cos is done by locals

In reality lake owner take about 2/3 of fishermen catches and it might rise during the year

Most of lakes have several lake owners

OTHER RESULTS / INFORMATION

COMMENTS

ANALYSIS : hypothesis raised, further investigation needed….

Lakes are so bad that they are used as open resource.

Controls are done by locals, they are easily bribed

In reality lake owner take about 2/3 of fishermen catches and it might rise during the year

Most of lakes have several lake owners

For some reason there are no pictures from this session

Appendix 5: Muynak Game session description canvas

GAME	Fisher's Game
SESSION	2 – Muynak
	GENERAL INFORMATION
Date	05/04/08
Location	Muynak hakimiat
Participants	15 fishermen, 3 of them having higher education. All fishing in lake Sarbas. Mostly mature man
	SETTINGS
Calibration	Not enough players to have 2 villages
	Lease = 60
	Both zones have their proper parameters but when the new population is computed from both parts, it is put all together and cut in half.
	1 lake owner has a jilim and the other 100
Roles assignement	Lake owners were chosenby the group. Both have responsibilities in the makhalla
Settings	1 village and 1 lake with 2 lake owners. The 2 zones have same size but fishes are more easy to catch in one zone than in the other.
Other	Room was too small – lake owners sat together
	Lake owners held the fishing bag
	Story was told about jilim lake owner being experienced and the other one being rich and new.
	Lake owners pay for having different level of control
	ANIMATION AND OBSERVATION (WHO, HOW, HOW LONG)
Game presentation	
Game animation	
Observation	
Debriefing	

GAME EVENTS

Lake owners got broke and had to bargain their catch proportion to keep their fishermen

Last time step, fishermen refused to get contract with 1 lake owner who did not want to bargain more and did not want to lend his calculator to the other one.

There was enough fishes in the lake for fishermen to get rich quite fast

One jilim team was particularly successful. It built a "trust agreement" with 1 lake owner on a 50/50 share and them all cleaning the lake. After 3 time steps they were able to buy a 2nd jilim.

DEBRIEFING POINTS AND GAME SIDE DISCUSSIONS

Debriefing with Jolasova :

"Good" lake owners give some salary, they bring support, they don't think ony about profit. They monitor lakes, clean it.. For monitoring they use "pasportisation" document where they fill up a whole serie of indicators and maybe have some abacus to evaluate the lake state. Ministry the makes statistics (?).

In Sarbas, the "good" lake owner lauched the hatchery project, created a joint venture with a Russian company and they export fish..

Lease money is used for hatcheries (25%) and NPA (15%). Not enough money to do properly monitoring process at national scale

BUIS give priority to agriculture. Fishing gets whatever water is left.

Hatcheries : 1 FAO project in Shege, 1 russian company joint venture with fishermen (Nukus Balek) – problems with water availability and fishermen behaviour – might need hydroponic system and articificial poinds

Lake owners might be big companies or small guys

About information and indicators , fishermen use only experience, and they manage with different size of nets (mesh size). If there is no big fish they take small mesh.

Jilim left come from soviet times and belong to former kholkoze people. New nets are all Chinese nets

Debriefing with Ablatyn : *thinks most of lake owners just hire as many fishermen as they can to make profit. Still some take care.*

In reality, there is no negotiation between fishermen and lake owner

Fishermen may access several lakes same season (poaching?)

The only management rule is normally not to fish small fishes

Other : people prefer chinese nets so that they don't have to share

OTHER RESULTS / INFORMATION

COMMENTS

No difference having 2 lake or 1 lake with 2 zones

People got interested playing with fishes and money, and playing with partners

They could realise it is good to put input in the lakes

The leader of the game was also a fishing leader in real life

ANALYSIS : hypothesis raised, further investigation needed….

Big problem of calibration or something else that makes that fishermen are much more powerful than lake owners in the game; which is not at all the case in reality

Lake owners may be big companies or small guys

"good" and "bad" lake owners practices :

- good : give salary and support fishermen; monitor and clean lakes; launch hatchery projects
- bad : hire as many fishermen as possible to make as much profit as possible

Fishermen management practices :

- mesh size – small mesh only if no big fishes
- jilims only left from soviet times, people buy chinese net (they don't want to share anymore)

Upper levels :

- BUIS give priority to agriculture in water allocation
- Lease money is partly used for hatcheries and NPA
- Ministry has not enough money to monitor correctly from pasportisation data
- Nukus Balek = fishermen association doing hatchery and joint venture with Russian company. Most fishing companies are member. No lobbying role to upper authorities. No trust in fishermen behaviour and water availability for establishing sustainable hatcheries in the lakes.

Information and indicators :

- lake owners do "pasportisation" = document where they fill up some indicators and have abacus to monitor lakes state
- fisherment have experience only

Observant researcher understanding too well the possible impact of RPG : "they realise it is good to put input in the lakes"

Appendix 6: Karakalpakstan Farmers Game – Detailed Game Description

Game settings

Animation team needed

1 moderator

2 or 3 assistants for observing and helping players

Material needed

Marbles, beads, seeds, paperclips or little rocks for water; production and money

Crop cards

State order sheets

For 1 WUA :

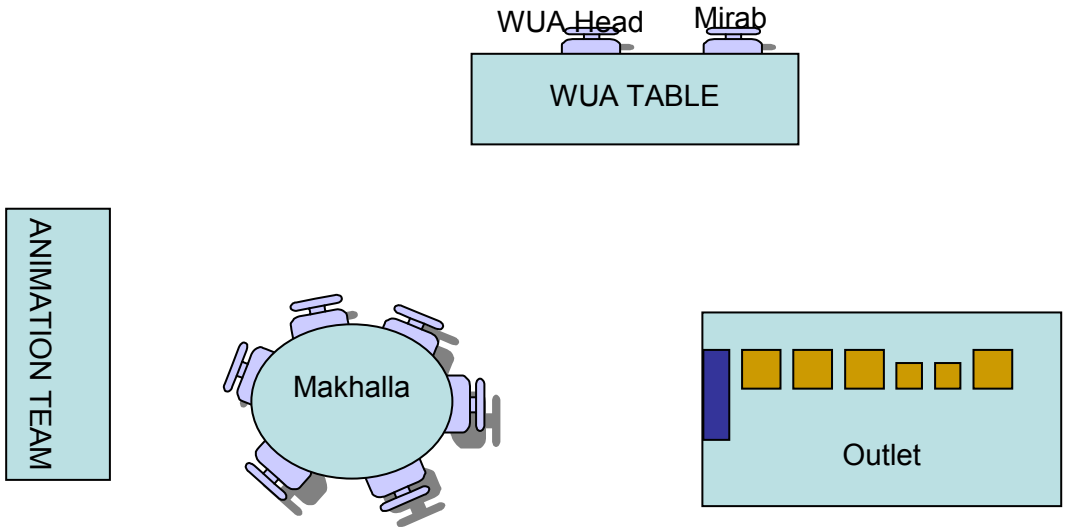
- 2 small table (WUA office and village) and a big one (fields)
- 1 bag
- 1 flipchart with plots draw on it

Board or flipchart to write general public information during game presentation

Space configuration

The game space is divided between different areas. The village is figured by a table where farmers sit and talk. Farmer fields are on another table next to the village. This table represents the WUA main canal. Fields lay upstream – downstream on this canal.

WUA cannot manage most than 6-8 farmers



The different roles

In each WUA, there is 1 mirab who is in charge of distributing water and 1 manager who is setting up and implementing allocation rules. The mirab and the WUA head are full-time jobs, they are not farmers.

All other participants are farmers. Farmers grow crops and try to get enough money from crops to make a living

Mirab and manager can volunteer or be chosen by the participants.

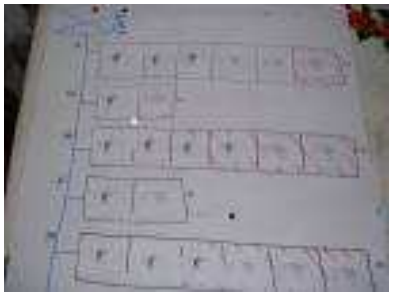
If there is several WUA, farmers must sit so that both WUA have same number of farmers, unless we want special WUAs (e.g. only women)

The fields

Each farmer owns several plots of 5 has. Big farms own 6 plots, small ones own 2 plots. Each plot can have good or bad soil. It is possible to have a different crop on each plot.

The more downstream, the more bad soils.

Pictures below show the 2 configuration used. On the 1st one, soils and rank were random. Farmers suggested a more realistic representation where some fields are closer than the other to the canal. This is 2nd configuration which is set up arbitrarly, putting more bad soils down stream and far from canal

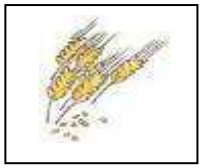


Farmers can get their field by drawing a number in an envelop

The crops

There are 2 different crops available:

- cotton
- wheat



Each crop is figured by a card. Putting a card on a plot means the crop is on the plot.

Depending of how much Water Unit and on which soil, the crop will have a certain yield (Production Unit).

This information is given to facilitators in a memo. Farmers only know optimal yields and WU necessary to get optimal yields.

Water, production and money

Water units are figured by paperclips.

Production units are figured by sunflower seeds

Money is figured by beads.

At each time step, WUA managers receives water from BUIS : he is given a bag of paperclips from facilitator.

WUA managers decides how paperclips must be allocated between farmers.

Mirab go in the fields and give water to farmers depending on WUA manager decision.

Playing a season

Initialisation : water allocation planning and state orders

1 time step represents a whole irrigation season.

At the beginning of a season :

- WUA managers gets water allocation planning (figure) from BUIS
- Each farmers get a state order saying how much cotton PU are expected

When the game starts, it is the beginning of a new cropping season.

Planning (10 minutes)

Farmers decide which crops for their plots and they inform WUA manager before putting cards on the plots.

WUA manager plans water allocation. They can discuss with mirab or farmers if they want. They can set any type of rule.

Irrigation (10 minutes)

WUA manager receives water bag from BUIS. He can adjust allocation if the amount is different from what was planned.

He gives the bag to the mirab. The mirab go the fields and give water to the farmers. He should conform to the manager rule.

Farmers are free to do what they want with the water they got from mirab.

Harvesting (5 minutes)

Assistant put seeds on plots according to their memos.

They collect state orders. If state orders are not reach more than 1 time, participants might get excluded from the game.

Remaining seeds are converted to money.

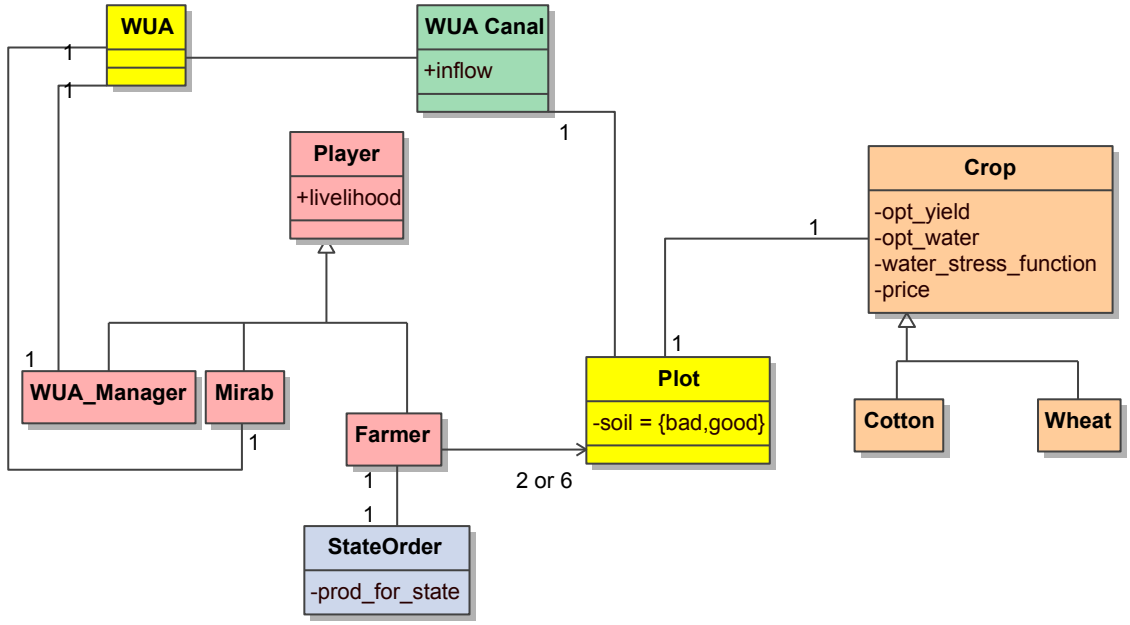
WUA Tax and livelihoods (5 minutes)

WUA manager decides how much tax farmers should pay. Mirab collects taxes for WUA.

Farmers pay for livelihoods and get happy faces if they have enough money.

Appendix 7: Farmer's Game Detailed Underlying Model and Calibration

Entities and parameters



Agronomic model

It is given by a simple table

From rough calibration[1] we used the following setting

			Water Units				
			0	1	2	3	4
2 MU for 1 PU	Cotton Prod Units	bad soil	0	1	2	3	4
		good soil	2	3	4	5	6
3 MU for 1 PU	Wheat Prod Unit	bad soil	0	0	2	4	/
		good soil	0	2	4	8	/

[1] Wheat : 2-4 t / ha for 5/6000 m3 /ha

Cotton : 3 t / ha for 7/8000 m3//ha

Impact of water stress rice > wheat > cotton

Wheat : 400.000 soms / ton

Cotton : 200.000 soms / ton

Calibration

State orders

State orders are decided depending on size and soil : small farmers get 1 plot, big farmers get 4 plots. Production objective is doable with ¾ optimal water.

Agro-economic parameters

It should be done so that in mean years, farmers can make a living with 3/4 optimal water.

It means that in mean year, there should be ¾ of the optimal necessary water for the whole plots of the WUA.

However the calibration prove too rude for bad soils.

Appendix 8: Presentation of the Farmers Game

This is the way the game was presented, just before a tea break

General presentation of the activity

- We want to bring new input on water management issues with a new type of activity. This activity might be different from what you are used to.
- In my institute we study how people make decisions together. For this we work together with farmers and managers so that everybody understand the way things function and understand each other, and then it is possible to work on making rules and decisions better. We know your world and your decisions are complex so we design a simple game like theatre where you have to play and manage water.
- The objectives of this activity :
    - 1. you discuss and exchange ideas
    - 2. we understand better your decisions
- After the game, we discuss and we will be happy to get your ideas. Some of these ideas, you can use it with Neela this afternoon.
- Back in France we will work with other Newater researchers to make model looking for better management
- First we explain you short the different moments of the game. Then we have tea break and after we explain more detail and we play.

General presentation of the game

- In this game you will have to play your own role, or the role of people you are used to interact with. Some of you will be farmers, other will be WUA manager or mirab
- Farmers have fields. They receive state order for cotton and can grow other crops for themselves beside
    - *Show flipchart, crop cards, state orders*
- Before irrigation season starts, WUA get information of BUIS water allocation. Farmers tell WUA about their crops, make request, and WUA manager can plan water allocation.
    - *Show water allocation info card*
- When irrigation season comes, WUA get water
    - *Show paper clips*
- Mirab distributes water to farmers, farmers distribute water on their crops
- Then depending on water and soil, farmers get harvest. They give state order and the rest they can sell and they get money
    - *Show sunflower seeds and beads*
- Some of this money they spend on living. But also WUA needs money for maintenance and for paying manager and mirab. So WUA manager must also collect money for WUA.

- This is it. Don’t be worry if you don’t understand everything. You will get more details after tea break. Also you can discuss with Madina, Andre, Nizom and Shuhat during tea break. And also you will understand while you play.

Game installation

- Pre fill WUA water for round 1
- Split people into 2 WUAs
- Ask for a manager and a mirab in each WUA
- Show people their fields

Game step organisation

- Give BUIS allocation to WUA
- Distribute state orders to farmers
- Ask farmers to choose crop and then to tell to manager
- Ask manager to make planning – alone or discussing with farmers
- Irrigation
    - Give water to manager
    - Ask him to give mirab instructions
    - Ask mirab to go and distribute water
- Harvest
    - Put harvest on fields
    - Collect state orders
    - Give money
    - Ask manager to collect tax
    - Get livelihood and give happy faces

Appendix 9: Kushkupil Game session description canvas

GAME	Farmers' Game
SESSION	1 – Kushkupil
	GENERAL INFORMATION
Date	2008 March 31st
Location	Rural council of Urta yop
Participants	24 people from 2 WUAs (Ashirmat and Kenegees), mainly farmers.
	SETTINGS
Calibration	Wheat : 2-4 t / ha for 5/6000 m3 /ha
	Cotton : 3 t / ha for 7/8000 m3//ha
	Impact of water stress rice > wheat > cotton
	Wheat : 200.000 soms / ton
	Cotton : 400.000 soms / ton
Roles assignement	5 pairs of farmers in each WUA.
	WUA manager and mirab were chosen by the group.
	For WUA1 one of them was actual manager
	For WUA2 it was farmers
Scenario	1 year with enough water for all cotton
	1 year with 85% water 1st year
Other	Room was too small to have village and fields separated.
	2 independent groups played 1 WUA each in parallel. Each group was mainly from 1 real life WUA
	The farmers decided their crops and "sowed" directly without informing WUA
	ANIMATION AND OBSERVATION (WHO, HOW, HOW LONG)
Game presentation	30 minutes, live translation from Shuhat
Game animation	1 hour. 2 time steps
	1 group by Madina, the other one by Gulya and Shuhat
Observation	Nizom and Andrei
Debriefing	Very short.
	All together, live translation from Shuhat
	GAME EVENTS

WUA1 mirab thought about selling excess water to WUA2 but the group preferred keeping water for washing land (which they know has no impact in the game)

WUA1 had interesting discussion on how to share water : priority to people with good soil

who make good production or to people with bad soil who need water for leeching ?

WUA2 mirab managed to get money for WUA taxes by bribing people with not giving water next year if he do not get money

WUA2 farmers discussed about selling water to each other but they did not do it

In 1st round WUA1 farmers took as much water they could grap from mirab (the faster the most water). In second round, following the facilitator's advices, they discussed and decide to help those with bad soil.

In WUA1, a downstream woman gave money to the mirab to get more water

Mostly farmers put state orders on good soils.

DEBRIEFING POINTS AND GAME SIDE DISCUSSIONS

To be a good farmer you need good soils. And then you need to help cleaning canal and other collective tasks

OTHER RESULTS / INFORMATION

Fields drawing was unrealistic (lines along a line), people suggested a more realistic drawing which was used in the following session

Sunflower seeds were used for water, people suggested to use it for production, which was done in the following session

People commented they are not connected enough in reality and they should negotiate and exchange as they do in the game.

People have difficulties with Water Units, Production Units …

Relative cotton and wheat price were accepted as realistic

People wanted rice in the possible crops. Their main request was alternative crops

COMMENTS

People did not understand until end of round 1

Then they realise they face same things in life. They explained lot to moderators…

Still only 2 were really understanding and leading. But the others could still take decisions on their own.

Women did not talk much in one group. In the other one they were strong and dominated the mirab

WUA1 farmers were teasing mirab all game telling him what he should do and criticizing their real mirab.

ANALYSIS : hypothesis raised, further investigation needed….

Only hypotheses from game observation can be done (no debriefing)

- water selling inter and intra WUA : talked about but not done
- negotiations with mirab :
    - mirab bribe no water if no WUA tax money
    - downstream give money to mirab to get water
- water sharing : good soils use water more efficiently, bad soils need water for leaching
- crops allocation : state orders go on good soils.

Appendix 10: Elikhala Game session description canvas

GAME	Farmers' Game
SESSION	1 – Elikhalla
	GENERAL INFORMATION
Date	April 2nd
Location	Art College of Ellikhala
Participants	30 people from different WUAs and irrigation administration. Mostly managers and technicians (farmers were on the fields for seedling). Most women were teachers.
	SETTINGS
Calibration	Lost
Roles assignement	2 independent WUAs with 6-7 pairs of players
	WUA1 : manager was a manager of something else than a WUA; mirab was really mirab
	WUA2 : manager and mirab were really manager and mirab of the same WUA
Scenario	1 year with enough water for all cotton
	1 year with 60% water 1st year
Other	Very beautiful large official rooms.
	Lot of official (among who the Hakim) coming in and out
	Different rule from Kushkupil : farmers have to go to manager and tell about their crops
	ANIMATION AND OBSERVATION (WHO, HOW, HOW LONG)
Game presentation	30 minutes, live translation from Shuhat
Game animation	1 hour. 2 time steps
	1 group by Madina, the other one by Shuhat
Observation	Nizom and Andrei
Debriefing	Very short.
	All together, directly by Shuhat and Madina

GAME EVENTS

Less favorized farmers gave little money to get water from favorized one, through mirab

A farmer gave water to another one in promise he will have it back the following year. Next year the other one had to beg for water loans from his fellow to pay his debt.

A farmer gave water to a lady without counterpart

Negotiations essentially between farmers, not with mirab

Old player did bribe the facilitator to get more yield and arguing he should win because of his

status

Farmers wanted to replace mirab because they were not happy with him

WUA1 sold water to WUA2. They wanted to give them the water but they were suggested to sell it.

Less crops in scarce year for WUA2

Fee proportional to number of plots for 1 WUA, same for everybody for the other one.

Water is given first to state order, then to other crops

DEBRIEFING POINTS AND GAME SIDE DISCUSSIONS

WUA usually give each other excess water

It is not possible to sell water to each other for farmers but they would like to

WUA managers decide how to allocate water according to land quality

They want to grow rice. No other crop because they get diseases

WUA thinks of water efficiency and farmers have to think about crop profit

WUA technicians centralize information. They know who has enough water and who has not

OTHER RESULTS / INFORMATION

COMMENTS

Very centralized session with professional managers using calculators and writing people water allocation on paper while they did not have to

Women were asking for calculation to men next them

Farmers were leading the round with enough water (choosing crop..) but managers were leading the round with scarce water (using water efficiently)

ANALYSIS : hypothesis raised, further investigation needed….

WUA managers played farmers and realized that farmers cannot think only of water efficiency, they need also to think about crop profit.

In the game farmers negotiate water between each other, with or without counter part. Water selling is forbidden but they would like it.

WUA give excess water to each other

WUA allocates water according to soil quality

WUA technicians centralize information

State order get water first.







Appendix 11: People Involved and Time Consumed

The following table lists the Uzbek and European scientists involved at some level in the RPG process

Id	Nom	Institution	Role in the RPG process
GA	Geraldine Abrami	Cemagref UMR G-EAU	Main Designer
OB	Olivier Barreteau	CemagrefUMR G EAU	Senior Expert
NM	Neela Matin	York University	Associate Designer
MS	Maja Schlueter	UFZ Leipzig	Associate Designer
AS	Abdulkhakim Salokhiddinov	Tashkent Institute of irrigation	Local Expert
GK	Gulchekhra Khasankhanova	Ministry of Agriculture and Water Resources	Local Expert + Facilitator
RT	Raisa Toryanikova	Research institute of the Uzbek Hydrometeorological Service in TAshkent	Local Expert
IJ	Ilya Joldasova	Uzbekistan Academy of Science in Nukus	Local Expert + contact in North Karakalpakstan
AM	Ablatdyin Musaev	ecology team in Nukus	Local Expert + contact in North Karakalpakstan
SK	Salikh Khanzin		Local Expert + contact in South Karakalpakstan
MK	Madina Khakmirzaeva	Tashkent Institute of irrigation	Local Expert °Facilitator
SM	Shuhat Maksumov	Central Asia Consulting Group	Facilitator
AZ	Andrey Zaikin	Tashkent Institute of irrigation	Field Assistant
NMa	Nizom Matkatrimov	Tashkent Institute of irrigation	Field Assistant
BB	Bahtiyor Bobadjanov	representative of WUA authority	Contact in Khorezm

Then for the 2 tests, were involved for around 2h

- 6 scientists and students from Newater
- 6 students from Tashkent Institute of Irrigation

The involvement of these people can be approximated to 2.5 p/m from September 2007 to March 2008:

- 1.5 pm was spent from September 2007 to March 2008 in designing the RPG. Most of this time was consumed by the designers (more than 1 pm by the main designer), plus a few hours by local experts and people involved in the tests.

- 1 pm was spent in 7 days for the workshops with 3 people (main designer + facilitators) almost full time

Finally 1 additional pm was spent after the workshops on building and agent-based model and writing a paper.

Details can be read on the following table

Phase	Period	Detail	number of days	number of people	people		TOTAL p/d	Main Designer TOTAL p/d
DESIGN 1	sept-nov 2007	design phase 1 - europe	15	1	Main Designer	15		
			2	2	Associated Designers	4		
		test 1 - europe	0.25	8	Associated Designers + Students	2		
	Nov-07	design phase 1 - uzbekistan	4	1	Main Designer	4		
			1	2	Local experts	2		
		test 1 - uzb	0.25	8	Local Students	2		
							29	**19**
DESIGN 2	Mar-08	design phase 2 - europe	2	3	Main + Associated Designers	6		
			3	1	Main Designer	3		
		design phase 2 - uzbekistan	1	1	Main Designer	1		
			1	1.5	Local Experts	1.5		
							11.5	**6**
RPG WS	Mar-08	Implementation	2	1	Main Designer	2		
			0.5	2	Local Experts	1		
		Workshops	2	5		10		
		Internal Debriefings	1	3	Main Designer + Local Experts + Facilitators	3		
		Design adjustments	1	1.5	+Field Assistants	1.5		
		Reporting	0.5	1	Main Designer	0.5		
		Cold debriefing	0.5	1	Associated Designer	0.5		
							18.5	**6.5**
ABM	May-Jul 08	Process assesment and follow up	3	3	Main + Associated Designers	9		
		ABM design	0.5	1	Main Designer	0.5		

	Feb-Apr 2009	ABM design	4	2	Main + Associated Designers	8		
		ABM implementation	2	1	Main Designer	2		
		ABM test and valorisation (ESSA paper)	2	2	Main Designer + Associated Designer	4		
							23.5	**11.5**
							82.5	**43**

Finally the following tables lists the participants (stakeholders) of the April 2008 workshops. All participants were involved in the RPG workshop for ½ day.

List of WS's participants in Qushqupir

Location "Urta yop" – rural council community

	First name and last name	WUA
1	Khojaeva Zuhra	WUA Ashirmat
2	Matnazarov Jumanazar	WUA Ashirmat, driver
3	Polvonova Nazira	WUA Ashirmat account
4	Ushokov Quronboy	WUA Ashirmat
5	Saidov Olimboy	WUA "Ashirmat", farmer
6	Sobirov Nurmamat	"Urta ep" village's community head
7	Quljonov Yangiboy	WUA "Ashirmat", farmer
8	Saidova Sholmonjon	WUA "Ashirmat", farmer
9	Abdullaeva Ugiljon	WUA "Ashirmat", farmer
10	Rahmonova Rajabibi	WUA "Ashirmat", farmer
11	Hayitova Zulfiya	WUA "Ashirmat", farmer
12	Dusumbaev Zarifboy	WUA "Ashirmat", farmer
13	Jabborov Rustam	«Ashirmat» village community member
14	Bekchanova Gulnora	WUA "Keneges", farmer
15	Allaberganova Rohat	WUA "Keneges", farmer
16	Turaeva Nigora	WUA "Keneges", account
17	Matchonova Roza	WUA "Keneges" farmer
18	Khusainova Bekposha	WUA "Keneges", farmer, hydrotechnic
19	Allazarov Otanazor	WUA "Keneges", farmer
20	Eschanov Said	WUA "Keneges", farmer
21	Davletov Sanat	Manager of WUA "Keneges", farmer

22	Kalandarov Otavon	«Кенегес» СФУ назоратчиси
23	Sattarov Ruzmat	WAU “Keneges”, farmer
24	Hasanov Matchon	First deputy of region water authority
25	Boltaev Tohir	Head of district water authority
26	Otajonov Otaboy	Managers of WUA “Ashirmat”
27	Usupov Botir	WUA “Ashirmat”, worker in the farm
28	Abdullaev Ruzim	WUA “Ashirmat”, worker in the farm
29	Boltaeva Dilorom	WUA “Ashirmat”, worker in the farm
30	Qutlimuradova Sharifa	Village community officer
31	Bobojonov Bozorboy	Village community officer
32	Quriyozov Omon	Village community officer
33	Nurmetov Bekchan	Village community officer
34	Tojiev Obod	Village community officer
35	Sobirov Otaboy	WUA “Ashirmat”, worker in the farm

List of WS’s participants “Elikalla»

	Last name and first name	Position	Location
1	Jumaniyozov Bog’dagul	«Paxta Arna Nayman» official	
2	Karimboeva Gulshod	«Paxta Arna Nayman» official	
3	Abdalov Quromboy	«Paxta Arna Nayman»	« Erna Jumagul » manejer
4	Reyimboev Usmon	«Paxta Arna Nayman»	« Nurulla Hofiz » manejer
5	Saimbetova Zima	«Paxta Arna Nayman»	ITB
6	Mambetov Satim	«Paxta Arna Nayman» WUA chairman	
7	Qurbonov Ozod	«Paxta Arna Nayman» accountant	
8	Erimbetov Jaqsiliq	Farmer	
9	Toreboev Maqsud	Depute Hakim	
10	Xaitboeva Aqchako’l	Melioration	
11	Toreniyozova Munavvar	Melioration	
12	Qurbonov Qozibek	Inspector	
13	Yusupov Yangiboy	«Bo’z yop» WUA chairman	
14	Allanazarov Rashid	Farmer	

15	Matnazarov Bozorboy	«Chashma bulog'i»
16	Yuldoshev Jumanazar	«Chashma bulog'i»
17	Ro'zimov Murod	«Buston» WUA
18	Qalandarov Ilxom	Accountant
19	Berdanova Obodon	Farmer
20	Urinov Zoir	Farmer
21	Jumaniyozov Samandar	«Qirqqiz»WUA
22	Matiyoqubov Komil	WUA accontant
23	Karimov Ibodulla	WUA
24	Aminov Ozod	Farmer
25	Amanboev Baxtiyor	Accountant
26	Sultonov Romon	Mexanik
27	Sultonov Mustafo	«Jayxun sohili» WUA
28	Jumaniyozov Saparboy	WUA chairman
29	Karimov Yaqurboy	Accountant in farmer
30	Xudoyberganov Ibrogim	«Uysalang» WUA
31	Begmanova Shukurjon	Farmer
32	Matchanova Muyassar	Farmer
33	Niyazimbetova Venera	Farmer
34	Jumaboev Erkin	Biusnesman
35	Jonibekov Maxmud	«Jonibek Sharif» farm

List of WS's participants "Muynak-Shege» - only men did take part in RPG

	Last name and first name	Position	Location
1	*Nurseytova Gulnor*		*Muynak qalasi*
2	*Palmanova Bazarxan*		*Muynak qalasi*
3	*Saparova Ig'ilimxan*	*Retairment*	*Shege*
4	*Alieva Zauresh*	*Retairment*	*Shege*
5	*Farieva Sapargul*	*Retairment*	*Shege*
6	*Jamoxova Zulfiya*	*Houswait*	*Shege*
7	*Bekmurotova Ayposha*	*Houswait*	*Shege*
8	*Nizamatdinova Amangul*	*Economis*	*Shege*
9	*Joldaseva Iliya*		*Nukus*
10	Sadikiv Abay	Retairment	Shege
11	Nurillaev Paraxat	Chairman water organization	Muynak
12	Taqirbekov Kurbonboy	National protection commute	Muynak
13	Duysenov Rustam	Hakimiyat	Muynak
14	Saitbekov Jaksiliq	Sekurety	Shege

15	Ismailov Kuvadik	speshilist	Shege
16	Nizamatdinov Boranboy		Shege
17	Abdiganiev Manas	School director	Shege
18	*Nasirova Botako'z*		*Shege*
19	*Sadikova Gulxan*		*Shege*
20	*Qulekeeva Zuxra*		*Shege*
21	*Qoyguileva Zao'resh*		*Shege*
22	*Do'sjonova Sheyrigul*		*Shege*
23	*Allanazarova Poyduq*		*Shege*
24	*Nizamatdinova Amangul*		*Shege*
25	*Dosjanova Bog'dagul*		*Shege*
26	*Madreimova Gulzira*		*Shege*
27	*Dao'letiyaova*		*Shege*
28	Tisuberganov Boltaboey	Doctor	Shege
29	Esboskenov Kutlimurod	Fisherman	Shege
30	Kojametov Salman	Fisherman	Shege
31	Kanyazov Yoqubboy	Fisherman	Shege
32	Alinbaev Batirboy	Driver	Shege

List of WS's participants "Muynak-Sarbast»- only men did take part in RPG

	Last name and first name	Position	Location
1	Kallibekov Maskao'boy		Muynak qalasi
2	Berdiboev		Muynak qalasi
3	Idoev Sanadil	Retairment	Shege
4	*Tleumuratova Anjim*	*Retairment*	*Shege*
5	*Jalgasbaeva Ranoy*	*Retairment*	*Shege*
6	*Qidirbaeva Mehribon*	*Houswait*	*Shege*
7	*Bekmurotova Ayposha*	*Houswait*	*Shege*
8	*Nizamatdinova Amangul*	*Economis*	*Shege*
9	*Joldaseva Iliya*		*Nukus*
10	Sadikiv Abay	Retairment	Shege
11	Nurillaev Paraxat	Chairman water organization	Muynak
12	Taqirbekov Kurbonboy	National protection commute	Muynak
13	Duysenov Rustam	Hakimiyat	Muynak
14	Saitbekov Jaksiliq	Sekurety	Shege
15	Ismailov Kuvadik	speshilist	Shege

16	Nizamatdinov Boranboy		Shege
17	Abdiganiev Manas	School director	Shege
18	*Nasirova Botako'z*		*Shege*
19	*Sadikova Gulxan*		*Shege*
20	*Qulekeeva Zuxra*		*Shege*
21	*Qoyguileva Zao'resh*		*Shege*
22	*Do'sjonova Sheyrigul*		*Shege*
23	*Allanazarova Poyduq*		*Shege*
24	*Nizamatdinova Amangul*		*Shege*
25	*Dosjanova Bog'dagul*		*Shege*
26	*Madreimova Gulzira*		*Shege*
27	Dao'letiyaova		Shege
28	Tisuberganov Boltaboey	Doctor	Shege
29	Esboskenov Kutlimurod	Fisherman	Shege
30	Kojametov Salman	Fisherman	Shege
31	Kanyazov Yoqubboy	Fisherman	Shege
32	Alinbaev Batirboy	Driver	Shege