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Research Report

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Abstract

We use decision making experiments to understand how we can promote equitable distribution of water and efficiency of water use while reducing conflicts between water users located upstream, midstream and downstream of the Chao Phraya river basin in Thailand. The participants in our study are farmers who face such problems on a daily basis. We look at two experimental treatments: (1) negotiation between representatives from each area and (2) trading between water users and compare the outcomes to a control treatment where no such negotiation or trade is possible. We find that negotiation reduces inefficient water usage. Moreover, negotiation leads to a reduction in the earnings gap between upstream, midstream and downstream water users. Water users express a preference for negotiation rather than trade.

JEL Classification: C79, C93, Q1, Q25

Keywords: Artefactual field experiment; Common pool resource extraction; Water sharing

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1. Introduction

The availability of fresh water in the Chao Phraya river basin in Thailand is under threat from climate change and human population growth. Climate change has led to altered precipitation patterns, which, in turn, have increased the frequency and severity of droughts. The water shortages resulting from droughts are compounded by human population growth and increased extractions to meet municipal and agricultural demands (Vörösmarty et al., 2000). As water becomes increasingly scarce and demands from different users rise, this often creates conflict between upstream and downstream users of water. If and when the upstream users hoard water, the flow of water to downstream areas is reduced considerably. This implies that a more integrated watershed management approach is required, and any such system should explicitly incorporate downstream concerns into upstream policy and decision-making processes (Petes et al., 2012).

Deliberative and participatory processes are gaining prominence as effective tools for better usage of common pool resources including watershed management and promoting mutual understanding between upstream and downstream water users (Johnson et al., 2001). An increasingly popular method of studying the effectiveness of such deliberative processes in addressing problems of local public good provision or common pool resource extraction are decision making games – often referred to as "artefactual field experiments" (Becu et al., 2003; Hagmann and Chuma, 2002; Harrison and List, 2004).[1] Such games can serve as a means for effective communication among water users and allow participants to reflect on the distribution and usage of water in various situations so that they can make appropriate decisions. By allowing water users to learn about complex issues in a relatively relaxed and tension-free environment, such games demonstrate how one's individual actions affect other users; this can help create greater understanding of the problem of collective action and create opportunities for cooperation (Burton, 1989; Barreteau et al., 2001; Lankford et al., 2004).

In this paper, we design an experiment to study the issue of water sharing among upstream, midstream and downstream water users in the Chao Praya river basin. The participants are farmers from two areas, namely Kra-Siao Reservoir in Suphanburi province and Tap-Salao Reservoir in Uthai Thani province and were recruited from upstream, midstream and downstream catchment areas. The key objective of the experiment is to consider ways of reducing excessive water extraction and hoarding upstream and enable the release of water to downstream areas, thereby reducing tension and conflict between upstream and downstream users. In particular, we test whether allowing representatives of different areas to communicate and negotiate the amount of water to extract and allowing the participants to trade any extra stored water have an impact on the amount of water storage. Prior experimental research has found that communication among participants typically leads to increased cooperation in social dilemma situations (Chaudhuri, 2011, Ledyard, 1995, Ostrom, 1990, Ostrom et al., 1992, 1994).

We also look at whether or not allowing participants the opportunity to trade water they have collected improves equitable distribution of water and efficiency of water use. Our results show that by allowing water users to negotiate water extraction and usage reduces water hoarding by upstream water users and reduces inefficient use of water resources. Compared to our control treatment negotiation

[1] An "artefactual" or "framed" experiment refers to a study like this one where we examine behaviour using a non-standard subject pool and explicitly introduce context from the field to the laboratory experiment by using loaded language and roles specific to the context. There has been a tradition in experimental economics of relying
on non-emotive neutral language in experiments. However, there is growing evidence that providing a context for the experiment might be desirable, especially in cases when the participants have direct experience with the particular context being studied. For example, both Cooper et al., (1999) and Harrison and List (2004) find that introducing a context that expert subject pools recognize from their past experiences triggers an application of learning from those past experiences.

and/or trade reduces the earnings gaps between upstream, midstream and downstream water users. However, despite the success of trade in promoting greater efficiency, of water users preferred negotiation to trade.

The rest of the paper is structured as follows. Section 2 describes the experimental design. Section 3 presents the results. Section 4 contains a discussion about water users' preference for negotiation over tread. Section 5 concludes. The appendix contains the instructions and all visual aids used in running the experiments.

2. Experimental design and procedures

Forty five participants were recruited from Kra-Siao Reservoir in Suphanburi province and Tap-Salao Reservoir in Uthai Thani province. A total of 28 participants are from Kra-Siao Reservoir (9 are from upstream area, 14 from midstream area and 5 are from downstream area). A total of 17 participants are from Tap-Salao Reservoir (8 from upstream, 4 from midstream, and 5 from downstream.) While participants have no prior experience with the specifics of our experiment, they are faced with water scarcity and conflicts in real life. All experiments were conducted at the meeting rooms at the Wang Yang Resort Hotel and Spa in Suphanburi province.

At the beginning of each session, the experiment monitor explained the game to participants along with power points demonstrating each step of the game. We also provide participants with printouts of summary instructions. See appendix for this material. There are three treatments: (1) control; (2) negotiation and (3) trade. There are 15 participants in each treatment with five upstream, five midstream and five downstream rice farmers. The distance of each farm to the river canal is ranked in order from the closest to the river canal to the furthest from the river canal. At the start of a session participants were assigned at random to each of these five locations within each area – upstream, midstream or downstream. Once assigned these roles remain unchanged for the duration of the session. Each farmer has a 1,600 square meters piece of land to grow rice.[2] Participants were told that the only resource they need to grow rice is water, which is provided at zero cost. We use marbles to denote quantities of water extracted with one marble representing one unit of water. Each farmer needs at least 2 units of water to successfully grow and harvest rice. Given 15 farmers in a session this implies 30 units of water (30 marbles) are required in order for every farmer to successfully harvest their rice.

The experiment consists of a number of rounds, with each round representing a year. The number of rounds is not announced before-hand. In reality the experiment ran for 15 rounds in each session. In each year, farmers harvest twice, once during the rainy season and another during the dry season and they need water for this. The only decision they have to make is how many marbles to pick. The upstream to downstream flow of water is implemented the monitor carrying a box full of marbles for each farmer to collect. The upstream farmer located closest to the river gets to choose first as to how many marbles (how much water) he/she wants to extract. This is followed by the upstream farmer second closest to the canal, and so on. Once all five upstream farmers have chosen the amount of water they would like to keep, farmers in the midstream get to move in the same order closest to farthest with the downstream farmers moving last. Clearly the greater the extraction of water by upstream farmers the less there is available for downstream ones.

Water available for extraction varies depending on the season. In the rainy season there is more water (in the form of more marbles) available compared to the dry season. There is also a probability that some years may experience a drought Farmers were informed that a drought could occur 2 times within a

[2] Thai farmers commonly use the term "rai" to represent the area of the farm. Hence we use this term in our experiment. 1 rai is equivalent to 1,600 square meters.

10 year period. The amount of water available in a drought is lower compared to the typical dry season. The differing availability of water during different seasons is implemented by having 4 to 20 marbles available for extraction during a drought, 22 to 46 marbles during the dry season and 68 to 80 marbles available in the wet season.

There is also a possibility that water stored might evaporate due to unexpectedly high temperatures. Water evaporation is more likely in the dry season than the rainy season. We assign a probability of 0.33 to water evaporating in the dry season and 0.2 to water evaporating in the rainy season; where the evaporation rate is 1 unit of water, which implies that 1 marble will be taken away from the farmer. In order to determine the evaporation rate we placed 4 orange balls and 1 white ball in a box during the rainy season and 2 orange balls and 1 white ball during the dry season. We asked each stream to select one farmer to pick a ball from the box. If he/she picks a white ball then the experimenter will remove one unit of water from every farm in that stream. Picking an orange ball does not affect the amount of water collected. Moreover the farm will get flooded if more than 6 units of water (6 marbles) are stored in the farm. In this case farmers will not be paid for that season. This essentially imposes an upper limit of 6 on water extraction by any individual farmer. Instructor announced aloud the range of the amount of marbles provided for that season prior to the beginning of each season.

Each round (year) consists of a rainy season and dry season. In some years the dry season may result in a drought. At the beginning of each round (year) the monitor announces the range of marbles that are available. For instance, in the rainy season of Round 1 the announced range is 68 to 74 while the actual number of marbles available is 70. For the dry season of Round 1, the range announced is 30 to 36, while the actual number of marbles is 30. See Table 1 for the announced range of marbles and the actual number of marbles available in a given round. Only the upstream farmers can see the actual amount of marbles. The midstream and downstream farmers only see the amount of marbles that is left for them to choose. At the end of each session, the monitor collects all the marbles; therefore farmers are not able to store marbles in the wet season to use in the dry season.

Each farmer gets paid at the end of every season if at least two marbles remain in his/her farm. Farmers in the upstream area get a lower payoff compared to midstream and downstream farmers. This is because agricultural water productivity is generally lower in the upstream areas compared to the other locations. In our experiment upstream farmers receive 10 baht per farm if at least two marbles remain in his/her farm at the end of the season. However midstream and downstream farmers receive 15 baht per farm if at least two marbles left in his/her farm at the end of the season. As noted above there are 15 rounds in each session. Out of these the first three rounds are used for practice. Farmers choose how many marbles to pick. There is no opportunity for negotiation or trade. There is also no payment for these rounds.

Rounds 4, 5 and 6 are also control rounds with no negotiation or trade, except here the farmers are paid for their marbles. In one of the three sessions there is no intervention and the farmers here continue to play in the same way as round 4-6, for another 9 rounds, 7-15, getting paid for each round. Each round in the control treatment proceeds in the following manner. First, the monitor announces out loud the range of water available at beginning of each season, rainy or dry. Then farmers are asked to draw water into their farm in the order mentioned before. After that each area (upstream, midstream or downstream) selects a farmer to pick a ball to see whether or not the water collected will evaporate. Finally, the payoff of each farmer is calculated and recorded.

In the other two sessions, a treatment in the form of instructions regarding negotiation or trading is introduced prior to the beginning of round 7. The negotiation treatment is the same as the control treatment except that each stream is asked to select a representative to negotiate the amount of water each stream would like to keep after the range of water available has been announced and before each famer can draw water. The negotiation process takes place in the different room. We asked the representative farmers to write down the amount agreed on a piece of paper and bring back to their compatriots and share this information with the other farmers in their respective area. Farmers are informed that this agreement is non-binding.

In the negotiation treatment, prior to Round 7, the following message was provided to farmers on a piece of paper and the monitor also read the message out loud for all farmers to hear.

> *"Before collecting marbles in the following years, we ask each stream to send a representative at the beginning of each season to negotiate the total amount of marbles each stream would like to collect. The experimenter will provide a piece of paper to keep a record of these numbers."*

The trade treatment is similar to the negotiation treatment except that here prior to the start of Round 7, farmers are given the opportunity to buy and sell water after water has been drawn into every farm and before the evaporation process. Buyers and sellers negotiate the price and number of marbles they would like to buy and sell.

The following message was provided to farmers on a piece of paper and the monitor also read the message aloud for all farmers to hear prior to the beginning of year 7.

> *"Before collecting marbles in the following years, we ask each area to send a representative at the beginning of each season to negotiate the total amount of marbles each area would like to collect. The experimenter will provide a piece of paper to keep a record of these numbers. Once all farmers have placed the collected marbles in their farms, they are able to buy and sell marbles that they have collected. They can use the money earned in the earlier years (year 4 to 6) to buy marbles. The price of marble is set by buyers and sellers. Once the trade process is over, we will carry on with the evaporation process."*

Our trade treatment is motivated by the following consideration. Water use in Thailand is free as the country has an open access rights regime. Given the increasing water scarcity in the Chao Phraya river basin, we want to explore whether or not the farmers are willing to trade water when water is scarce. We know that there are several constraints that inhibit the emergence of water market for water, e.g., clearly defined rights, measurement of volume of water, establishment of water rights, etc. However, the experiment is designed as a preliminary step towards understanding the farmers' behavior.

We will focus primarily on the decisions made in the last 9 rounds, i.e., round 7 through 15, following the intervention in the two treatment conditions. There are 15 participants in each treatment – control, negotiation and trade – making two decisions per round. This gives us a total of 15X2X9 = 270 observations in each treatment for a total of 810 observations across three treatments. Each session lasts around 2 hours. Participants are allowed to communicate with other players in the same stream but they are not allowed to communicate across streams unless told otherwise. The total earning per person on average is 177 baht. Each participant received a show up fee of 800 baht in addition to the traveling cost. Table 1 presents the actual amount of marbles available and the announced range for each season and year.

Table 1: Actual amount of marbles and the announcement for each year and season

Year	Season	Actual marbles	Announcement
1. Control no payment	Rainy	70	68-74
	Dry	30	30-36
2. Control no payment	Rainy	68	62-68
	Drought	20	20-26
3. Control no payment	Rainy	76	76-82
	Dry	36	36-42
4. Control with payment	Rainy	74	72-78
	Dry	32	28-34
5. Control with payment	Rainy	76	74-80
	Dry	28	22-28
6. Control with payment	Rainy	78	72-78
	Dry	30	24-30
7. Control/Negotiation/Trade	Rainy	74	72-78
	Dry	28	26-32
8. Control/Negotiation/Trade	Rainy	76	76-82
	Dry	24	24-30
9. Control/Negotiation/Trade	Rainy	78	78-84
	Dry	32	28-34
10. Control/Negotiation/Trade	Rainy	72	68-74
	Drought	14	14-20
11. Control/Negotiation/Trade	Rainy	76	74-80
	Dry	26	24-30
12. Control/Negotiation/Trade	Rainy	72	66-72
	Dry	30	30-36
13. Control/Negotiation/Trade	Rainy	76	76-82
	Dry	34	28-34
14. Control/Negotiation/Trade	Rainy	78	72-78
	Drought	16	16-22
15. Control/Negotiation/Trade	Rainy	76	76-82
	Dry	34	28-34

3. Experimental results

3.1 Amount of water extraction

Result 1: (i) Water extraction in rainy season is higher in the control treatment compared to the other two treatments; this effect is particularly pronounced for downstream farmers in the rainy season; (ii) upstream farmers extract more water in dry season in all three treatments.

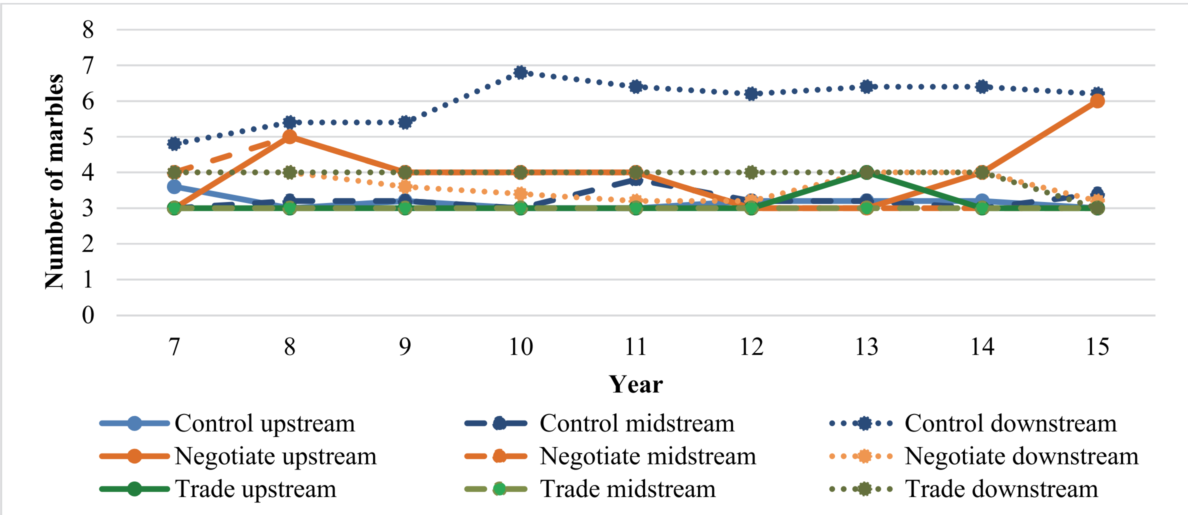
On average, during rainy season farmers draw more water into their farms in the control treatment (4.13 units) compared to the negotiation treatment (3.76 units) and the trade treatment (3.33 units). Downstream farmers in the control treatment drew collected the most the water (6 marbles on average). In the dry season, we find that upstream farmers, who get to choose first, draw more water in all three treatments. In the control treatment, upstream farmers collected 3.09 marbles, midstream farmers collected 1.6 marbles and downstream farmers collected only 0.6 marbles. In the negotiation treatment, upstream farmers collected 1.87 marbles, while midstream farmers collected 1.64 marbles, and downstream farmers collected 1.78 marbles. In the trade treatment, upstream farmers collected 1.98 marbles, while midstream farmers collected 1.53 marbles, and downstream farmers collected 1.78 marbles. Table 2 reports the average number of marbles collected by each stream and treatment.

Table 2: Number of marbles collected by each stream and treatment on average

Treatment	Stream	Rainy season	Dry season
Control	**Average**	**4.13**	**1.76**
	Upstream	3.16	3.09
	Midstream	3.22	1.6
	Downstream	6.00	0.6
Negotiation	**Average**	**3.76**	**1.76**
	Upstream	4.00	1.87
	Midstream	3.67	1.64
	Downstream	3.62	1.78
Trade	**Average**	**3.33**	**1.76**
	Upstream	3.11	1.98
	Midstream	3.00	1.53
	Downstream	3.89	1.78

Figure 1 shows extraction patterns over time. Looking at the average amount of water drawn over time, we find that in the rainy season farmers who are located in the downstream area of the control treatment consistently drew more water compared to the other streams and treatments. No farmers in any treatment collected less than 3 marbles which is a rational choice given that water could evaporate by 1 unit.

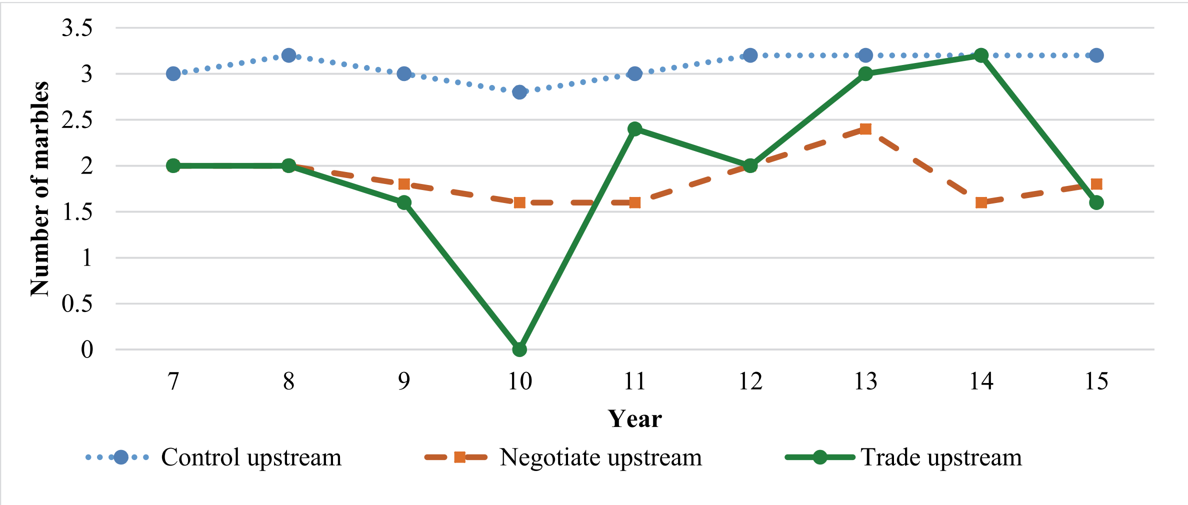
Figure 1: Amount of water drawn into the farm in the rainy season over time



In Figure 2 we focus more closely on the behavior of upstream farmers over rounds 7 through 15, given that they have first mover advantage. We found that farmers located in the upstream area in the control treatment consistently drew more water compared to the other treatments, on average around 3 marbles. In the negotiation treatment, the amount of water upstream farmers drew is on average around 2 marbles and this is consistent over time. There is considerable fluctuation in water extraction in the trade treatment but in general the average amount extracted here is less than that in the control treatment. Note that in year 10 which was a drought year none of the upstream farmers and midstream farmers in the trade treatment chose to draw any water into their farms. Therefore all the water was left for downstream farmers to collect.

We investigated this issue further by looking at the conversation recorded during the negotiation process. We found that all upstream farmers have agreed to first see what the other streams would like to do. If the other streams want all the marbles then they are happy to not take any marbles in that year. As for the midstream farmers, they stated during the negotiation process that in this year only 14-20 marbles available therefore they asked upstream farmers to pass all the water to the downstream farmers.

Figure 2: Amount of water drawn by the upstream farmers in the dry season over time



3.2 Water-use efficiency

Results 2: Intervention such as negotiation between streams reduces an inefficient use of water resources in the dry season.

In order to calculate water-use efficiency we divided earning of each farmer by the number of marbles stored in the farm. The average water-use efficiency of each treatment in each year shown in figure 4 used the following equation to calculate:

$$average\_water\_use\_efficiency_t = \frac{\sum_{i=1}^{15} \frac{earning_{i,t}}{no.\_of\_marbles\_stored_{i,t}}}{15}$$

where i represents each farmer in this case we have 15 farmers (upstream, midstream and downstream each has 5 farmers) and t represents year.

The higher the value of water-use efficiency implies that farmers can manage water more efficiently. For example, an upstream farmer who collected 3 marbles and grows crops successfully his/her earning is 10 baht and the efficiency level is 3.33. This farmer is more efficient than those who collected 4 marbles as their efficiency level is lower at 2.5.

We found that in the rainy season the trade treatment generates the highest efficiency followed by the negotiation treatment, and then the control treatment (Figure 3). However in the dry season farmers in the trade treatment generate the lowest level of efficiency. Hence allowing farmers to buy and sell water might give the highest level of efficiency in the rainy season but not in the dry season (Figure 4).

On average, farmers in the control and negotiation treatments achieved similar level of efficiency in the dry season. We would like to note that if water does not evaporate, that is, if we look at the average of the efficient level without water evaporation, we found that the negotiation treatment generates the highest efficiency level in the dry season. The efficiency level is 3.8 with negotiation, 3.6 with trade and 3 for the control treatment.

Figure 3: Water-use efficiency in rainy season across treatments over time

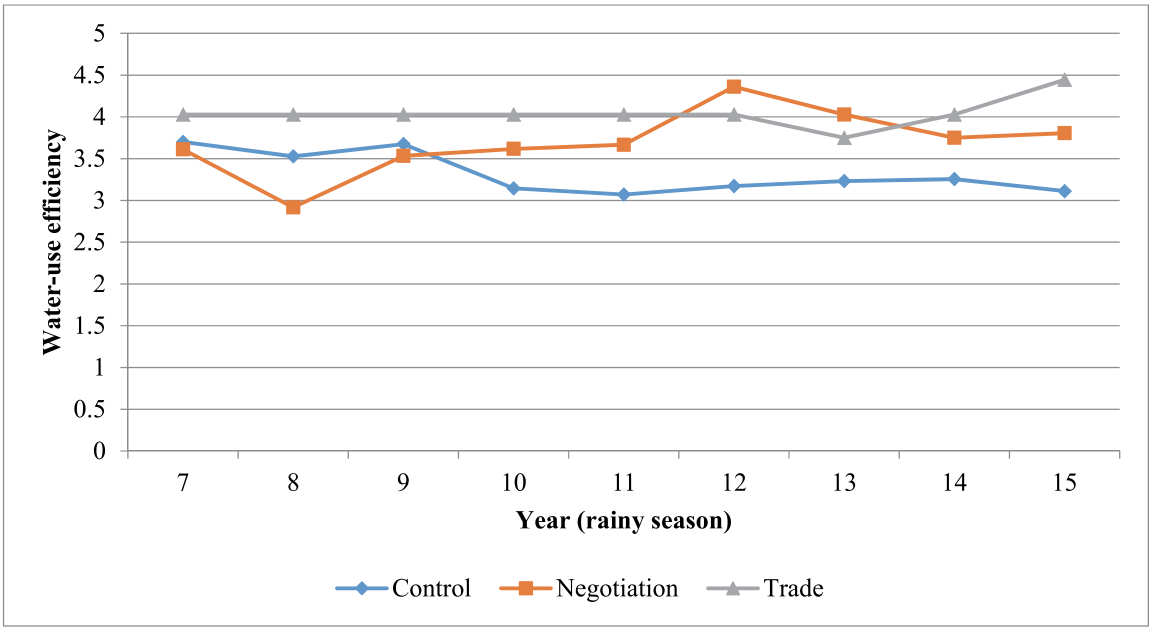
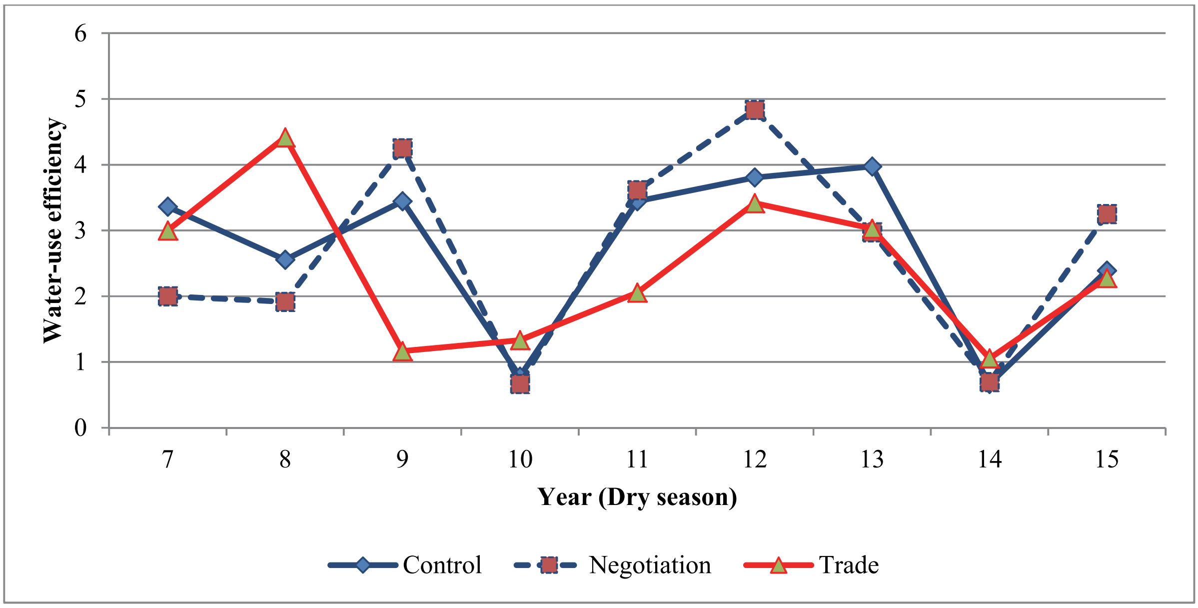


Figure 4: Water-use efficiency in dry season across treatments over time



3.3 Earnings

Result 3: Both the negotiation and the trade treatments reduce the earnings gap between upstream, midstream and downstream farmers.

Table 3 reports the average earnings by treatments, streams, and seasons. We found the average earning per person per season for all three treatments is 10 baht with a higher average earning of 13 baht in the rainy season compared to the dry season of 7 baht. We observe that on average downstream farmers in the control treatment earn the least in the dry season due to the small amount of marbles left for them to collect. Negotiation and trade increase earnings of downstream farmers compared to the control treatment. Average earning of 9.33 baht in the negotiation treatment and 7.67 baht in the trade treatment compared to 2 baht in the control treatment.

The range of earning in the dry season between upstream, midstream, and downstream is between 2-9.7 baht in the control treatment, 5.3-9.3 baht in the negotiation treatment and 4.9-7.7 baht in the trade treatment. Since the range is much smaller in the negotiation and trade treatment compared to the control treatment, this implies that negotiation and trade interventions yield more equitable distribution of earnings.

Table 3: Average earning by streams and treatments

Treatment	Streams	Both seasons	Rainy season (baht)	Dry season (baht)
Control	**Total**	**2,530**	**1,575**	**955**
	Average	**9.37**	**11.67**	**7.07**
	Upstream	9.78	10	9.56
	Midstream	12.33	15	9.67
	Downstream	6	10	2
Negotiation	**Total**	**2,730**	**1,800**	**930**
	Average	**10.11**	**13.33**	**6.89**
	Upstream	7.67	10	5.33
	Midstream	10.5	15	6
	Downstream	12.17	15	9.33
Trade	**Total**	**2,675**	**1,800**	**880**
	Average	**9.91**	**13.33**	**6.52**
	Upstream	7.44	10	4.89
	Midstream	10.94	15	7
	Downstream	11.33	15	7.67

3.4 Regression analysis

We use regression analysis to understand the pattern of water usage in various treatments. We have cross-section of subjects making a series of decisions over time. Thus the appropriate way to treat the data generated is to use a panel data model. All 15 participants in each treatment play the game for 9 years with two seasons in each year. Hence we have a total of 810 observations.

Let W_{it} be the water stored of player *i* in year *t*. This observed water stored W_{it} equals the desired water stored, W_{it}^* (which is the latent variable), if and only if $0 \le W_{it}^* \le 6$.[3] Therefore we have:

[3] We selected 6 for the upper bound because if a farm stored more than 6 marbles it will get flooded.

$$W_{it} = \begin{cases} 0 & if \quad W_{it}^{*} < 0 \\ W_{it}^{*} & if \quad 0 \le W_{it}^{*} \le 6 \\ 6 & if \quad W_{it}^{*} > 6 \end{cases}$$

and W_{it}^{*} is determined by the following equation:

$$W_{it}^{*} = X_{it}\beta + v_i + \varepsilon_{it}$$

for *i* = 1,…,n and *t* = 1,….,T. The random effects (v_i) are IID $N(0,\sigma_v^2)$ and the error (ε_{it}) are $N(0,\sigma_\varepsilon^2)$ independent of v_i. The amount of water stored by each participant is bounded by zero from below and by eight (units) from above. Thus the model used for this estimation is random effects Tobit regression.

We look at two specifications. The first specification – specification 1 - includes: (1) number of marbles available, i.e., number of marbles left in the bucket for farmers to collect, and (2) interaction terms between treatments and streams – with upstream farmers in the control treatment being the reference category.

In addition to specification 1, specification 2 includes the following individuals' characteristics: (3) age, (4) gender dummy – female as the dummy with male being the reference category, (5) marital status dummy – married as the dummy with single being the reference category, (6) education dummy – vocational studies, and bachelor degree and higher as the dummy variables with secondary education and lower being the reference category, (5) job dummy – daily wages jobs, own business, farming, and unemployed as the dummy variables with public servant being the reference category, (6) social status dummy – social committees, and general citizens as the dummy variables with community leader being the reference category, (7) two dummies for total monthly family income – one for monthly income between 20,000 and 50,000 baht, and another dummy for monthly income more than 50,000 baht with monthly income less than 20,000 baht being the reference category, and (8) number of family members. We control year and the season effects in both specifications.

The results of both specifications are presented in Table 4. Results regarding treatment effects are the same for both specifications. Both specifications report that upstream farmers in the trade treatment collected significantly less marbles compared to upstream farmers of the control treatment. This implies that by allowing water users to buy and sell water reduces the hoarding behavior of upstream farmers. The estimated coefficient for upstream farmers in the negotiation treatment is negative but not significant.

Once we have accounted for the individuals' characteristics (Specification 2), we found that those with vocational education collected marbles significantly more than other education levels. Public servants collected marbles significantly less marbles compared to the other occupations. Thus occupations play an important role in the individuals' decisions.

Table 4: Regression results on the number of marbles collected

Number of marbles collected	Tobit Specification 1	Tobit Specification 2
Age	-	-0.03***
		(0.01)
Dummy female	-	0.09
		(0.23)
Dummy married	-	0.11
		(0.44)
Dummy vocational education	-	0.61*
		(0.31)
Dummy bachelor degree and higher	-	-0.27
		(0.39)
Dummy daily wages jobs	-	0.95
		(0.83)
Dummy own business	-	2.0**
		(0.77)
Dummy farming	-	0.88***
		(0.32)
Dummy unemployed	-	1.15**
		(0.49)
Dummy 20,000< monthly family income < 50,000 baht	-	-0.35
		(0.26)
Dummy monthly family income > 50,000 baht	-	0.87***
		(0.26)
Number of family members	-	-0.20**
		(0.09)
Marbles available	-0.05***	-0.06***
	(0.01)	(0.01)
Control*Midstream	-1.52***	-1.98***
	(0.34)	(0.40)
Control*Downstream	-1.72***	-2.07***
	(0.42)	(0.46)
Negotiate*Upstream	-0.18	-0.37
	(0.32)	(0.37)
Negotiate*Midstream	0.43	0.65
	(0.45)	(0.60)
Negotiate*Downstream	-0.10	-0.08
	(0.46)	(0.50)
Trade*Upstream	-0.57*	-0.84**
	(0.32)	(0.37)
Trade*Midstream	0.54	0.58
	(0.45)	(0.53)
Trade*Downstream	0.65	0.77
	(0.46)	(0.47)
Constant	7.41***	9.61***
	(0.64)	(1.21)
Number of observation	810	702
Number uncensored	646	554
Number lower censored	131	116
Number upper censored	33	32

Note: ***, **, * denote 1, 5 and 10 percent significance respectively.
Standard errors are presented in parentheses.

4. Preference on water management systems

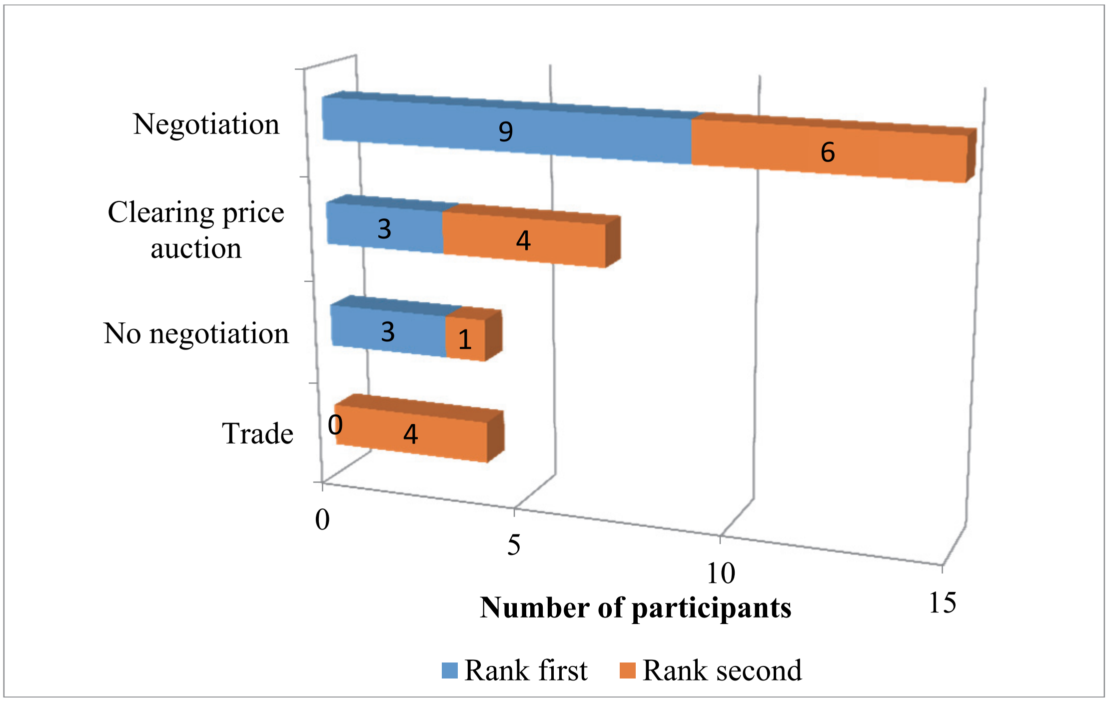
To understand the preference of farmers on different types of water management systems. We allowed the same participants to experience all of the interventions mentioned above, which are (1) no intervention, (2) negotiation, and (3) trade. In addition we added the *"clearing price auction"* treatment. This clearing price auction treatment is a multiunit auction with ascending price where trade will occur only at the market-clearing price, that is, the quantity demanded is equal to the quality supplied at a given price.

Participants are the same as in the negotiation treatment. After we have collected the data for the negotiation treatment we asked participants to stay behind and play two more experiments, which are trade treatment and the clearing price auction treatment. Note that these participants have already experienced the game without any intervention for 3 years before negotiation. Therefore we have 3 years of the control treatment followed by 9 years of the negotiation treatment, 3 years of the trade treatment, and 3 years of the clearing price auction treatment. At the end of the experiment, we asked the participants to rank the most preferred to the least preferred method of solving the water shortage problems.

Figure 5 reports the number of participants that select each method as the most preferred and the second most preferred. We found that the most preferred water management method is allowing representatives to negotiate how water should be divided among the three streams prior to the farming season, followed by the clearing price auction, then no negotiation, and the least preferred method is trade.

We observed that negotiation between representatives of each stream in the trade treatment was very intense. The negotiation in the trade treatment often include upstream representatives proposing to draw most of the water in the dry season and offer to sell to the other streams. Clearly, midstream and downstream representatives opposed to this idea and the negotiation goes on until all parties can agreed to the decision. The negotiation process in the trade treatment took much longer time compared to the other treatments.

Figure 5: Preference of water resource management



5. Conclusions and policy implications

This paper explores whether negotiation between water users and trade improves income equality and reduces conflicts between water users in upstream, midstream and downstream. Our results suggest that negotiation between representatives from different streams reduces an inefficient use of water resources. Earning gaps between water users in upstream, midstream and downstream areas become closer in both the negotiation treatment and trade treatment compared to the control treatment. Occupations play an important role in the individuals' decisions. We found that public servants collected significantly less marbles compared to the other occupations.

Despite the positive impact of trade on earnings, water users prefer this water management system the least and preferred the negotiation system the most. Therefore we suggest that having negotiation between representatives alone is possibly the best practice to improve equity.

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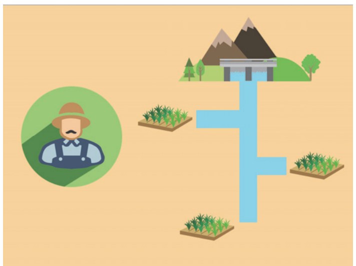
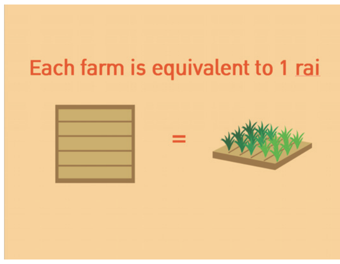
Appendix A

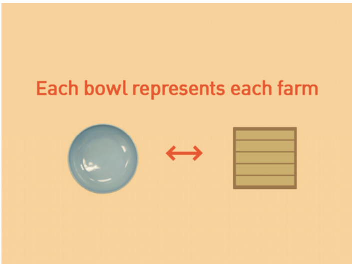


1
Each of you will play a role of farmer. Each farmer will be randomly assigned to a farm which is located either in the upstream, midstream, or downstream.

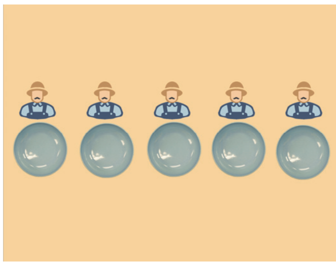
2
There are 5 farms in each stream. Each farmer owns a farm.



3
Each farm is equivalent to 1 rai.

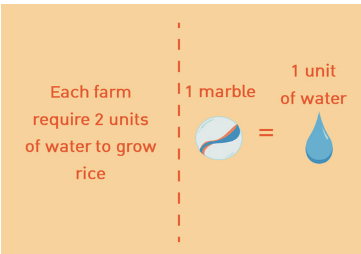


4
We use a bowl to represent 1 rai farm.



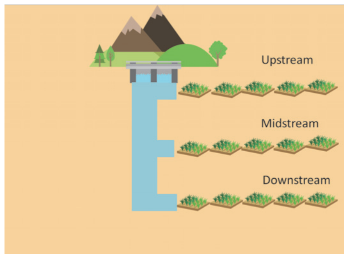
5
Therefore, there are 5 bowls in a stream and each famer owns a bowl.

6
There are two harvesting seasons in a year. One in the rainy season and another is in the dry season.



7
To grow crops successfully each farm needs 2 units of water. We use 1 marble to represent 1 unit of water.

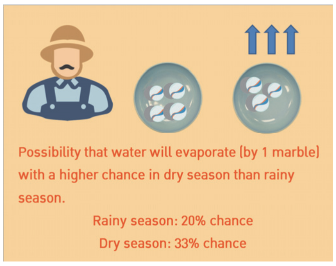
8
Therefore, each farm requires 2 marbles to grow crops successfully. However a farm has more than 6 marbles, this implies that there is too much water in a farm and the farm gets flooded. The crops cannot grow in this situation.



9
Water (marbles) is treated as a free resource and supplied by experimenters. Farmers are asked to collect marbles they wish to keep in their farms to grow crops.

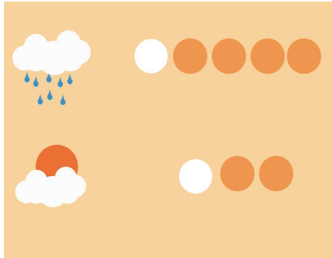
10

There are enough marbles to grow crops for every farm in the rainy season but not in the dry season.



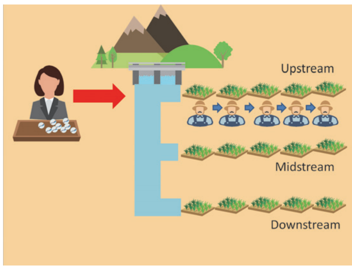
11

Once all the farmers have collected marbles, there is a possibility that 1 unit of water of every farm in a particular stream may evaporate due to high temperature with higher chance in the dry season (33% chance) compared to the rainy season (20% chance).



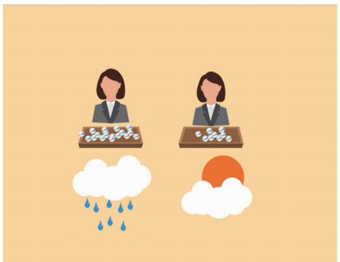
12

One farmer from each stream is asked to pick a ball from a bucket. In the rainy season, there are 4 orange balls and 1 white ball in the bucket. In the dry season, are 2 orange balls and 1 white ball. If the ball picked turn out to be white then this implies that the tempreture is high in that season. Therefore an experimenter will remove 1 marble from the each farm in that stream, otherwise the number of marble remains the same.



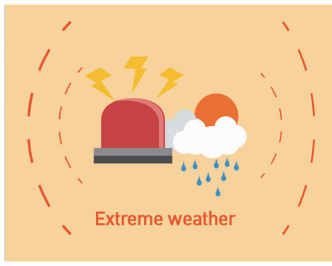
13

The water flow from upstream to midstream then to downstream. To replicate this flow pattern an experimenter will carry a bucket of marbles in this order. Famer located upstream and nearest to the river canal gets to collect marbles first, followed by farmer located in the second closest to the river canal, and so on. Once all five upstream farmers have chosen the amount of water they would like to keep, farmers in the midstream get to move in the same order, and finally farmers in the downstream get to move.



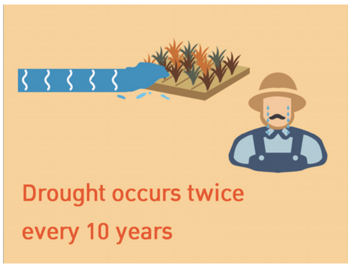
14

There will be plenty of marbles in the rainy season but not enough for every farm in the dry season.

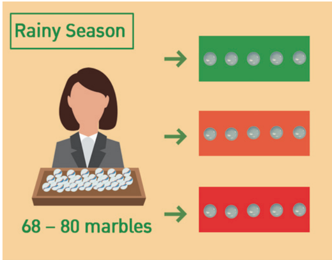


15

There is also a possibility of drought during a dry season, with 0.2 probability of drought occurrence. This means that drought could occur 2 times within 10 years. The amount of water available during drought is lower compared to the typical dry season.

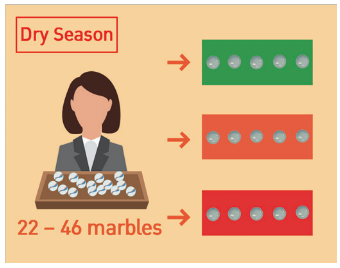


16



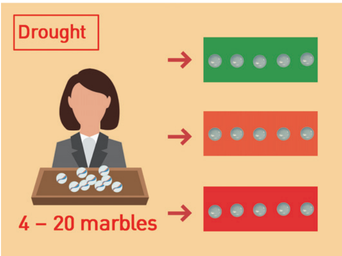
17

In the rainy season, an experimenter will supply between 68-80 marbles.



18

In the dry season, an experimenter will supply between 22-46 marbles.



19

During drought an experimenter will supply between 4-20 marbles.

20

At the beginning of each season, an experimenter will announce aloud the range of the amount of water available for that season prior to the beginning of each season.

21

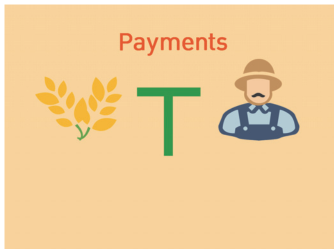
The range is between plus and minus 6 units of the actual amount of water available. For example if an experimenter announces that the amount of water available is between 16-20 units, this implies that the number of marbles in the basket could be either 16 or 17 or 18 or 19 or 20 or 21 marbles.

22

An experimenter will collect all the marbles back at the end of each season.

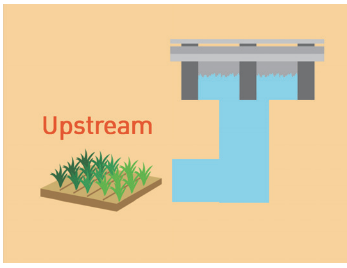
23

There are two seasons in each year (rainy and dry seasons), therefore farmers can harvest twice a year. Farmers are not told which year the experiment ends.

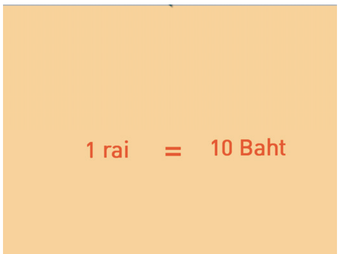


24

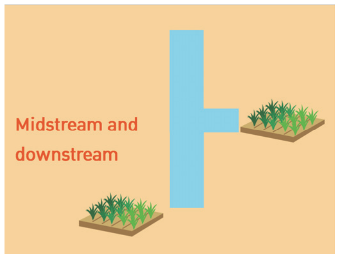
Each farmer recieves cash at the end of the experiment for crops grown successfully. Agricultural water productivity is generally lower in the upstream areas compared to the other locations. Therefore the return of crops grown is lower in the upstream area compared to midstream and downstream.



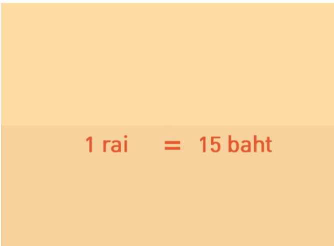
25
Upstream farmers get 10 baht for each rai that crop grown successfully.



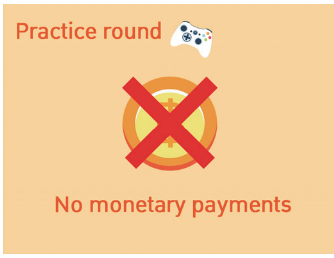
26



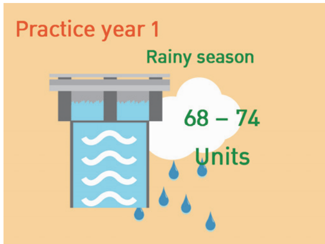
27
Midstream and downstream farmers get 15 baht for each rai that crop grown successfully.



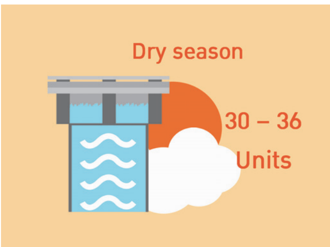
28



29
We will start with practice rounds where farmers will not receive any money for these rounds.



30
In the practice year 1, we announced that there will be plenty of water of 68 – 74 marbles in the rainy season.



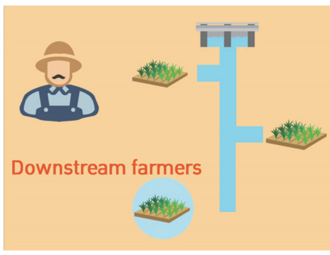
31
In the practice year 1 dry season, 30 – 36 marbles will be avaliable.

32
Upstream farmers draw water.

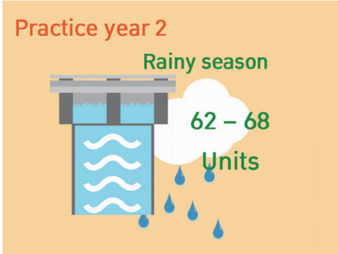
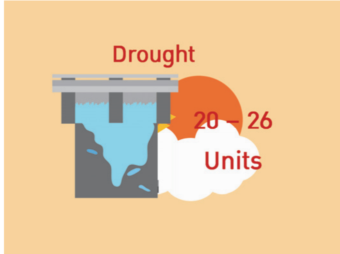
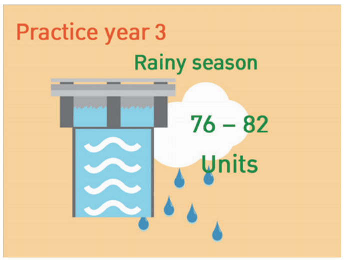
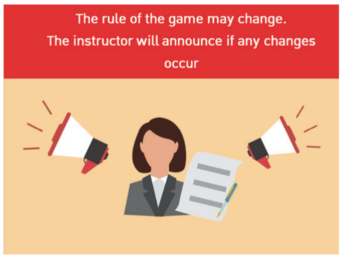
33

34
Midstream farmers draw water.

35



36
Downstream farmers draw water.

 37	 38 In the practice year 2 drought season, 20-26 marbles will be avaliable.	 39
 40 In the practice year 3 rainy season, 76-82 marbles will be avaliable.	 41	 42 The rule of the game may change. The instructor will announce if any changes occur.

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