Learning about Climate Change Adaptation through Game: Thinking out of the Box

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Abstract

Adaptation to climate change is now at the forefront of national and international debate and agenda; nevertheless, such ongoing debates have surprisingly contributed little to the understanding and awareness of vulnerable groups. In this paper, we develop game as a tool for communicating climate risks to farmers and facilitating learning and interactions that support the interweaving of reflection and action across all farmer participants, who have experienced inequitable access to water for agricultural purposes. The game encourages real-time planning and learning for handling complex decision on adaptation strategies. The main lessons drawn from this learning game are twofold. First, the farmer participants learned how climate change affects the amount of water available for agricultural production and choose crop varieties and crop types basing on their anticipation about climate condition and water availability. Second, by allowing for within-group interactions and discussions, the participants learned to discuss concerns and ideas; share water and take turns in growing crops particularly in the period of water shortage.

JEL Classifications: Q25, D83, D03, Q54

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1. Introduction

Climate Change is having a significant impact on environment, economies and communities worldwide. Its impacts threaten economic development and livelihood, hinder the operation of market, and affect the corporate strategies and individuals' behavior. One of the most serious impacts of climate change is that it will have major and unpredictable effects on water resources around the world, and Thailand is not an exception. The consequences of climate change on water resources are expected to be far-reaching, ranging from reducing the supply of fresh water that is vital for agriculture and industry to making extreme droughts and flooding become more common. This paper focuses on agriculture as this sector is highly vulnerable to changes in climate variability, seasonal shifts and changes in the precipitation patterns. Given that crop production and livestock husbandry account for a large portion of farm household income, these farmers will suffer the most due to their dependence on natural resources, low capacities for adaptation, lack of awareness, and lack of access to technology and knowhow on crop diversification (Maponya et al., 2013). The increased risks of floods and droughts could potentially be devastating for farmers' ability to sustain their living.

To minimize the vulnerability posed by climate change, two components are necessary. The first component is to anticipate the effects of climate change and understand the impacts climate change could impose on the livelihood. For the second component, it is vital that the vulnerable groups in the society take appropriate action and take advantage of opportunities that may arise (European Commission, 2015). Well planned and early adaptation action could save money and lives later. However, the current system does not yet facilitate deeper understanding about climate change, especially among the small-scale farmers.

Several authors identify the potentials of games as educational tools to help increase engagement and understanding of climate change. Educational games can take a number of forms, including simulation, action adventure, strategy, puzzles or a combination. By engaging people in interactions and challenges in the game, the learning process is leveraged and the consequences are highlighted. The ability of games to simulate complexity and feedback mechanisms, alongside inherent entertainment value, enables the game participants' engagement on a cognitive and emotional level. Fabricatore and López (2012) discuss how games encourage real-time planning and feedback mechanisms for enhanced learning through a sequence of steps that involve different thinking processes, skills and knowledge (Figure 1).

It is relatively important that, in an interactive gaming environment, participants will be encouraged to search for and discuss with others about how to cope with the problems and constraints they are facing at the different stages of a game.

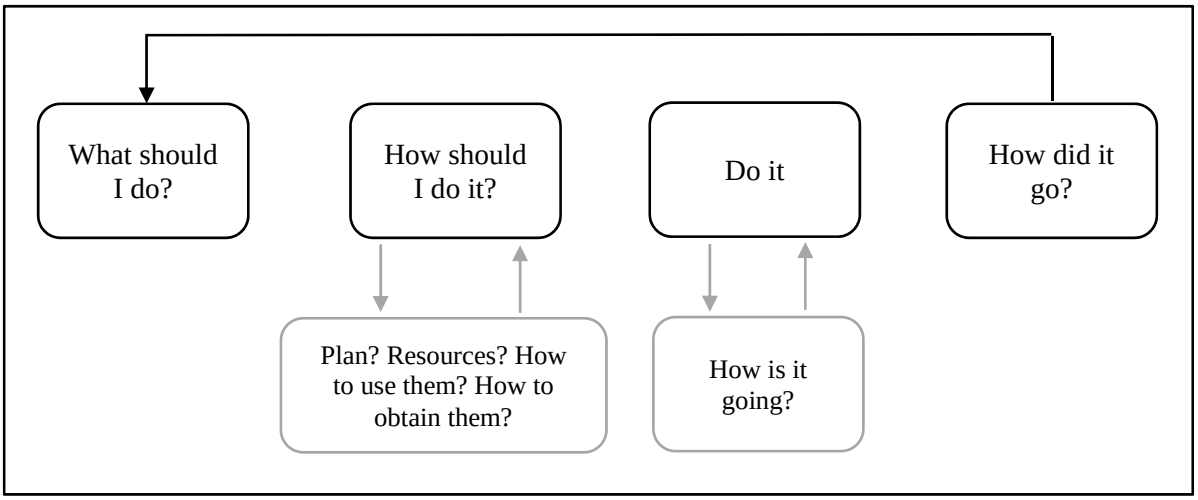

Figure 1: Game experience, with feedback mechanisms

Source: Fabricatore and López (2012)

This process is applicable to farmers in Thailand. There is an opportunity here to take advantage of games to promote awareness and create the mindsets that climate change adaptation is crucial, not only among the farmers, but also for all other groups of people in the society. A few studies investigate the prospects of using games to promote learning amongst farmers in Thailand, with a focus on water management and natural resources. One example is a study conducted by Bernaud et al. (2015), which use modeling and role-playing of multiple stakeholders involved in water management in Akha Community in Northern Thailand. The authors show that, through open discussions, people could better comprehend the situation and perspectives of others with regard to water. As a result, the game developed by Bernaud et al. (2015) could promote sustainable and equitable management of natural resources.

The other application of game was the one developed by Dionnet et al. (2008). It is the role-playing game and policy simulation exercises associated with irrigation management for Moroccan small-scale farmers. The study investigates a participatory process utilizing game and simulation tools to enhance awareness, highlight knowledge gaps and enable concrete decision making.

The purpose of this paper is to explore how to use learning games to increase awareness and improve understanding on the impacts of climate variability on agricultural production and income, and to highlight how the adoption of adaptation strategies could reduce the impacts of climate change on their livelihood. Specifically, the learning game is designed with two objectives in mind. The first objective is to promote deeper understanding among small-scale farmers about the consequences of climate risk on the amount of water resource available for agricultural production. Second, the game aims to spread awareness among Thai farmers on the benefits of adaptation to minimize the devastating impacts of floods and droughts on their livelihood. Throughout the game, the participants individually learn to choose crop varieties that are resilient to uncertain future climate conditions. The groups also collectively learn how to best allocate the water to support agricultural production in their village.

The rest of the paper is structured as follows. The second section is devoted to discussing about the construction of the game and the materials used in the game. The third section describes how the game proceeds. Lastly, the fourth section contains our observations and reflections on the learning game.

2. Game Design

As it is commonly observed that water flows from a place at higher altitude to a place at lower altitude, the upstream farmers who are at the upstream area will have first access and can enjoy more water supply from the irrigation systems while the farmers at the downstream area will be likely to have less available water especially in the time of severe water crisis. To replicate the gravity nature of water flows, this learning game will represent farming in a small river basin with upstream and downstream flow of water where the farmers in the upstream location will gain advantages from the irrigation system over those in the downstream.

Assume that the flows are principally generated at the top of the catchment and the amount of water available for the downstream area is mainly determined by the behavior of the upstream farmers. This addresses an important issue on the rural people’s inequitable access to water. The game allows farmers to reflect on the distribution of water in various situations and to strategize accordingly by choosing appropriate crop and crop varieties.

Gaming Materials

To run the game, various materials are used, including trays, dice, balls, crop cards, plastic boards, beads, bucket and bowls (Figure 2).

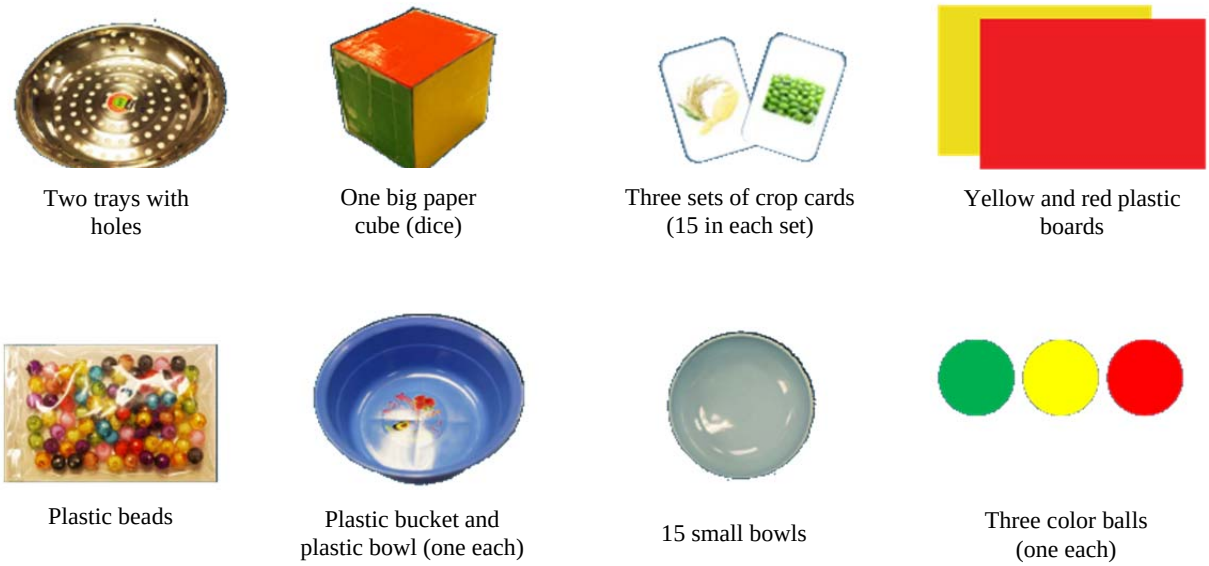

Figure 2: Materials in the Learning Game

- Tray with many small holes and plastic bucket are used to represent a technology farmers use to draw water from the river into their farmlands; however, it is possible that poor management of the technology may give way to leakage of water from the system.

- The rolling of cube or dice helps farmers understand a broad idea of uncertainty in the weather conditions. By design, the rolling of the dice each time can have one of the three possible facets – red, yellow or green.

- When extreme weather events become more common and intense, three color balls instead of the dice are used to teach farmers about the more pressing concern about climate variability. By using three balls, the probability of flood and drought conditions increases from 0.16 to 0.33.

- Each blue small bowl is used to represent one plot of farmland for each farmer. It is designated that each farmer can plant only one type of crop in each season.

- At the very beginning of the game, each farmer is provided with three crop cards, a card for promoted rice variety, flood tolerant rice variety, and mung beans. He can plant only

one of the three crop varieties in a season. Note that each crop generates different payoff for farmers, depending on the farming season, the weather condition and the water availability.

- Plastic beads represent units of available water for agriculture. However, the number of plastic beads to be distributed in each season is determined based on the rolling of the dice or the drawing of the ball.

- The yellow and red plastic boards are designed to represent upstream and downstream catchments respectively.

The Construction of the Game

Farmers' involvement:

This game is comprised of 15 farmers: 8 farmers are at the upstream area and 7 farmers are at the downstream. The upstream catchment is represented by yellow plastic board, and the downstream catchment is represented by red plastic board. Each farmer is allocated a plot of farmland, each with the size of 1 rai (equivalent to 1,600 square meters). In the game, a farmer is provided with a blue small bowl, which is used to store beads (representing water).

Regarding the participants, the 15 farmers who participated in this learning game were partly recruited from Kra-Siao Reservoir in Suphanburi province and partly from Tap-Salao Reservoir in Uthai Thani province. The participants were a mix of farmers from the upstream and downstream areas. In the game, some of them were however assigned plot of farmlands in locations different from their real life. The game was conducted at the meeting room at the Wang Yang Resort Hotel and Spa in Suphanburi province.

Farming seasons and crop varieties:

Assume that there are two seasons in each simulated year, i.e. rainy and dry season. The farmer can grow only one type of crop on his plot of land. Each farmer makes decision about crop to plant at the beginning of each season. Each farmer can plant one of the three crop choices. The promoted rice variety consumes a lot of water but can generate high income in normal weather condition whereas flood tolerant rice variety, although consuming similar level of water as the promoted rice variety, can tolerate excess water situation up to some extent when flood occurs. On the contrary, although mung beans have lower value, the farmers will be benefited particularly during drought events because mung beans consume far less water than rice. Note that rice cultivation requires 6 units of water (or 6 beads per plot),

while the mung bean requires only 2 units of water (or 2 beads per plot). However, the selection of crop to be planted depends very much on the farmers' past experience in the game and expectation about the future weather condition.

Probability of weather condition and the availability of water:

In this game, the climate condition in a particular season depends on the outcome of rolling dice. However, the colors on different sides of the dice are not equally distributed. In the game, the dice is designed to have one red side, four yellow sides, and one green side, suggesting that the occurrence of normal weather condition happens more frequent. The probability of normal weather condition is 0.66; of flood event is 0.16; and of drought event is 0.16.

The dice rolling outcome determines the amount of beads to be put into the bucket. There are two configurations. In the rainy season, red side, yellow side and green sides of dice means 65 beads, 120 beads and 160 beads will be put into the central bucket, respectively. In the dry season, red side, yellow side and green sides of dice means 20 beads, 40 beads and 60 beads will be put into the central bucket, respectively (Table 1).

Table 1: Number of beads to be distributed in each season

	Number of beads to be distributed in rainy season	Number of beads to be distributed in dry season
Red	65	20
Yellow	120	40
Green	160	60

3. How does the game proceed?

To simplify the setting, this game is designed to involve only two parties, the farmers at the upstream and downstream locations and the facilitator of the learning game acting as a meteorologist who provides the forecast on the weather condition in the coming simulated season and makes announcement on the amount of water or the number of beads available for agriculture in a particular season. Each farmer will be remunerated in accordance with the constructed payoff structure which computes payoff basing on type of crop planted and number of beads a farmer puts in his small bowl.

The game proceeds as follows.

Stage 1: Each farmer selects one crop type from three types of crops to plant in a particular season and places the selected card on his own bowl (Figure 3). Nevertheless, the farmer does not know beforehand about the amount of water or the number of beads available at this stage.

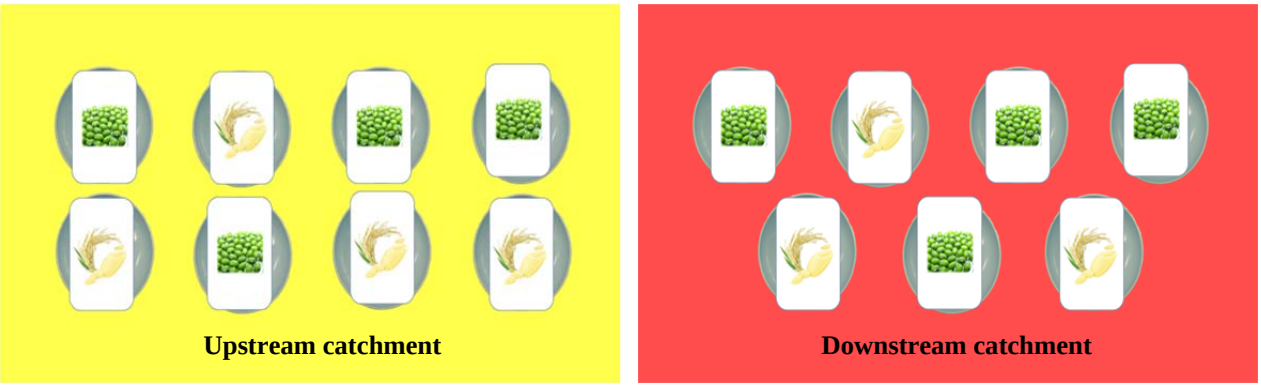

Figure 3: Example of crop selection and card placement

Stage 2: After all farmers decide the crop to plant, the facilitator will roll the dice or draw a ball from a box. Note that the color on the side of the dice that turns up determines the total amount of water (or number of beads) available for farming in that season. The facilitator then places the beads according to the outcome of dice rolling or ball drawing into a bucket.

Stage 3: Since water normally flows from areas in the higher altitude (upstream) to areas in the lower altitude (downstream), the facilitator thus allows a representative farmer from the upstream catchment to draw the water (beads) into their village first. At this stage, the facilitator will pour all the beads earlier placed in the bucket into the tray (with holes) and the representative farmer has to shake the tray for 4 seconds until some of the beads fall into the arranged bowl. The farmers in the group will discuss the way the beads (water) to be allocated to each individual in their community. For the beads that remain on the tray, the facilitator will follow the same procedure to the downstream group of farmers; however, the downstream representative is allowed to shake the tray for 6 seconds. When the number of beads is determined, all farmers must write down the number on a given sheet.

Stage 4: The facilitator presents a payoff matrix to the participants on the screen (Tables 2 and 3). At this stage, each farmer calculates his own payoff and keeps record of his payoff on the same sheet provided earlier.

The game continued for 10 rounds (including 4 rounds of practicing at the very beginning of the game). In later rounds of the game, the facilitator is allowed to change the likelihood of occurrence of drought and flood events by drawing color balls instead of rolling the dice. Note that a note taker is assigned to each group so as to observe the farmers' behavior and the discussion and to take notes during each round of the game.

Table 2: Payoff matrix for farming in the rainy season (Unit: baht)

Crop planted	Range of beads put in the small bowl				
	0-2 beads	**3-4 beads**	**5-6 beads**	**7-8 beads**	**> 8 beads**
Promoted rice variety	-8	8	20	-8	-8
Flood tolerant rice variety	-8	6	16	14	-8

Table 3: Payoff matrix for farming in the dry season (Unit: baht)

Crop planted	Range of beads put in the small bowl				
	0-1 beads	**2-3 beads**	**4-6 beads**	**7-8 beads**	**> 8 beads**
Promoted rice variety	-8	8	16	-8	-8
Mung beans	-4	24	-4	-4	-4

4. Observations and reflections on the learning game

Water Allocation

In the very first rounds of the simulated game, the farmers in each catchment collectively came up with the rule that they would equitably allocate beads among themselves. However, as the farmers learned in the subsequent rounds about the appropriate level of water for different types of crops and the payoffs, they were likely to allocate number of beads to plots of land that could generate positive payoffs by minimizing the group's overall losses from water allocation, instead of allocating beads to all plots equitably but failing to generate income. In other words, the group considered the crop type selected by each farmer and the minimum water requirement of that crop before reallocating the amount of beads accordingly. If the amount of beads was not enough for everyone, some farmers had to

sacrifice by suspending planting in that season. In the following seasons, if the problem of water shortage occurred again, other farmers in the group who suspended their planting in the previous season take turns in growing crops. This suggests that the farmer participants tended to share benefits and losses at least over a short-time horizon.

Selection of Crop to Plant

During the initial rounds, the farmers in each catchment did not yet discuss and agree on the crop type to be planted. The farmers separately decided on the crop type. The anchoring effect was quite prominent initially. Specifically, the crop choice is driven by the farmers' previous experience.

It is important to highlight that the choice of crop to be planted in each season was influenced by the weather forecast at the beginning of each season as the forecast affected the amount of water (beads to be put into the central bucket). However, in the later rounds, other factors entered into farmers' consideration, especially the amount of income they would earn. Moreover, the farmers in each catchment collectively engaged in planning the type of crop for each individual farmer, considering the distance and proximity of their farmland to the assumed canals. In some years whereby water was expected to be scarce and limited, farmers tried to convince each other to suspend rice production and grow mung beans instead because they require less water. Given that mung beans require less water than many other crops, the farmers that chose to grow mung beans had the priority of receiving water.

Conflict in Water Allocation

During the game, there was no conflict among the participants in the allocation of water. However, few participants revealed that the experience in the game is quite different from reality. In fact, some farmers are interested in pursuing their own self-interest, i.e. to acquire sufficient amount of water to plant their crops productively. Even though there exist the collective water allocation rules within a group, without punishment, these rules will not be enforced successfully in realty. In practice, it is necessary that there should be not only within group discussion about the rules, but also between group collaboration and agreement on water allocation amongst the concerned parties.

What did the Participants Learn from the Game?

Through this learning game, there are few things that the participants learned. First, they learned about the impact of climate variability and the change in water management policies and the significance of adaptation. Second, regardless of the uncertainty on climate,

the participants learned how to choose crop type and crop varieties that made them resilient to future climate condition. Third, the game enhanced the participants' understanding and awareness about the equitable access to water and the importance of shared water resources for the overall benefits of the group or community.

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