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Abstract

There are debates about climate-led resource scarcity and users' behavior. Common pool resources (CPRs) are of particular interest in this regard as climate change may increase existing challenges. One reason for this is that CPR users may change their behavior in ways that affect other users.

This paper looks at communal irrigation as a CPR in Ethiopia, where reduced availability of water may lead to unfair water allocations. Unfairness could lead to envy, which may pose extra problems for sustainable water management. I therefore conducted a *joy-of-destruction game* involving 192 randomly selected household heads (players) that mimic burning of another's possession. Using a random draw, players were grouped into either the scarce water condition or abundant water condition. Within each group I randomly paired two players to play the game. This hypothetical game asks if the player in the group is willing to damage the other group's irrigation field to maximize his/her own benefit. Both descriptive and econometrics methods of analysis were employed.

Surprisingly, I found that players display less envious behavior when there is water scarcity than abundance. This is an astounding result and the possible explanation could be that the participating farmers in the experiment were not fully detached from their real-life perceptions. Both variables, water condition and amount of deduction, significantly influence the players' decisions. The paper has implications on possible interventions of CPRs management, and suggests the need for further work on methodological aspects to enhance external validity in field games.

Keyword: Climate; Scarcity; Common Pool Resources; Irrigation Water; Envy; Joy-of-Destruction; Tigray; Ethiopia

JEL classification: C79, C93, D91, Q25, Q54

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1. Introduction

"Does resource scarcity matter?" This question is at the core of understanding how environmental problems may affect the management of common pool resources (CPRs). Environmental problems such as climate-led scarcity, may affect an individual's behavior towards others, which in turn influences the sustainability of many CPRs. Pfaff et al. (2015) claim that how one treats others is crucial in the management of CPRs that need collective action. Their study tested the hypothesis if resource scarcity in the past could change users' behavior towards having other-regarding preferences. They found that higher water scarcity[1] can erode user's prosocial behavior, and consequently it undermines coordination. As such, their findings support the notion that fierce competition about a scarce resource may lead to a conflict and less sustainable management.

Various qualitative and quantitative cases suggest that scarcity of resources contributes to violent conflicts particularly in developing countries (Bernauer et al. 2012; Homer-Dixon et al. 1993). Pro-social feelings deteriorate when an individual has a motive to abstract the largest amount of benefit for him- or herself. Scarcity triggers more selfish behavior, leaving no or less of the resource to others (D'Exelle et al. 2009; Lecoutere et al. 2010). This creates conflict regarding benefit sharing among users.

However, there is also some contrasting evidence, notably by Bogale and Korf (2007), who found that scarcity strengthens incentives for cooperation and resource sharing. The rationale behind their finding is that without cooperation and responsible behavior by the parties involved, future benefits from a resource may decline. Agro-pastoralist communities in the resource-scarce

[1] Water scarcity is defined as an excess demand over available water supply in which partial or no satisfaction of expressed demand, conflict among users, and irreversible negative impact on the environment are some of its manifestations (FAO 2012).

(drought-led) Somali Region of Ethiopia fit this category. Here, locals seek resource-sharing mechanisms that provide opportunities for asset-poor households to manage even under scarcity. This kind of social responsibility creates cooperative rather than conflict-ridden solutions.

Such contrasting findings of scarcity opens a question for social scientists who deal with scarcity: Is scarcity a driving force behind anti-social behavior? Anti-social preferences like spite, malice, envy, and jealousy are the aftermath of an individual's motive for fairness, inequity, or loss aversion (Beckman et al. 2002; Ben-Ze'ev 1992; Grossman & Komai 2013; Wobker & Kenning 2013; Zizzo & Oswald 2001). Behavioral scientists reiterate that individuals are not only sensitive to unfairness, but also compare their losses and gains against others. Most individuals have a strong negative preference towards unfair economic outcomes. Perceptions of relative status, income or wealth are important triggers for antisocial preferences, and could in some cases lead to working for reducing the wellbeing of others. Jensen (2010) defines functional spite as a condition in which individuals develop selfish behavior to get benefits from the harm of others and by extension it contributes for the development of envious behavior.

Envy[2], according to Ben-Ze'ev (1992), is a negative attitude toward another person's superiority, and the desire to gain what this person possesses. This happens if there is a feeling of own inferiority or a desire to achieve relative gains by reducing the fortune of others deemed undeserving of their wealth. However, Dow (1981) made it clear that the feeling of the envier is related to the fortunate situation of the person who possesses an object but not the object itself.

[2] Envy has many forms. Here, I focus on the destructive aspect of it as my money burning experiment mimics that connotation. Various authors have discussed envy in comparison with other types of social behaviors such as malice (Beckman et al. 2002), jealousy (Parrott & Smith 1993), the forms and its unique features (Wobker & Kenning 2013).

Extending this definition, Parrott and Smith (1993) have indicated that extreme feelings of inferiority, resentment, longing, and disapproval emotions are causes for envious behavior.

Scarcity alone may not turn people to behave in an anti-social way regarding the use of irrigation water. Environmental problems associated with other factors like position in an irrigation system (head-end vis-à-vis tail-end users) may create collective action problems. Power asymmetries that exist among irrigators due to position, may lead to competition among them (Amede 2015). Head-end users may have an incentive not to share the water, and tail-end users' responses may include unwillingness to supply labor to maintain the irrigation system. Moreover, tail-enders may resist income inequality created due to positional asymmetry and develop an envious behavior towards head-end users. Evidence shows that tail-end users start to disagree with head-end users when the latter take unequal shares (Janssen et al. 2011). Such disagreements then affect collective action negatively (Pfaff et al. 2015). Unless there are favorable conditions for cooperation between head- and tail-end users for irrigation water (Anderies et al. 2013), cooperative management is unlikely.

To circumvent the management problems of CPRs, innovative management is important. Innovation is more likely if the expected innovation benefits are perceived to benefit all involved rather than just a few. For example, abandoning or minimizing position led inequality among head- and tail-end users, and reducing scarcity could create favorable conditions for innovation or cooperation (Janssen et al. 2011). In terms of water use and irrigation, innovative management may be motivated internally or externally. For example, an external NGO could ease tensions and reduce obstacles for cooperation by mediating viewpoints held by users, or by providing support to increase the payoff of cooperative solutions. However, envy hinders innovation (Dow 1981; Kebede & Zizzo 2011; Mui 1995), impedes market reforms in transition economies (Beckman et al. 2002), and hence, obstructs innovative management of CPRs.

Kebede and Zizzo (2011) conducted "money burning" experimental games in Ethiopia to see if farmer's envious preference affects agricultural innovation and technology adoption. In this experiment, resources (money) were distributed to players first and then allowed them to use some of their money to decrease others' money ('burn' money).Their findings reveal that burning behavior has two contrasting effects in agriculture: it enhances the likelihood of agricultural adoption, but negatively affects agricultural innovation due to the envious farmers' behavior. Wealth, rank, the amounts by which subject are burnt (Zizzo & Oswald 2001), the extent of income inequality, and the distance from the subject's reference group (Ben-Ze'ev 1992) influence money burning behavior. To sum up: People are willing to burn their money due to envy or fairness concerns.

Studies conducted in different countries, including Ethiopia (Adeba et al. 2015; Ayenew 2007; Schewe et al. 2014; Yohannes et al. 2017), so far focus on water scarcity and its causes, water management policies, and efficiency of water policies. Many of these studies focus on small-scale irrigation resources as they generally are more targeted towards subsistence production. This implies that conditions that affect such resources negatively also disturb the lives of many people. Along with weak local institutions, there are indications of performance and management concerns or problems emanating from various reasons including poor agronomic and management practices in most small-scale irrigation practices (Amede 2015).

I therefore hypothesize that there could be envious behavior among irrigation users in Tigray. As far as I know, there are no prior empirical works on irrigation water scarcity and envious preferences (anti-social behavior) in general and Ethiopia in particular. However, the work by Prediger et al. (2014) on the scarcity of grazing land in Namibian commons, identifies the differences and driving factors of an envious behavior that could exist among users at different level of resource stocks. Building on these insights, this paper aims to answer the following questions:

1. Which group, irrigators under scarce versus abundant water conditions, are more likely to display behavior that suggest than envy matters?
2. What factors reinforce (lead to) an anti-social decision among communal irrigation users?

Knowing users' behavior is important to figure out best management strategies and paves the way for the introduction of newly innovated management mechanisms. Hence, one contribution of my study in this regard could partially fill the gap by conducting the outlined joy-of-destruction game among irrigators in Tigray, Ethiopia. At a wider scale, my study also provides implications for policy for the management of CPRs.

This paper is organized as follows. Section 2 briefly discusses the general problem of water scarcity and its management with emphasis to the study area. Section 3 presents the materials and methods adopted in the study, elaborating all methodological steps starting from experimental design to analysis. It also discusses the data and outlines the hypotheses. Section 4 presents the analyses of the data using descriptive and econometric methods. The final section discusses and concludes based on the findings from this study.

2. Review of the relevant theoretical literature

Renewable resources depletion in general and water scarcity in particular are growing with the rise of population, domestic and industrial uses, human actions of food production, and growing differences between the poor and the rich (Adeba et al. 2015; FAO 2012; Homer-Dixon et al. 1993). Mekonnen and Hoekstra (2016) found that about two-thirds of the world population (four billion people) are currently living under water scarcity at least one month in a year, and nearly half a billion people live under scarcity all the year round. Climate change has been the main contributor, currently increasing both regional and global water scarcity (Ayenew 2007; Schewe et al. 2014). Evidence shows the number of victims could increase in the future. For example, a 2℃ rise in global warming increases further the number of affected population by 15% of the global population, and this figure could increase the number of people living under absolute water scarcity by another 40% in the future (Schewe et al. 2014).

Besides, water demand is sharply rising due to various factors in which irrigation expansion is one (Mersha et al. 2018). Unless supported by concerted efforts that enhance subsistent irrigation, we might reach a point that does not meet the unparalleled demand. Reforms, such as the integrated water resources management (IWRM), have been adopted worldwide including Ethiopia. It emphasizes policies and legalization with particular emphasis on the sustainable management of water resource (Mersha et al. 2018; Mersha et al. 2016). Despite this, IRWM policies have not been able to meet the growing demand for irrigation. Furthermore, Ethiopia's strong emphasis to expand irrigation to boost its economy complicates its implementation effectively. Overall, institutional problems coupled with management problems at scheme-level and/or farm level exacerbate water scarcity. A recent study from Tigray confirms that poor on-farm and scheme-level water management increase the intensity of irrigation water scarcity (Yohannes et al. 2017).

Scarcity changes in users' behavior. The direction of the change, however, may be positive that enhance efficient use of CPRs or vice versa. For instance, Osés-Eraso and Viladrich-Grau (2007) found that users of CPRs change their appropriation behavior by restraining themselves when they found resources are scarce. Similarly, scarcity enhances cooperation among poor societies, causes individuals to stabilize and enhance their asset-base (Bogale & Korf 2007). Conversely, water scarcity prompts selfish appropriation behavior (Lecoutere et al. 2010) that induces conflictive behavior among Tanzanian irrigators. The rise in interest to decrease another's payoff below one's own triggers conflict among users. In an experimental game by Prediger et al. (2014), individuals exhibit a tendency of burning others payoff. Their results suggest a higher risk of conflict among users in areas of greater scarcity. According to Lecoutere et al. (2010), however, scarcity could augment conflicts when they associated scarcity with other factors as some agents in their experiment react conflictive during scarcity. Agents, who are poor, marginalized, or having low human capital, react most highly with conflictive appropriation behavior.

Similarly, scarcity may stir violent conflicts that turn into war at a larger scale. Political scientists claim the current depletion and hence scarcity of such resources contribute to violent conflicts in different parts of the world (Homer-Dixon et al. 1993). With rising population growth, the scarcity of such resources in most developing countries is already causing great adversities. While scarcity by itself may not cause violent conflicts, environmental changes can trigger violent conflicts under specific circumstances, like when the environmental changes lead to a decline in economic performance and migration (Bernauer et al. 2012).

3. Materials and Methods

3.1. Irrigation background of the study area

Water scarcity is more common than water abundance in the Tigray area in Ethiopia. Water is also a key input for agriculture in the region. Therefore, the consequences of damaging other irrigators' crops under scarce water supplies are expected to be more severe than under water abundance.

In the study area irrigation generally requires joint efforts due to the large investments needed in time and resources to have an irrigation system that limits the negative impacts of dry periods. This is particularly the case for drilling to gain access to the underground aquifers that are the most important source of water. Hence, the distance between the water source and farm fields varies within an irrigated area. This is reflected in the distinction between head-end and tail-end users in the experiment.

Most of the irrigation water in the study area is drawn from underground aquifers. This delays revelation of water usage above the allotted shares for individual users. It also provides tail-end users with a possibility of harming head-end users as excessive water use lowers the ground water table, in particular in dry periods. Still, head-end users have more possibilities of inflicting damage on tail-end users than conversely.

1.1. Experimental design and sampling

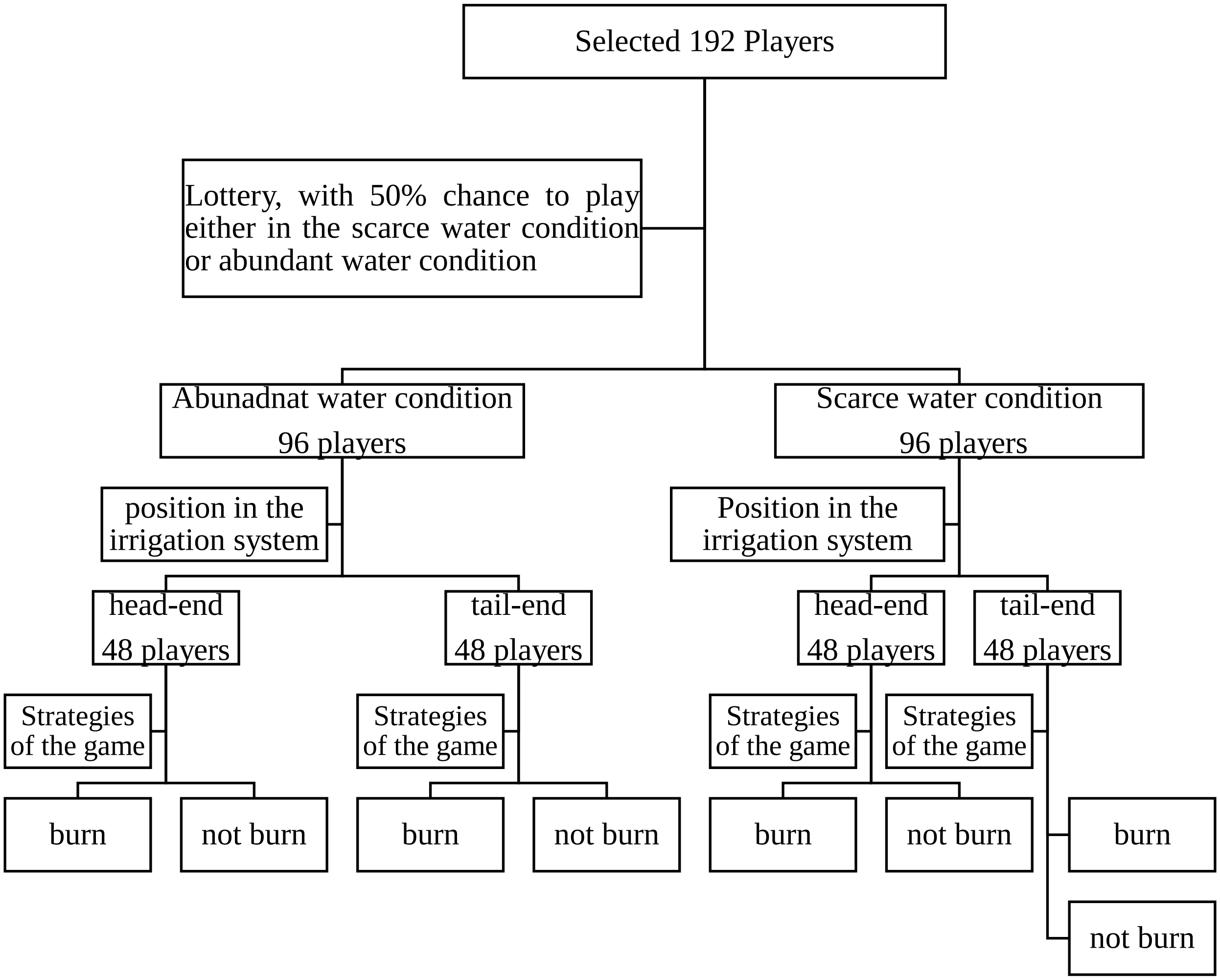
I conducted a *joy-of-destruction* game where players have the possibility to "burn" (damage) other player's irrigation crops under different level of water condition, where burning is a signal of envy[3]. It draws on the original experimental protocols and questionnaires designed by Prediger et al. (2014) with small modifications to fit my scene of varying availability of irrigation water. The design also controls the potential existence of power asymmetry due to head or end position of a player in an irrigation system to see its effect on gaming behavior. Furthermore, I followed the original design which is easy to apply in a field experiment with a pen-pencil game (Otto & Wechsung 2014).

Before conducting the game, however, I selected players from 12 rural villages of Tigray, Ethiopia. The villages are selected purposively considering their susceptibility to recurrent drought and irrigation access. Initially, 384 respondents were selected to participate in the other part of the survey with each village is represented by an equal proportion (32 sample units). For the purpose

[3] In their study, Kebede and Zizzo (2011) captured the envious behavior of farmers by money burning in the experimental game.

of the game, however, they were reduced to half based on a lottery (see figure 1, for the diagrammatical presentation of the game). Similarly, a lottery was used to group players into two water conditions: scarce or abundant irrigation water condition. Each setting (group) composes two players. Each player was immediately assigned her/his position in a communal irrigation system in a similar way. In my study, I considered only two extreme positions, head-end and tail-end users. This might be a limitation of the paper; however, doing this coincides with the two options of the resource condition, scarce or abundant water condition. In each group, therefore, 48 players are head-end users and 48 players are tail-end users. The game has two available strategies for all players irrespective of the water condition: "burn" or "not burn". This gives each player a 50% chance to "burn" an irrigation field of another player.

Figure 1: Structure of the selection of players and the game



Players are farm household heads in which some of them have formal education (about 46%) and the remaining (about 54%) are illiterate (unable to read and write). Since players need to understand the game, two enumerators per group were assigned (mind that a group has two players). These enumerators help to assure that each player understands the game. In the beginning, however, one of the two enumerators explains the game for the whole group and assign the position of the player in an irrigation system. Next, each enumerator takes care of each player in every step of the game. Players were told to make their decision secretly and the assigned enumerator supports in this matter too. Therefore, the enumerator recorded the player's position in an irrigation system, socio-economic data, and dispatched initial money to the player. The game starts with each player receiving an equal amount of money. Nonetheless, it differs across groups of players based on the game-endowed resource condition. Accordingly, players in the abundant water setting (group) were endowed with an initial income of ETB 50 and players in the water scarce setting were endowed with ETB 10. This variation in endowment depicts the effect of water variation on farmers' income.

Like the other money burning games such as Kebede and Zizzo (2011) [4], players have two strategies to follow. "burn" or "not burn" (see Figure 1). When a player follows the "burn" strategy, s/he is damaging (burning) an irrigation crop of another farmer (player) at the expense of his or her personal income. The loss is, however, lower than the cost of burning on the other player. For example, assume the players are "A" and "B". If player "A" follows the "burn" strategy, then player "B" loses an income of ETB 25(5) for games in the abundant and scarce water conditions respectively. The amount that player "A" loses his or her own income for burning irrigation of player "B" is ETB 5(1) depending on the water condition. See the details of the game in the next section.

Following the Abbink and Sadrieh (2009) and Prediger et al. (2014), the experiment is a "one shot game", which relieves the dynamics of the game so that each player is statistically an independent

[4] The money burning experiment of Kebede and Zizzo (2011) started by grouping players into two based on their level of income, i.e., high and low income groups. The low-income players were endowed with an initial income of ETB 7 and the high-income players were endowed with ETB 15. Players pay their own money for burning the money of others. The amount is 10 percent of the amount to burn.

observation (Abbink & Herrmann 2011). This implies that players do not have a motive for reciprocity, or regrets. Hence, this game investigates individual behavior towards others across subjects and between areas of having different environmental water conditions.

Moreover, each player in the group was allowed to chat and know the other player because such talks take place among irrigators in the villages. However, players were told to keep their decisions secret during the game. At the end of the game, the two enumerators of the group tell each other about the move of each player and calculate the amount of each player's deduction from their initial endowment. The enumerators also calculate and announce the final net income that each player receives at the end of the game. The game was conducted after extensive measures were undertaken to reduce the risk of players not understanding the game.

Finally, participants were asked to fill out a brief survey on their opinion about the game and the instructions. They answered questions related to how they felt the experiment compared with their real-life experience and the way irrigators behave. Finally, players received the tokens earned from the game plus an additional show up fee of ETB 50.

1.2. The Game

Under the scarce water condition branch of the game (see Figure 1), and his/her position in the irrigation system, a player is asked if s/he lets some of the irrigation water to an irrigation field of another irrigator (player). When the player agrees (decides[5]) to share the water, both players get insufficient amount of water and reduces the harvest level of each irrigation field. This reduction in harvest level is represented by an equal reduction (deduction) of income of both players by ETB 5. Conversely, if the player decides to get the maximum benefit out of his/her irrigation field, then

[5] I use the word "decision" in the text interchangeably with "strategy" to indicate the strategy and the move that players follow in relation to the game.

the player leaves no, or smaller extra water left after satisfying his/her demand. The irrigation filed of the other player then burns due to shortage of water and thus, his/her irrigation income falls by a large amount (ETB 5). As a communal water, however, players are informed the existence of a regulation on the distribution of irrigation water and for this, a penalty will be imposed upon an envious individual for his/her anti-social behavior. Therefore, the maximum benefit that a player makes by abstracting enough amount of water is reduced by the amount of the penalty, which is equal to 10% of an initial endowment (ETB 1). Similarly, the second player has the same option that could decide without knowing the strategy (decision) of the first player. The payoff matrix of the game is presented in table 1.

Table 1: The payoff matrix of the game under scarce water condition

	Decision		**Player B**
		Burn	Not to Burn
Player A	Burn	(-5, -5)	(-1, -5)
	Not to Burn	(-5, -1)	(-5, -5)

The negative sign indicates the amount by which an income of each player is reduced from the initial endowment given at the start of the game.

However, the overall effect of the game depends on the strategy that both players has followed. If both players make the "burn" decision, for example, then their income reduces by the loss of irrigation income plus the penalty. That is, a reduction of ETB 5 plus the penalty for an envious behavior (ETB 1), which equal ETB 6. When one player (let's say player A) decides "not to burn" and the other (player B) decides to "burn", the income of player B has reduced only by the amount of the penalty (ETB 1) and that of player A has reduced only by ETB 5, which is due to an envious decision of player B. The overall income reduction of player A is ETB 5 and that of player B is ETB 1. The payoff matrix of the overall deduction of each player's income is displayed as in table 2.

Table 2: Each player's overall deduction under scarce water condition

		Player B	
	Decision	Burn	Not to Burn
Player A	Burn	(-6, -6)	(-1, -5)
	Not to Burn	(-5, -1)	(-5, -5)

The negative sign indicates the amount by which an income of each player is reduced from the initial endowment given at the start of the game.

In the abundant water condition branch of the game, the player is asked to decide about releasing the surplus water available in his/her field to an irrigation field of the second player. Surplus water creates flood and burns the crop in the field due to water logging. Hence, a decision to release the surplus means using only the necessary amount of water and getting maximum production at the expense of another irrigator's production. Therefore, a decision to burn by player A, for example, means the player is protecting his/her field from water logging. In contrast, discharging a large amount of water lets another player's irrigation to flood and "burn" the crop due to water logging. Like the game under a scarce water condition, players under abundant water condition have the same options to decide, "burn" or "not to burn". Making the "not to burn" decision means, the player allows himself to face the reduction in the production due to waterlogging. A decision to "burn" by, let us say player A reduces the income of another player, let us say player B, by ETB 25. The penalty for player A for behaving anti-socially is 10% (ETB 5). If player B decides "not to burn", then his/her move does not hamper on the payoff of the other but reduces his own production by half by letting his/her irrigation field logged with excess water. This is indicated with the reduction of the initial endowment (ETB 50) by half. Like the game in the scarce water condition, both players have the same available strategies that they can follow: "burn" or "not burn". Table 3 presents the game and the payoff of each player's decision.

Table 3: The payoff matrix and the overall deductions at the end of the game (in ETB)

The payoff matrix of the **game under abundant water condition**

			Player B
	Decision	Burn	Not to Burn
Player A	Burn	(-25, -25)	(-5, -25)
	Not to Burn	(-25, -5)	(-25, -25)

The overall deduction under abundant water condition

			Player B
	Decision	Burn	Not to Burn
Player A	Burn	(-30, -30)	(-5, -25)
	Not to Burn	(-25, -5)	(-25, -25)

The negative sign indicates the amount by which an income of each player is reduced from the initial endowment given at the start of the game.

The amount of deductions also resembles the environmental conditions. It is higher in the abundant water condition than in the water scarce condition. However, for interpretation and further analysis of the data across treatment groups, the deduction in both conditions was set to be either a 10% or 50% of players' initial endowment. In both treatments, there is no penalty for showing a prosocial behavior. All in all, players were also informed about their position (on lottery method) in the irrigation system before they decide what strategy to follow.

From the payoff matrix, the dominant strategy is the "burn" strategy. A selfish player thinks the best strategy is that the one that minimizes his/her loss or maximize the benefit. The "burn" strategy reduces either ETB 5 (25) or ETB 1 (5) respectively in scarce and abundant water conditions depending on the strategy of the other player. Conversely, the "not to burn" strategy reduces an equal amount of ETB 5 (25) in both strategies. So, if the second player follows the strategy "not to burn", then the payoff for the first player that follows the "burn" strategy is a reduction of ETB 1(5), which is lower than the case when both players follow the “burn” strategy, ETB 5 (25). Hence, a selfish player is expected to exploit this opportunity and decide to follow the “burn” strategy. Accordingly, both players follow the same strategy (decision) and the dominant will become the “burn” strategy.

1.3. Method of analysis and specification

I employ both descriptive and econometrics methods of analysis. Tables, graphs, and other relevant tests such as the Mann-Whitney test are also adopted to support the econometric analysis. The nature of the dependent variable and specification test dictate what type of method to follow for the analysis. The response received is qualitative in the form of “Yes” or “No” to capture an envious preference of a respondent. Furthermore, the data is cross sectional. Therefore, for dichotomous response outcome variables, the binary method, logit or probit, are the most appropriate methods (Wooldridge 2014). Probit assumes normal distribution of the cumulative distribution function (cdf), whereas logit assumes logistic distribution. The estimate is similar except with slight differences in the magnitude of the coefficients. Further, the qualitative response is then changed to a binary value that attaches a value of “1” if the response is yes, “0” otherwise. This leads to estimate a response probability as a function of covariates (Hansen 2014; Wooldridge 2014). Hence, the mathematical denotation of the response probability function is:

$$\Pr(decispl = 1|x_i) = F(x_i'\beta) \tag{1}$$

where $F(.)$ is a cdf, which is symmetric about zero, so that $F(x_i'\beta) = 1 - F(-x'\beta)$. The logistic cdf, $F(x_i'\beta)$ is mathematically formulated as:

$$F(x_i'\beta) = (1 + e^{-x_i'\beta})^{-1}$$

However, if estimation is based on probit model, the cdf is normal:

$$F(x_i'\beta) = \Phi(x_i'\beta) = \int_{-\infty}^{x_i'\beta} \phi(v)dv$$

In both cases, the cumulative density functions lie strictly in between zero and one.

The qualitative response, which is a binary value, is a latent (unobserved) dependent variable. Both logit and probit models are derived from the underlying latent (unobserved) variable (Wooldridge 2014), which is, in this case, player's decision($decispl^*$). The model is thus specified as:

$$decispl^* = x_i'\beta + e_i \quad (2)$$

$$e_i \sim F(.)$$

$$decispl = \begin{cases} 1 & if\ decispl^* > 0 \\ 0 & otherwise \end{cases}$$

where e_i is the error term, which is symmetrically distributed about zero. x_i is a vector of explanatory variables of the model, and β are coefficients of each variable. Estimation in both cases is carried out using maximum likelihood.

1.4. Data and Hypothesis

Various factors could affect the decision of each player. Hence, the amount of irrigation water, the overall deduction, relative position in an irrigation system, and socio-demographic covariates are all control variables. Covariates related to the game are expected to have a significant effect on the response variable, that is, the burning variable. For example, a common theoretical expectation is that scarcity compels players to be more envious; however, the reverse could be true. Therefore, players in a scarce water condition are expected to show either: 1) selfish behavior and leave little or no water to the next irrigator, or 2) more cooperative behavior and share the water equally. Similarly, under the abundant water condition players may not want to see their irrigation field affected due to waterlogging. In this case, a player is expected to divert the excess water by ignoring its effect on the other player. Given these contrasting potential outcomes, it is not possible to predict the exact effect a priori.

The position of irrigators did not enter in the pay-off matrix because we assume that at least, a player's position is not expected to directly affect his/her income from irrigation. In the experiment, every irrigation filed is assumed to produce its maximum if it gets enough water. Individual behavior, however, determines the amount of irrigation water that each field gets. Position is hence expected to affect the behavior of players. The relative position creates power asymmetries on the use of the resource. Upstream (head-end) users are closer to the resource and are the first to get access to it. Hence, they might exhibit more selfish behavior and are expected to make a decision that damages an irrigation field of the tail-end (downstream) users.

The data shows the average age of the players is 44 years (see Table 4). The youngest is about 20 years of age whereas the oldest is 80 years old. They have an average farming experience of 22 years. As the minimum farming experience is one year, there are players with no irrigation experience at all. About 56 percent of the players are irrigators.

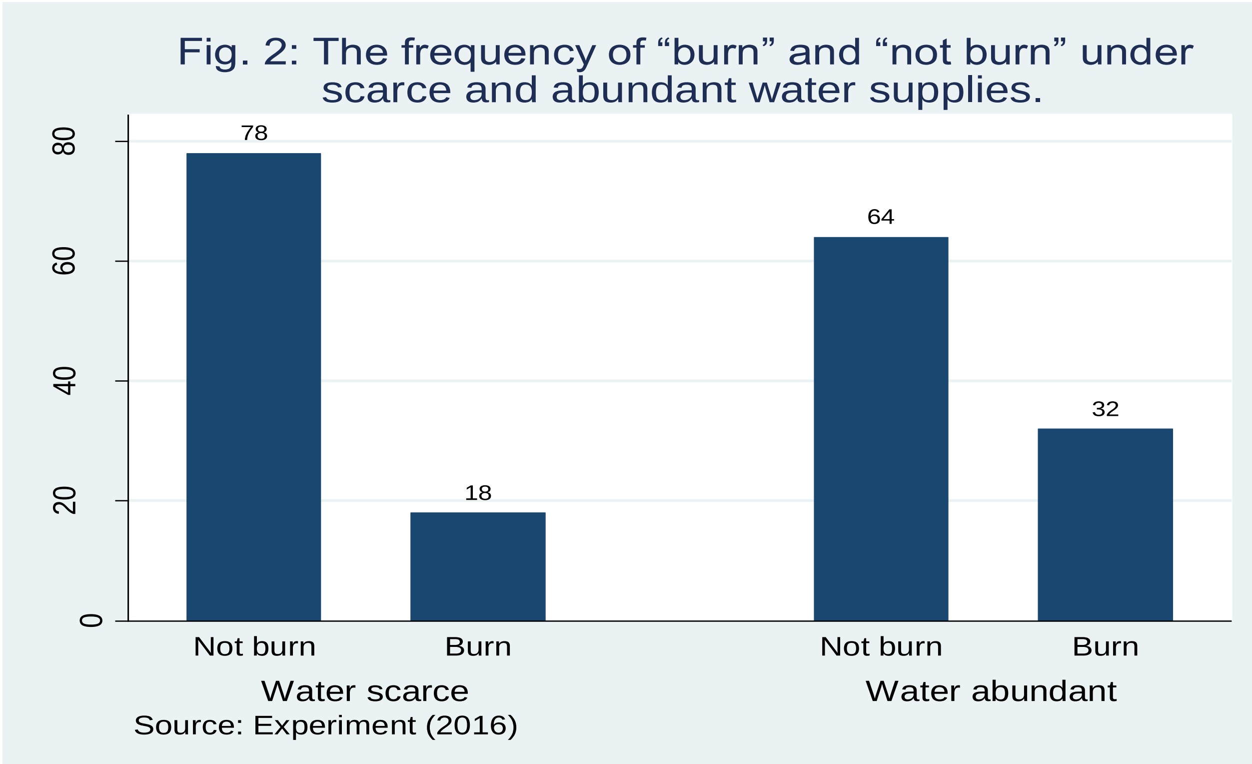
Table 4: Summary Statistics of Variables

Variable	Definition	Mean	Std. Dev.	Min	Max
decispl	Player's decision (1 if burn, 0 otherwise)	0.260	0.440	0	1
Age	Age of the player (in years)	44.005	12.692	20	80
Sex	Sex (1 if female)	0.214	0.411	0	1
eduHH	Education (1 if the player is literate)	0.464	0.499	0	1
expfarm	Farming experience (in years)	22.135	12.906	1	65
playposjo	Position in the irrigation system (1 if the player is head, 0 otherwise)	0.5	0.501	0	1
plah2ocojo	Water availability (1 if there is enough water or abundant, 0 otherwise)	0.5	0.501	0	1
deducjo	Amount of overall deduction due to players decision (in ETB)	12.964	10.642	1	30
Irr	Irrigation (1 if the farmer is irrigating, 0 otherwise	0.5677083	0.4966895	0	1

2. Data Analysis

2.1. Descriptive Analysis

Based on the water conditions, 78 and 64 participants who played under water scarce and abundant conditions made the "not burn" decision respectively (Figure 2). More players decide to "burn" in the abundant water condition than under water scarcity. Players under the water scarce condition are more prosocial than those under water abundant conditions are.



The average deduction and net incomes from players who made a decision of "not burn" are almost equal. It is approximately ETB 14 (Table 5). The maximum deduction is about ETB 30 while the minimum is ETB 5, with a range of ETB 25. The range of the net income in the same group is about ETB 21, the maximum being ETB 25 and the minimum is ETB 4. However, for those who decided to "burn", the average deduction and net income are approximately ETB 10 and 26 respectively. Whilst the range of the deduction is about ETB 29, the range of the net income is about ETB 41. The difference in the statistics between the two groups of players is due to income difference, which is purposely created at the beginning of the game to show the effect of water availability on irrigator's income. Nevertheless, the average deduction and net income for the whole sample are about ETB 13 and ETB 17 respectively. This is much closer to the same statistics of players in the scarce water condition than those played in the abundant water condition are. The larger proportion of players who decided to "burn" in the abundant water condition has a downward effect on the sample average deductions and net income. However, there is equal proportions of players in both sample groups.

Table 5: Summary Statistics of Net Income and Deductions against Players' Decision

Decision	Stats	Deduction	Net Income
Not burn	N	142	142
	Mean	14.092	13.937
	Sd	10.076	9.933
	Min	5	4
	Max	30	25
Burn	N	50	50
	Mean	9.76	25.84
	Sd	11.628	16.439
	Min	1	4
	Max	30	45
Total	N	192	192
	Mean	12.964	17.036
	Sd	10.642	13.023
	Min	1	4
	Max	30	45

Source: Survey Result

Position wise, more head-end players make a decision of "not burn" (Table 6). Only 23 out of the 96 head-end players made the "burn" decision. They are fewer than players at the tail-end position. The difference is, however, almost negligible. Using the two-sample Mann-Whitney test (Appendix B), there is no evidence that the possible difference in the decision is due to a position. Statistically, it fails to reject the null hypothesis that player position has no effect on an individual's decision to "burn" or "not burn".

Table 6: Decision of players against their position in an irrigation system (Frequency)

	Position		
Decision	Tail-end	Head-end	Total
Not burn	69	73	142
Burn	27	23	50
Total	96	96	192

Source: Result from the Experiment

2.2. Econometric Results

I estimated both linear and non-linear binary models. The estimations are robust and thus tests are based on the robust standard errors. The specification test for the Linear Probability Model (LPM), which is an estimate based on simple linear regression (OLS), fails to reject the specification test. The Ramsey RESET test also rejects the null hypothesis of no omitted variable (Appendix). Nevertheless, the binary estimations have come out with better estimates consistent with the theory that binary models are more preferred techniques for a dichotomous variable (Wooldridge 2014). The findings of all estimation techniques are, however, similar (Table 7). Coefficients, which are statistically significant in LPM, are also significant in the binary models. The number of significant coefficients and their signs is the same, but different in magnitude. Furthermore, a test on the goodness-of-fit using the classification test shows that both non-linear models predict more than 84% of the values correctly (Appendix D). Looking into the explanatory power of the models, Pseudo R-squared is above 0.2 (see Table 7). For binary models, Pseudo-R squared is fairly low and it could be acceptable well above 0.2 (Verbeek 2017; Wooldridge 2014). Hence, the discussion is based on the results from both binary models, logit and probit.

One of the questions of the study is to see how water conditions affect irrigators' behavior and burn others' irrigation in a given irrigation system. Thus, the estimation focuses on the direction and likelihood of the effect, but not on the magnitude of the likelihood (the margins).

The econometric results (Table 7) show that only covariates about water condition (*plah2ocojo*) and deductions (*deducjo*) have strong and statistically significant effect on a player's decision. A player having abundant water is more likely to make decisions against his or her partner in the game. It is less likely that a player in the water-scarce environment wants to destroy the joy of another person by letting his or her irrigation field destroyed. The covariate deduction is statistically significant with the expected negative sign. The higher the deduction due to a player's decision, the higher is the probability that a player makes the "no burn" decision, which is socially more acceptable. However, factors mainly related to socio-demographics are statistically insignificant. Explanatory variables such as farming experience and player's position are also statistically insignificant.

Table 7: LPM (OLS), Probit, and Logit Estimates of Decision to Burn

Variables	LPM	Probit	Logit
Age of the player	-0.004	-0.019	-0.033
	(0.003)	(0.013)	(0.023)
Sex of the player	0.061	0.249	0.416
	(0.070)	(0.266)	(0.453)
Education of the player	-0.022	-0.090	-0.153
	(0.059)	(0.242)	(0.421)
Farming experience	0.004	0.018	0.030
	(0.003)	(0.013)	(0.023)
Player's position	0.011	0.043	0.080
	(0.053)	(0.217)	(0.379)
Water condition	0.786***	2.747***	4.954***
	(0.047)	(0.319)	(0.967)
Deduction	-0.037***	-0.125***	-0.238***
	(0.004)	(0.022)	(0.063)
Constant	0.450***	-0.002	0.247
	(0.119)	(0.504)	(0.881)
R-squared/Pseudo	0.323	0.259	0.269
BIC	195.648	205.094	203.136
Log-Lik	-	-81.517	-80.538
chi^2		97.932	56.254
Observation	192	192	192

legend: * p<.05; ** p<.01; *** p<.001, standard errors are in parentheses

Source: Author's computation

3. Discussion and Conclusion

The overall research question of this paper deals with the effect of climate led scarcity on changing the behavior of individuals who use communal irrigation. Environmental conditions affect the behavior of communal resource users. Therefore, the paper asked which group are more likely to display behavior that suggest than envy matters thereby categorizing players into abundant and scarce irrigation water users. Moreover, it sought to answer what factors reinforce (lead to) an anti-social decision among communal irrigation users.

In this study I also sought to identify other factors that would affect the dependent variable in question. The position of a player in an irrigation system is one of the covariates controlled in the econometric model. It is, however, statistically insignificant, i.e., it has no influence on the decision of an individual player. The Mann-Whitney test also affirms that an individual's position in an irrigation system does not influence one's decision to burn or not (Appendix). This is a striking result, contravening the hypothesis of the study that head-end users could use their relative position to accrue more benefit out of the resource. It also differs from the findings of Amede (2015) and Anderies et al. (2013) who argue that under water scarcity, head-end users could abuse tail-end users by leaving no or less amount of water due to position-led power asymmetry. When head-end users try to accrue large benefits out of the communal irrigation, tail-end users decline to contribute to the maintenance costs of the system. This could cause conflict and non-cooperation among users. However, my findings support neither of these arguments.

The decision to "burn" is more likely when there is abundant irrigation water than when there is scarcity. That means, farmers show anti-social behavior by letting more water flow and damage the crop of the other player to protect their own irrigation. Surprisingly, water scarcity makes a higher fraction of the individuals behave and act prosocial. During scarcity, individuals appear less envious, and do not want to harm others by restricting or reducing the flow of irrigation water. It is more likely that players act generously and share the resource than doing things that destroy others' irrigation. A possible explanation for these somewhat unexpected results that anti-social behavior is less likely under water scarcity than abundance is that the participating farmers in the experiment were not fully detached from their real-life perceptions. Suppose that the consequences of antisocial behavior are more severe under scarcity than abundance. The reason for this concern follows from Beekman et al. (2014), who conducted a field experiment in Liberia on how real life experiences affected cooperation. Their insights coupled with my finding suggest more research on how detached players in field experiments are from their real-life experiences.

Similarly, scarcity, according to my findings, could have less effect on triggering conflict among communal irrigation users. This is against the common belief that conflict increases more during water scarcity. Generally, there is no any evidence in the data that supports that conflict could occur because of scarcity and irrigators' position. This finding is more plausible given the finding that conflicts occur rarely. A previous study by Gebretsadik (2018) has revealed conflict management strategies and/or overall management strategies of CPRs undertaken by users have contributed to low level of conflict.

Emphasizing the research question of disentangling the difference in envious behavior based on the stock level of water resource, therefore, this paper leads to the following conclusions.

1. The share of players who decided "not burn" is higher than the share of "burn" players.
2. Neither water scarcity nor the head-end position of an individual in an irrigation system leads to antisocial behavior. On the contrary, abundant water makes antisocial decisions more likely. However, it is beyond the scope of this study to conclude that scarcity enhances cooperation among communal users. Moreover, this paper has not solicited factors that suggest that envious behavior under abundant water conditions. Thus, further research is crucial on these points to conclude strongly on this theme.
3. Imposing high deductions for individuals that behave antisocially could induce individuals to make decisions that are less anti-social.
4. With anti-social behavior more prevalent under water abundance, it appears important for intervention to give more emphasis on ways to foster cooperation under abundant water settings. This could lower the likelihood of anti-social behavior, and may have implications

for more sustainable management of water resources, at least for conditions like those in Tigray.

Finally, this paper helps to fill the gap on factors that could make anti-social behavior more prevalent. This may particularly be the case for how to intervene in the management strategy of communal resources where the effects of climate-led scarcity are adverse.

The paper is, however, subject to some methodological limitations. First, the game is played with two players. Hence, important group dynamics may be lost. Conducting similar experiments with numbers of players being closer to the numbers of members of communal projects could lead to other outcomes, and hence other insights.

This paper has provided some new insights on the issues of factors reducing the extent of anti-social behavior. There are still issues in this area to be investigated. This paper may have provided inspiration for and some implicit guidance on how to conduct further studies on these issues.

Appendices

A) Water Conditions and Player's Decision: Mann-Whitney test

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

decispl	obs	rank sum	expected
Not burn	142	13031	13703
Burn	50	5497	4825
combined	192	18528	18528

```
unadjusted variance   114191.67
adjustment for ties   -28545.59
                      ----------
adjusted variance      85646.07

Ho: plah2o~o(decispl==Not burn) = plah2o~o(decispl==Burn)
             z =  -2.296
    Prob > |z| =   0.0217
```

Source: Author's computation.

At 5% level of significance, the test rejects the null hypothesis that a player's decision is the same irrespective of the water condition, whether there is abundant or scarce water condition. The finding is of this Mann-Whitney test is similar to the econometric findings.

B) Position and Player's Decision: Mann-Whitney test

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

decispl	obs	rank sum	expected
Not burn	142	13895	13703
Burn	50	4633	4825
combined	192	18528	18528

```
unadjusted variance   114191.67
adjustment for ties   -28545.59
                      ----------
adjusted variance      85646.07

Ho: playpo~o(decispl==Not burn) = playpo~o(decispl==Burn)
             z =   0.656
    Prob > |z| =   0.5118
```

Source: Author's computation.

The Mann-Whitney test supports against the argument player's decision is affected by his/her position relative to other users in an irrigation system. It fails to reject the null hypothesis, which is also similar to the econometrics result.

C) Specification Test

```
Ramsey RESET test using powers of the fitted values of decispl
       Ho:  model has no omitted variables
                 F(3, 180) =     60.77
                  Prob > F =      0.0000
```

Source: Author's computation.

The Ramsey RESET test is an omitted variables test conducted after the LPM model. The result shows that the test fails to reject the null hypothesis.

```
. linktest

      Source |       SS           df       MS      Number of obs   =       192
-------------+----------------------------------   F(2, 189)       =     53.58
       Model |  13.3796796         2  6.68983981   Prob > F        =    0.0000
    Residual |   23.599487       189  .124865011   R-squared       =    0.3618
-------------+----------------------------------   Adj R-squared   =    0.3551
       Total |  36.9791667       191  .193608202   Root MSE        =    .35336

------------------------------------------------------------------------------
     decispl |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        _hat |   -.611707   .4896872    -1.25   0.213    -1.577662    .3542475
      _hatsq |   1.513018   .4495885     3.37   0.001     .6261624    2.399875
       _cons |   .2228153   .0757736     2.94   0.004     .0733446     .372286
------------------------------------------------------------------------------
```

Source: Author's computation.

It is a specification test after the LPM. It rejects linearity at 1% level of significance. Accordingly, I estimated both non-linear models.

D) Specification test of the Probit Model: Dependent Variable "decispl"

```
              -------- True --------
Classified |         D            ~D  |      Total
-----------+--------------------------+-----------
     +     |        20             0  |         20
     -     |        30           142  |        172
-----------+--------------------------+-----------
   Total   |        50           142  |        192

Classified + if predicted Pr(D) >= .5
True D defined as decispl != 0
--------------------------------------------------
Sensitivity                     Pr( +| D)   40.00%
Specificity                     Pr( -|~D)  100.00%
Positive predictive value       Pr( D| +)  100.00%
Negative predictive value       Pr(~D| -)   82.56%
--------------------------------------------------
False + rate for true ~D        Pr( +|~D)    0.00%
False - rate for true D         Pr( -| D)   60.00%
False + rate for classified +   Pr(~D| +)    0.00%
False - rate for classified -   Pr( D| -)   17.44%
--------------------------------------------------
Correctly classified                        84.38%
--------------------------------------------------
```

Source: Author's computation.

E) Specification test of the Logistic Model: Dependent Variable "decispl"

```
              -------- True --------
Classified |         D            ~D  |      Total
-----------+--------------------------+-----------
     +     |        20             0  |         20
     -     |        30           142  |        172
-----------+--------------------------+-----------
   Total   |        50           142  |        192

Classified + if predicted Pr(D) >= .5
True D defined as decispl != 0
--------------------------------------------------
Sensitivity                     Pr( +| D)   40.00%
Specificity                     Pr( -|~D)  100.00%
Positive predictive value       Pr( D| +)  100.00%
Negative predictive value       Pr(~D| -)   82.56%
--------------------------------------------------
False + rate for true ~D        Pr( +|~D)    0.00%
False - rate for true D         Pr( -| D)   60.00%
False + rate for classified +   Pr(~D| +)    0.00%
False - rate for classified -   Pr( D| -)   17.44%
--------------------------------------------------
Correctly classified                        84.38%
--------------------------------------------------
```

Source: Author's computation.

E) Correlation Test

	age	sex	eduHH	expfarm	playposjo	plah2ocojo	deducjo
age	1.0000						
sex	-0.1076	1.0000					
eduHH	-0.3114	-0.2040	1.0000				
expfarm	0.7913	-0.1516	-0.2694	1.0000			
playposjo	-0.0095	-0.1144	0.1358	0.0251	1.0000		
plah2ocojo	0.0547	-0.0127	-0.0104	0.1020	0.0000	1.0000	
deducjo	0.0509	-0.0557	0.0701	0.1040	0.0594	0.8101	1.0000

Source: Author's computation.

I tested for the possibility of collinearity among covariates. However, the test reveals there is no high collinearity that affects the estimation.

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