

Research article

Water Resources Conservation in Bali: A Non-cooperative Game Theory Approach

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Abstract: Entering the 21st century, the world faces a global water crisis threat, due to increasing competition for freshwater which is an implication of economic growth, population growth, and climate change. Therefore, institutions that can secure the availability of water resources sustainably are urgently needed. In contrast to the tendency of research in the last two decades, which was dominated by experimental methods, this research studies local institutions in Bali called *Subak* using game theory as a reasoning method. Water management was analyzed using three economic frameworks namely, institutions, transaction costs, and contracts, to reveal how water institutions in Bali are managed. This study found that there are strong social norms that can maintain trust, act as a coordinating medium, eliminate transaction costs, and enforce contracts. Furthermore, the study also discusses the failure possibility of the current government intervention system because the capitalist production function alienates the value of water from its production system. Empirical research through experiments is very important, however, economics has a set of theories that can be used to predict or develop incentive mechanisms within an institution. The social norms that were found in this study can be used as a basis for the design of clean water management institutions at the village or community level with public participation.

Keywords: water management, social norm, game theory, institutional economics

JEL Classification: D71, C720, P48, Q25

Abstrak: Memasuki abad ke-21, dunia menghadapi ancaman krisis air global akibat peningkatan persaingan untuk air tawar yang merupakan implikasi dari pertumbuhan ekonomi, pertumbuhan penduduk, dan perubahan iklim. Oleh karena itu, lembaga yang dapat menjamin ketersediaan sumber daya air secara berkelanjutan sangat dibutuhkan. Berbeda dengan kecenderungan penelitian dalam dua dekade terakhir, yang didominasi oleh metode eksperimental, penelitian ini mengkaji lembaga lokal di Bali yang disebut *Subak* dengan menggunakan teori permainan sebagai metode penalaran. Manajemen air dianalisis menggunakan tiga kerangka ekonomi, yaitu lembaga, biaya transaksi, dan kontrak, untuk mengungkap bagaimana lembaga air di Bali dikelola. Penelitian ini menemukan bahwa terdapat norma-norma sosial yang kuat yang dapat mempertahankan kepercayaan, bertindak sebagai media koordinasi, menghilangkan biaya transaksi, dan menegakkan kontrak. Selain itu, penelitian ini juga membahas kemungkinan kegagalan sistem intervensi pemerintah saat ini karena fungsi produksi kapitalis menjauhkan nilai air dari sistem produksinya. Penelitian empiris melalui eksperimen sangat penting, namun, ekonomi memiliki serangkaian teori yang dapat digunakan untuk memprediksi atau mengembangkan mekanisme insentif dalam sebuah lembaga. Norma-norma sosial yang ditemukan dalam penelitian ini dapat digunakan sebagai dasar untuk desain lembaga pengelolaan air bersih di tingkat desa atau masyarakat dengan partisipasi publik.

Kata kunci: pengelolaan air, norma sosial, teori permainan, ekonomi kelembagaan

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1. INTRODUCTION

The renewable water supply on earth is governed by the hydrologic cycle that occurs continuously, of the large amount of water that is recycled annually through this system, only a small portion of this water is available annually to humans. Of the estimated total volume of water on earth, only 2.5 percent (1.4 billion km³) of the total volume is fresh water. Of this amount, only 200,000 km³, or less than 1 percent of all freshwater sources (and only 0.01 percent of all water on earth), is available for human consumption. In general, this amount appears to be sufficient to supply every individual on earth (about 7.5 billion people in 2020), about 12,000 liters per year per person (Meran et al., 2021). But in fact, it was found that many people are experiencing vulnerability to fresh water. Asia and the Pacific, home to 60 percent of the world's population, of the 1.5 billion people living in rural areas and 0.6 billion in urban areas, lack adequate water supply and sanitation. 27 of ADB's 49 member countries face serious water constraints, and 18 of these have not adequately protected their populations from water-related disasters (ADB, 2020). These facts show that water has the potential for scarcity for humans.

Water management has recently become a global issue, fueled by a growing population, environmental challenges, climate change, adverse local conditions, and lack of proper regulation and institutions. The United Nations (UN), therefore, then sets the water problem in the 2000 Millennium Goals and continues to pursue it in the 2030 Agenda for Sustainable Development Goals (SDGs). Sustainable Development Goal 6 (SDG 6) is to "Ensure access to water and sanitation for all". How will these goals be achieved, given the challenges faced in water management? Coordination is one of the classic problems in realizing a common goal and achieving development. Coordination failures, such as those modeled in the famous *The Tragedy of Common Property*, can be avoided by the existence of social norms as a "focal point" among property rights holders to coordinate under asymmetric information.

Based on these problems, this research is aimed at finding the institutional framework (rules of the game) of the community that they have lived and trusted for a long time. Although formal institutions (top-down regulation by the government) change rapidly, often the institutions followed by society change very subtly (bottom-up social norms). The findings from these institutions will be used to complement or even improve top-down institutions. One issue that also wants to be discussed is the current water resources management policy with the top-down designation of *Subak* as a world cultural heritage.

Since water is essential and fundamental to all aspects of life, institutions that manage water must have been around for a long time. Civilizations in the past certainly also had complex and sophisticated institutions (Fagan & Durrani, 2021), however, because the environment is constantly changing, institutional changes are important to observe. For example, Asia has a lot of evidence that its society successfully performs complex water management systems, which could be the source for studying the institution with its focal point to coordinate and handle transaction costs as well as the enforcement of the social contract. Various historical sites scattered throughout Asia show that temples played an important role in ancient irrigation systems. In Cambodia, temples have become an important element in the Khmer irrigation system. Northern Thailand has an irrigation system where spirit gods have control over the irrigation. Java, in the 14th century, placed mountains and rivers as sacred sources of power and became locations for royal palaces. If we believe that the metaphysical philosophy of economics is human behavior in managing scarce resources, it will be very difficult to get lessons about meaningful coordination devices (the focal point) for water resource management from these historical sites. Institutional forms will continue to adapt and change, but the basic principles of human behavior such as those underlying economics are not. Customary institutions with their social norms are very flexible. Institutional change is a nonlinear, complex, and non-ergodic process, where the success or failure of this change will greatly determine the success or failure of economic development. Fortunately, *Subak* which is developed from the same philosophy as another historical site, still runs well in traditional farmer groups in Bali which makes the study of social norms a "focal point" possible.

Subak is a community organization that specializes in fostering rice field irrigation systems used

in rice cultivation in Bali. This system is managed in groups and stages with a specific role distribution for each member. *Subak* is one of the systems in Indonesian agriculture that undergoes an "involution" process. A complex social institution without significant technological or political changes, which was born from the intensification of wet rice cultivation that has been carried out for centuries. *Subak* has survived for centuries in the life of the Balinese people because it was built from the philosophy of belief of religion adhered to by the Balinese people. *Subak* expert from Udayana University, I Wayan Windia, stated that *Subak* is a traditional organization that refers to the concept of *Tri Hita Karana*, (Mulyati, 2019). *Tri Hita Karana* is a philosophy of the balance of human life in its interactions with fellow humans, nature, and God, which originates from the teachings of Hinduism. This traditional irrigation system is organized through the stratification of the temple system in Bali, especially for agriculture. This system has proven to be very effective in maintaining the sustainability of agriculture and the availability of water which is the most important input in agriculture and human life (Norken et al., 2015; He et al., 2019).

Bali's economic transformation as a result of the foreign tourist "boom" over the last three decades has made the structure of the Balinese economy jump rapidly from agricultural domination to service domination. The mobility of potential workers out of the countryside, which is the location of most Balinese agriculture, continued land conversion and led to a decrease in the productivity of the agricultural sector of the island. Although the development of the economy of Bali, which is driven by the tourism industry has had many positive impacts, it is feared that the continued decline of the interest of the younger generation in agriculture will threaten the existence of *Subak* and the future of the water resources conservation in Bali (Jayasuriya et al., 2020; Diputra & Arsha, 2023). For this reason, a new management institution is needed for water management in urban industrial systems. The issues faced will of course be the same, namely institutional problems, transaction costs, and enforcement of social contracts. Therefore, this study is needed to identify social norms that can be used as media for coordination within the institutional framework by describing how traditional water management institutions in Bali work.

This study will use three institutional frameworks that coordinate communities to manage water resources. The first conceptual framework is institutional theory. Until recently, the accepted theory assumed that resource users would fail to coordinate in securing their resources, requiring the presence of the government to present a solution through coercive mechanisms. Based on research in various disciplines, it has been found that some government policies accelerate the destruction of resources, whereas some users of resources have invested their time and energy to achieve sustainability. The second conceptual framework to be used is transaction costs. In transaction cost theory, governance is seen as an overarching concept, and transaction cost economics is an operational means of realizing governance and organization. Transaction costs will determine the efficiency of the form of coordination within the organization (Menard & Shirley, 2022). The last conceptual framework is contract theory, which consists of several models: (i) principal-agent theory, (ii) principal-agent model of moral hazard and adverse selection types, (iii) implicit contract theory, (iv) Incomplete contract theory, and (v) Model self-enforcing agreements (Menard & Shirley, 2022).

Based on the previous description, it can be concluded that this study will descriptively analyze water institutions in Bali using the institutional economic framework. The expected results of the study are a description of the strategic interaction between agents in the *Subak* organization and the identification of social norms in the analytical framework as a medium for coordination. The findings from this analysis will be very useful for evaluating interventions by the government in protecting water resources. An important point in the findings of this study is that there is a possibility that "good intentions" can end in undesirable conditions due to a failure to understand people's "rational choices".

2. RESEARCH METHODS

The study will employ game theory to analyze the *Subak* institutions. Game theory is a branch of mathematics that studies the strategic behavior of decision-makers, also known as players, in situations of interdependence or conflict. It provides a framework to analyze and understand the

behavior of individuals and groups in settings where the outcome of their actions depends on the actions of others. Game theory is widely used in economics analysis because it allows economists to model and predict the behavior of firms, consumers, and other economic agents in a variety of settings, such as market competition, bargaining, pricing, and auctions. By using game theory, economists can identify the optimal strategies for different players in these situations and evaluate the likely outcomes of their interactions.

The game theory that is mainly used in this study is the non-cooperative game theory. Non-cooperative game theory is a branch of game theory that focuses on analyzing strategic interactions between players who are assumed to act independently and do not necessarily communicate or cooperate. In this type of game, each player is primarily concerned with their payoffs and seeks to maximize their interests. In a non-cooperative game, each player has a set of possible strategies available to them, and they must choose one strategy without knowing the choices made by the other players. The outcome of the game depends on the strategies chosen by all players, and the payoffs that each player receives depend on the combination of strategies chosen. A classic example of a non-cooperative game is the Prisoner's Dilemma. Non-cooperative game theory provides a framework for understanding such situations and predicting the likely outcomes of strategic interactions between self-interested players. It is widely used in economics, political science, and other social sciences to analyze a wide range of phenomena, such as market competition, bargaining, and voting behavior.

Solution methods and techniques for solving the games in this study are using the Nash Equilibrium Method (Mussah et al., 2020). A Nash Equilibrium is a situation where each player's strategy is the best response to the strategies chosen by the other players. In other words, no player can improve their payoff by changing their strategy, given the strategies chosen by the other players. To identify the Nash Equilibrium, we need to look for a combination of strategies where no player has an incentive to change their strategy. This means that each player is already choosing the best possible strategy given the strategies chosen by the other players.

Instead of using quantitative and experimental data, like used by (Sukadana & Saraswaty, 2014), this research uses more qualitative information. Data, or qualitative information in this case study, was collected using in-depth interviews with farmers leaders, traditional water management experts, and the staff at the Regional Development Planning (Bappeda) Bali. The information was then analyzed using the Nash Equilibrium of a non-cooperative game method, by following the steps as follows:

- (1) Identify the players: Identify the individuals or entities who are making strategic decisions within the game.
- (2) Define the strategies: Identify the possible actions or strategies available to each player.
- (3) Construct the payoff matrix: Construct a table that shows the possible payoffs for each player, based on the combination of strategies chosen by all players.
- (4) Analyze the matrix: Analyze the matrix to determine the best response of each player to the strategies chosen by the other players.
- (5) Identify the Nash Equilibrium: Identify the combination of strategies where no player has an incentive to change their strategy, given the strategies chosen by the other players.

It's important to note that not all games have a Nash Equilibrium, and some games may have multiple Nash Equilibria. In some cases, it may also be necessary to use more advanced game theory concepts, such as mixed strategies or repeated games, to identify the Nash Equilibrium.

3. RESULTS AND DISCUSSION

This section will discuss the analysis of *Subak*, as water resources management, using three theoretical frameworks which include: the Institutional Economic Framework, the Transaction Cost Framework, and the Contract Theory Framework. The analysis will end by providing a discussion regarding the future of water resources management in Bali based on predictions from non-cooperative game theory analysis. The discussion also tried to provide suggestions regarding development areas for future public policy research.

3.1. Bali Water Management in the Institutional Economic Framework

Subak is said to have existed centuries ago, so the analysis will begin by using the past setting where, based on various historical literature, Bali's economy was characterized by sub-system agriculture domination. In this sub-system economy, every household will both produce and consume their products at the same time, it could be a market system that exists, but it can be said that the market is almost perfect (producer = consumer). This condition is assumed to be equivalent to a monopolistic competitive market structure. In this kind of market structure, there are many producers with horizontally differentiated products as well as many consumers.

In the past, other production inputs such as land and labor were not a problem because they were available in abundance. The opportunity cost of land as agricultural land is zero. Meanwhile, workers at that time still followed the caste system, where the working class (*Sudra*) did not have the opportunity to change professions. This caste system ensures the availability of abundant workers in the agricultural sector, so their existence could be negligible in the model. Then, water becomes the only input that is endogenous and important to manage because, based on economic principles, its existence is scarce. Based on the previous description, several propositions can be made as follows:

- Proposition 1: Sub-system agricultural economy
- Proposition 2: The structure of the agricultural industry is monopolistic competition
- Proposition 3: The production function is Production with a single input, $Q = f(\text{Water})$
- Proposition 4: Water is produced by nature in an uncertain manner

In the theory section, it has been explained that institutions aim to direct individual behavior in a certain direction. *Subak* in this case, mainly aims to make individuals' have the behavior to maintain the sustainability of very limited water availability. Rational farmers (more precisely we admit that there is bounded rationality) will follow what the institution directs (through a set of rules) if the institution can place incentives to eliminate uncertainty arising from interactions between farmers and farmers with nature as the water providers. Then, the incentive mechanism to create stable institutions is explained by a non-cooperative game theory framework based on the Battle of Saxes game model. Table 1, shows a description of the Nash equilibrium for farmers in *Subak* institutions.

Table 1. Pay-off Matrix of Farmer's Nash Equilibrium

Pay-off Matrix		Farmer A	
		Farm	Conserve the water
Farmer B	Farm	- 1, - 1	2, 1
	Conserve the water	1, 2	0, 0

Source: Researcher Calculation, 2023

A multiple Nash equilibrium, where in the Super Game setting (in the infinite sequential game setting) the first mover distribution is assumed to follow the binomial distribution so that the total welfare between Farmers A and B will be normally distributed in the infinite game setting. Temples and priests are used as "focal points" by farmers to determine which equilibrium will occur from the existing equilibria (multiple equilibria). This focal point is important to keep the outcome from falling into an "out-of-equilibrium" condition (Farm, Farm or Conserve the water, Conserve the water). As revealed by (Yu et al., 2015) the social norm, as we found in *Subak*, was able to self-enforce the role of punishment (the negative outcome in Farm-Farm payoff) to promote cooperation which is very important in the evolution of the institution.

3.2. Bali Water Management in the Transaction Cost Framework

At a glance, *Subak* is just an ordinary irrigation system in the form of a Farmer Managed Irrigation System (FMIS) or an irrigation system managed by farmers, but what makes *Subak* special among other FMIS, is that it contains very dense ritual activities (Windia et al., 2015). *Subak* has a series of religious rituals in agriculture in Bali. Rituals in the *Subak* system are seen as an expression

of gratitude to the creator for the success of reaching this stage of life (agriculture). If reflected in the framework of the principal-agent model of capitalist organizational structure, the principal in the life system designed in *Subak* is God, while the Farmers are Agents who manage water resources for their lives. Because in the conception of Hinduism, it is also known as the concept of God which permeates and integrates in all things, optimizing agricultural output must at the same time optimize God's objectives (in the Hinduism perspective) as the principal. This concept is known as *Tri Hita Karana*. Information transaction costs in this case become non-existent.

Unlike the classical production theory, in which producers maximize profits with input cost constraints (given owned technology), inputs are assumed to be exogenous. Meanwhile, in the *Tri Hita Karana* concept, farmers maximize profits with input cost constraints with endogenous inputs. Where input sustainability is determined by the behavior of individual farmers in coordinating to protect water sources, as described in the Nash equilibrium in Table 1, in the previous section. This coordination can occur because of very low transaction costs, this low transaction cost occurs because of the high investment of social capital, namely mutual trust. Based on the previous description, several propositions can be made as follows:

- Proposition 5: The principal is God, and the agent is the farmer.
- Proposition 6: Principal-agent information transaction costs equal to zero.
- Proposition 7: Coordination is maintained by trust as social capital.

The coordination mechanism among *Subak* members will explained using a non-cooperative game theory framework based on the Prisoner Dilemma model. Table 2, describes the Prisoner Dilemma game and shows how *Subak* maintains coordination.

Table 2. Pay-off Matrix of The Prisoner's Dilemma Model

Pay-off Matrix		Farmer A	
		Obey	Cheats
Farmer B	Obey	1, 1	0, 10
	Cheats	10, 0	-1, -1

Source: Researcher Calculation, 2023

In the past, where the monitoring system was minimal, fraudulent behavior (water hogging) that was not detected was very likely to occur, so in Table 2, the temptation to cheat is reflected by a pay-off that is 10 times the pay-off of Obey so that the Nash equilibrium is Cheats strategies for both farmers. *Subak*, was able to maintain coordination, even though the pay-off (in a one-shot game setting) was very low. But in the infinite game setting, the present value obtained from the Obey strategy is far greater than the cheats strategy. The philosophy of the Balinese Infinite game is the belief in the existence of *Samsara* (rebirth). Meanwhile, the credibility of the existence of punishment for cheating strategies is also extended along with the infinite concept through the belief in the law of *Karma*. In a more complex setting where agents do not know each other, institutions can create complex ritual systems as a screening mechanism for which farmers are genuinely obedient or who will cheat (Carvalho & Sacks, 2021; Levy, 2019).

3.3. Bali Water Management in the Contract Theory Framework

The analysis in the previous section, especially Table 2, implies that the appropriate contract theory to explain the *Subak* is the theory of self-upholding (self-enforcing agreements). The reason is that *Subak* has been able to create a system that can uphold itself, there is no need for a third party to enforce the rules of the game (punishment for bad choices, for example). Information is considered perfect, with one exception, the parties do not know whether the other party can be relied upon (honest), but honesty is guaranteed by the philosophy of *Samsara* and *Karma*. The common belief in the Almighty Principal (God) will guarantee *Samsara* and *Karma* Credible.

Subak has been operated so far without a formal contract, all stated in the form of an informal contract based on trust (social capital). The incomplete contract model is an effort to formalize the transaction fee approach. The main assumption of this model is the symmetrical information and

imperfect future foresight about the type of improvement, but perfect knowledge of the cost of realization and the possibility that improvements will occur. With this model, *Subak* is very flexible for changes in the times and the view of human life.

The Green Revolution, in the 1980s, provided a drastic change in the foundation of farmers' lives and the way they farm. The principle of capitalism has changed many traditional agricultural systems in various parts of the world, but Bali's traditional agricultural systems have not been impacted significantly. However, the growth in the tourism industry, which offers higher profits and wages has been threatening the preservation of water resources (Cole & Browne, 2015). In the tourism production function, water is no longer an endogenous input, but exogenous (following the capitalist profit maximization mechanism).

The government, the United Nations, NGOs, and other environmentalist organizations continue to voice on preserving *Subak*. One of the governments and the United Nations' attempts to preserve *Subak* was by establishing it as a world cultural heritage. UNESCO recognized the Bali Province Culture Landscape which was built by *Subak* as a World Heritage Site, at the first trial that took place in Saint Petersburg, Russia in 2012. If we analyze the effort by the game theory framework of analysis, especially in the self-enforcing contract theory, it is analogous to the threat (bluff) that is not credible. The establishment of *Subak* as a cultural heritage is not able to provide certainty to future outcomes including credible punishment. The establishment can be translated as the "death of *Subak*", *Subak* which was once an organic institution turned into an institution that was designed intentionally and ordered by the authorities. Of course, the outcome that occurs is not a Nash Equilibrium. Based on the previous description, several propositions can be made as follows:

- Proposition 8: There are new, more promising industry alternatives.
- Proposition 9: Asymmetric information about the future
- Proposition 10: There is no credible punishment (by social norm or belief).

The analysis of how farmers leave agriculture and *Subak* will explain using a non-cooperative game theory framework based on the entry game model. Table 3, describes the modified Entry Game to show exit behavior from farming and *Subak*.

Table 3. Pay-off Matrix of The Exit Model

Pay-off Matrix		Farmer A	
		Fight	Accommodate
Youngster in agriculture	Exit	0, 0	2, 2
	Stay	1, 5	1, 5

Source: Researcher Calculation, 2023

The government has a mission to maintain culture and make it a new product, namely a tourist destination. The government's goal is to give a signal to the pre-game conditions, to prevent youth exit from agriculture. The government has launched various programs to make it happen, one of which is to make *Subak* a world cultural heritage.

Even though the future of youth who exit agriculture is asymmetrical, (they cannot know their future in the city with certainty), however, punishment, in this case higher profits on agriculture also not certain, so the Nash Equilibrium occurs in strategy (Exit, Accommodates). Empirical evidence of the existence of this equilibrium can be traced from the declining agriculture output proportion in Bali's economic structure, lower term of trade of farmers, and unstoppable land conversion (Bendesa & Asti Aksari, 2018; Jayasuriya et al., 2020; Pickel-Chevalier et al., 2021).

The results of the analysis in this section show that efforts to protect water resources by establishing protection through a protected status by law or regulation are unlikely to succeed. This result is consistent with the finding that laws that are very contrary to prevailing social norms can backfire, while gradual tightening of laws can be more effective in influencing social norms and behavior (Acemoglu & Jackson, 2017).

3.4. Discussions

The results of this study are in line with (Sunarta et al., 2021), who found that There has been a transformation of spatial functions: from agricultural functions to cultural service functions. The change in spatial planning indicates a tendency to shift the socio-cultural community around the Kuta Tourism Area from agrarian to sub-urban characteristics. Thus, it has an impact on the existence of Subak as the last bastion of sustainable tourism development in Bali. Another implication of this new business practice is the scarcity of water availability for agriculture because there is no coordination mechanism as described in Farmer's Nash Equilibrium Pay-off Matrix (see Table 1 in Section 3.1). This finding is by the results of the analysis in Section 3.3 of this study, which provides an argument that the designation of *Subak* as a world cultural heritage is not credible for maintaining Bali's water resources. Instead of conserving water resources, this stipulation has even opened a new tourism product, namely *Subak* eco-tourism, which of course has nothing to do with the agricultural production process that succeeded in preserving water resources in the past.

The findings in this study are more inclined to provide support that bottom-up institutions (institutions that emerge and continue to develop based on social norms, traditions, values, and trust when they interact and exchange with each other in society), are more successful in maintaining the sustainability of natural resources, especially natural resources that are essential for human life such as water. However, institutions like these only change gradually, as individuals evolutionarily change their values or beliefs. What about the efforts to protect water resources? A new contract scheme is needed, which can be derived from the *Subak* institution. Current socio-economic terms make it impossible to apply the contact system as in the (old) *Subak*. Even though the Balinese still adhere to their beliefs and uphold trust among themselves, the change in the economic structure from traditional agriculture to services in urban areas has put water conservation efforts at risk. The urban modern sector seems to have "forgotten" the value of water, which is a gift from the creator because water has been disguised by other modern inputs in increasingly complex production functions. Residents are increasingly alienated from the values entrusted by their predecessors, as shown in the analysis section.

However, one thing that needs to be emphasized, is that the capitalist production function must treat the input of water as an endogenous input from the process of optimizing the production of the capitalist product itself. This includes when water becomes a final commodity, such as in clean water products provided by the government. It seems that an important role in changing the current situation is held by the government, as an entity that can direct the behavior and socio-economic decisions of the people. Opportunities may come from policy designs based on the philosophy of libertarian paternalism as it underlies various policy designs based on "Nudge" ideas (Thaler & Sunstein, 2021). Nudge design with social norms and supported by remote sensing technology in water management, as studied (Aryastana et al., 2020) could be an opportunity to secure the availability of water in Bali. The finding could also support the application of Payments for Ecosystem Services (PES). (Jespersen & Gallemore, 2018) find examples of everyday work undertaken to build and maintain PES institutions, or else to disrupt institutions that stand in the way. While we find that social norms still strongly influence coordination, the PES model could be used to complement the norms. In general, the implications of this research suggest that institutional design has to be in line with pre-existing social norms to be able to achieve goals successfully according to previous findings (Deffains & Fluet, 2020).

4. CONCLUSIONS

Based on the analysis and discussion in the previous section, this study draws several conclusions, First, social norms are proven to be able to coordinate cooperation and prevent miscommunication which can end up in an out-of-equilibrium condition within an institution. Second, the belief in the existence of an almighty power from nature which is manifested in various beliefs, such as *Samsara* and *Karma*, can become a medium for upholding trust among members of the farming community in Bali. A series of complex ceremonial events can be a screening mechanism to separate compliant (Obey) members from fraudulent (cheats) members in interaction settings

with asymmetric information. Third, efforts to save Subak through the cultural heritage scenario have not been able to help water resource conservation. Finally, in the future, new research based on the "Nudge" design is needed to improve policies.

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