

The institutional viability of water management practices in subak Deman



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Executive Summary

Local irrigation system managed in Bali namely subak Deman is under pressure from water scarcity. Most literatures on water management focus on the actors; however there is less emphasis on the practice and institution that emerges from the practice. Therefore, the objective of this research is to understand to what extent and how the institutional features of water management practices in the subak system stay intact under the condition of external pressures. This research evaluated the institutional features of water management practices in subak Deman using Perri 6's institutional viability theory by observing water management practices and interviewing the actors on the way they manage the irrigation system. By doing that, this research understood whether the institution can survive under the external pressure. This research was done for 3 months in subak Deman, Tabanan, Bali, Indonesia. This research contributes to the growing body of literature on water management from the perspective of institutional dynamic of water management practices.

Key words: water management-social technical practices-institutional viability-solidarities-subak

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List of Acronyms

<i>awig-awig</i>	Customary rule book for subak
<i>empelan</i>	Irrigation weir
<i>kelian</i>	Customary head of a smaller subak
<i>matelik</i>	Irrigation canal surveillance activity to prevent the sabotage of the canal
<i>ngayah</i>	Collective work in subak, usually for constructing, repairing, or maintaining irrigation infrastructures
<i>pekaseh</i>	Head of a subak that governs more than one smaller subak
<i>prajuru</i>	Leader role in a smaller subak
<i>subak</i>	Bali's irrigation rice cultivation system
<i>tektek</i>	Portion of allocated water for rice fields in subak
<i>telabah</i>	Irrigation canal
<i>tembuku</i>	Irrigation structure that allocates water for rice fields

1. INTRODUCTION

Tourism and farming are the main contributors to the economic sector in Bali. In 2016, tourism provided direct employment for 30.15 percent of working people in Bali, compared to 20.94 percent of the farming sector. The tourism sector also contributed to 22.76 percent of Gross Domestic Product the same year, compared to 14.67 percent of the farming sector (Bali Province in Figures, 2017). However, in some regions in Bali, farming is still the main economic sector. In Tabanan regency in 2016, for example, farming sector provided direct employment for 36.48 percent of working people, compared to 26.95 percent of the tourism sector. It also contributed to 22.67 percent of Gross Domestic Product, compared to 21.57 percent of the tourism sector (Tabanan Regency in Figures, 2017). However, in term of the economic contribution, the tourism sector in Tabanan has become more dominant than the farming sector in recent years. Statistic showed that from 2013 to 2016 the tourism sector in Tabanan has experienced significant development with the Gross Domestic Product growth of 53 percent, while during that period the farming sector has lower growth with 39 percent (Tabanan Regency in Figures, 2017).

Several studies showed that the rapid growth of tourism in Bali has caused impacts to the farming sector, for instances in the way of life, land use, and water supply (Budiasa, Setiawan, Kato, Sekino, & Kubota, 2015; Salamanca, Nugroho, Osbeck, Bharwani, & Dwisasanti, 2015). Because of the low-income it generates compared to the tourist industry, many farmers sell their lands to the developer and change their livelihood (Salamanca, Nugroho, Osbeck, Bharwani, & Dwisasanti, 2015; Strauß, 2011). Many young people prefer to work in the tourism sector rather than working as a farmer (Salamanca, Nugroho, Osbeck, Bharwani, & Dwisasanti, 2015). Moreover, there was also a loss of 6,109 ha of rice fields into the non-farming ground from 1997 to 2011 (Budiasa, Setiawan, Kato, Sekino, & Kubota, 2015). Lanya, Subadiyasa, Sardiana, & Adi (2015) reported that there was a rapid decrease of rice area from 108,336.99 ha to 79,967.18 ha over a period of 11 years (2002 – 2013). Furthermore, the demand of water from the tourism sector has put pressure on the finite water resource availability in Bali. Several studies argued that there is water shortage problem for the farming sector that is caused by the growth of the tourism sector (Cole & Browne, 2015; Lanya, Subadiyasa, Sardiana, & Adi, 2015; Salamanca, Nugroho, Osbeck, Bharwani, & Dwisasanti, 2015; Strauß, 2011).

In order to organize water management in rice farming, the farmers in Bali practice cooperative water management for irrigation called subak (Roth, 2011). This traditional irrigation system has been practiced since the 11th century (Lorenzen & Lorenzen, 2005; Spiertz, 1990). Subak, in which experiences water shortage problem, has provided an

opportunity to study the institutional viability of water management practices under external pressures. The actors in subak who are responsible to water management may respond to water shortage problem by implementing rules or institutions to deal with the issue. This research aims to study the viability of institutions of water management practices in a subak that encounters external pressures. Thus, this raises the question: **To what extent and how do the institutional features of water management practices in the subak system stay intact under the condition of external pressures?**

This thesis proposes Perri 6's concept of institutional viability rooted in the Neo-Durkheimian cultural theory to study the conditions that enable institutions to be viable (6, 2003). Perri 6 argued that institutions that are more likely to be viable under the tension of external pressures and internal tensions require the interaction of basic institutional forms and the settlement to contain the conflict between these forms. To understand institutions and their dynamic in water management of a subak, this research need to zoom in on the actual practice of managing water by the actors. For that purpose, this research utilizes Nicolini's concept of practice to study the interconnected practices in water management of a subak (Nicolini, 2011). This concept argues that knowledge is stored in interlinked practices and can be observed through the events when the practices occur. Following from this concept, this research investigates the events of interlinked practices where knowledge of water management in dealing with external pressures materializes itself.

This research understands that water management practices in a subak are the integration of social and technical aspects of managing water. Therefore, to study the social technical practices of water management, the technography approach as the study of practice (Jansen and Vellema, 2011) is used in a case study of water management practices in a subak. This operationalization generates specific research questions to help answer the main question: (1) **How do the actors manage the water distribution within their subak community?**, (2) **What kind of rules and how are they used to manage the water in a subak?**, and (3) **How do the actors respond individually and collectively to the water shortage problem?** All these questions refer to the social and technical aspects of the situated practice of water management.

There are several previous studies that focus on how to achieve a successful irrigation management. Sinclair, Kumnerdpet, & Moyer (2013) argued that the participation of water users in all phases of irrigation management is important to achieve sustainable water management through better water allocation and effective water usage within agricultural system. Thus, farmers' role is important in managing the irrigation system. However, there are other factors that also important to ensure a successful participatory irrigation

management. Blaikie (2006), based on some researches in Malawi and Botswana, argued about the importance of political conditions and interaction between program and the local communities in order for community-based natural resource management to be successful. Ricks (2016) also emphasized the importance of local political contexts in order for participatory irrigation policies to be effective. The local political environment highly influences the implementation of resource management policies that encourage participation from all stakeholders. Ricks (2016) drew a conclusion from his works in Indonesia that local leadership will force bureaucrats to promote farmer participation in water management only when irrigation is an important issue. In other research in India, Rao, Bower, Gaur, & Visvanatha (1998) emphasize more on well-designed program to ensure successful tertiary level irrigation system with participation of the farmers. In sum, these studies emphasized on the importance of cooperation between all stakeholders to ensure a working irrigation management. However, this research argues that it is important to address the question on the practice and the viability of institutions that emerge from the practices. This research therefore would like to contribute to the study of water management from the perspective of institutional dynamic of the practices of managing water.

This thesis continues by further elaborating the concepts of practice and institutional viability and their operationalization in Chapter Two. Chapter Three explains the description of the case study and the methodological choices taken in this research. In the methodology, the technography approach to explain the social-technical dimension of the water management practices is presented and the methods taken to support the approach. Chapter Four focuses on the empirical data of the field work in Bali, Indonesia and elaborates on the water management practices in a subak in dealing with water scarcity issue. Chapter Five presents the analysis on the assessment of institutional viability of water management practices in a subak. And, chapter 6 provides the discussion and conclusion of the analysis.

2. CONCEPTUAL FRAMEWORK

In this chapter the concepts used in this research and their operationalization are explained. This research combines the concept of practice of Nicolini (2011) with the concept of institutional viability of Perri 6 (2003). This chapter starts by elaborating on water management as social technical practices in a subak using Nicolini's concept of practice as the site of knowing. The choice to focus on the interconnected practices of managing water is to study the knowledge that materializes when the actors in a subak practice water management in dealing with the external pressure of water scarcity. Taking off from the interconnected practices, this research turns the attention towards the institutions that emerge from the practices. Utilizing Perri 6's concept of institutional viability, this research elaborated on the conditions in which the institutions have the greatest chance to be viable. The last part explains the operationalization of the concepts.

2.1 Water management as social-technical practices in a subak

This research aims to study the institutional viability of water management practices in a subak that encounters the external pressure of water scarcity. For the purpose of studying the institutions, this research needs to focus on the practices, as the institutions emerge from the practices. This research proposes that knowledge of water management becomes visible through the daily practices of managing water. These practices are connected and distributed among the actors, objects, and practices of water management. To study knowledge of water management, this research proposes to study the interconnected activities inside the water management practices.

Nicolini (2011) argued that practice is a site of knowing, where knowledge materializes itself and becomes visible. The site of knowing is not a single practice, but manifested through interconnected practices. Knowledge in practice is distributed among individuals, objects, and practices. The distributed knowledge among these varieties is connected and dependent on each other. The practice approach does not start by studying individuals; however, individuals are still studied as the performers of practice. Nicolini suggested one should focus on the activities of a practice and its structure of relationship with other practices to study knowledge. In line with this argument, this research proposes that water management in a subak is a group of practices that linked together. Knowing of water management takes places through the activities such as deciding the schedule of planting season, monitoring and maintaining of the irrigation system, enforcing rules of irrigation, or dealing with water scarcity situation.

The actors in subak manage the water for irrigation by combining the social and economic aspect with the material and technical aspect. The social and economic aspect of water management in subak, for instances, are financial income of farmers, decision-making mechanism, and collective work and financial cost for irrigation maintenance. Meanwhile, the material and technical aspect of water management, for instances, are water availability, geographical landscape, weather condition, and the irrigation structures. Both social and economic and material and technical aspects are part of water management practices in subak. Therefore, to understand the practices, this research must also study the material and technical aspect of water management.

2.2 Institutional viability

This research proposes that there are social rules or institutions that structure the interaction of the actors who perform the water management practices in a subak for the purpose of dealing with the external pressure of water scarcity. These institutions have to be viable in order to ensure water management practices in a subak could sustain external pressures. This section explains Perri 6's concept of institutional viability used in this research to understand the conditions in which the institutions of water management practices in a subak have the greatest chance to be viable.

The theory presented in this section is sourced from Perry 6's study of the institutional dynamic in a system, derived from a Neo-Durkheimian cultural theory perspective. The Neo-Durkheimian cultural theory perspective is commonly applied in many types of research; however, the concept of institutional viability as proposed by Perry 6 has not been widely used in discussing the institutional dynamic.

6 (2003) described institution as a formal or an informal restricting social rule that constructs interaction and recognized by the participants as creating an obligation to accept responsibility or some task to provide good performance and either be rewarded or punished based on evaluation and which leads to the shaping of more or less consistent social patterns. Institutions can be distinguished into empirical and fundamental institutions. Empirical institutions are explicit rules that acknowledged by participants, meanwhile fundamental institutions are rules that *"implicit, causally important for whole policy or social domains and which define socio-metric structures of ties and accountabilities for the basic forms of solidarity that sustain economic, political and social life"* (6, 2003, p. 397).

Meanwhile, viability is described as the capability of a set of empirical institutions to survive within their environment despite all external pressures and internal tensions, if necessary by altering that set of institutions in a way that most people would recognize it as

the continuation of generally the same set of institutions (6, 2003). Following from this description, Perri 6 described institutional viability as the capability of a set of empirical social rules that structure the interaction of actors to endure the external and internal pressures (6, 2003). In line with that, this research describes institutional viability of water management practices as the capability of a set of empirical social rules that shape the interaction of the actors in water management in a subak to sustain the external and internal pressures. The concept of institutional viability of Perri 6 is used in this research to understand the conditions in which water management practices in a subak that encounters external pressure of water scarcity are institutionally viable.

The first condition that any social system to have the greatest chance of viability is to have four basic forms of institutions and display specific relationships between them (6, 2003). Each form is solidarity, which means an institutional form of social organization that supports many empirical institutions. By using Durkheim's two basic dimensions of forms of social organization, namely social regulation, and social integration, a typology of four solidarities was identified (6, 2003). Those four forms are hierarchy, enclave, individualism, and isolate. Hierarchy is a bureaucratic culture with an emphasis on the rules and procedures. In this solidarity, there is an emphasis on the importance of collective over individuals. Enclave is a community culture with the egalitarian perspective that advocates equality for all. In this solidarity, there is an emphasis on strong relations between group members. Individualism is a self-regulated culture with competitive behavior. In this solidarity, individuals pursuit personal benefits and interaction between individuals is based on negotiation. Isolate is a fatalist culture that accepts fate as it is and relies on the external power to change fate. This solidarity is characterized by passive individuals, in which there is a belief in destiny and coincidence.

Perri 6 took the cultural theory from a typology of institutional forms to a dynamic theory with the argument that solidarities tend to reinforce themselves and clash with each other through the positive and negative feedback processes (6, 2003). Positive feedback is the process in which solidarity reinforces its characteristic by accessing resources and energy. Positive feedback, as shown in Figure 1, may cause a neutral effect; however, it can also be destructive by weakening itself or others, resulting in wider disorganization. Meanwhile, negative feedback, as shown in Figure 2, happens when an institutional force resists against others in correcting or controlling a positive feedback. Positive and negative feedback process happen as a result of institutional self-assertion responding to the assertion of other institutions. According to 6 (2003), uncontrolled positive feedback happens when solidarity is provoked into assertion by another solidarity and there is no resistance from other solidarity. If there is a resistance, negative feedback happens. However, the uncontrolled negative

feedback can be devastating, causing gridlock when the institutional forces are evenly matched or creating conflict. Thus, either uncontrolled positive or uncontrolled negative feedback can weaken the viability of system.

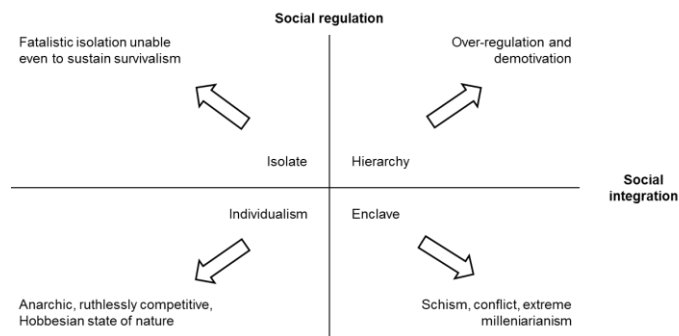


Figure 1. The positive feedback dynamics of the four solidarities. Reprinted from "Institutional Viability: A Neo-Durkheimian Theory" by 6, P, 2003, *Innovation*, 16(4), p. 400.

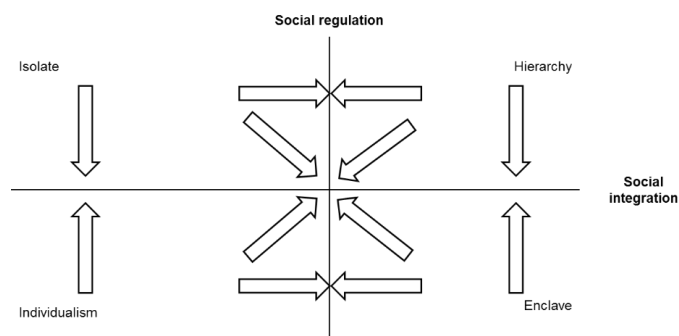


Figure 2. Negative feedback between the four solidarities. Reprinted from "Institutional Viability: A Neo-Durkheimian Theory" by 6, P, 2003, *Innovation*, 16(4), p. 401.

The second condition that any social system to have the greatest chance of viability is there must be one or more types of settlements between the positive and negative feedback forces so that all four solidarities co-exist. (6, 2003). Settlement will give both forces some space to operate, but will also moderate both the destruction of their change and dynamics and their conflicts with each other. A settlement is "some social or political accommodation, some pragmatic way of giving structure to co-existence, and therefore some way of limiting the aspirations to consistency and completeness for institutions of accountability" (6, 2003, p. 402). 6 (2003) described four forms of four-way settlement, which are:

1. Toleration of a specific institution, in which there is recognition of each solidarity's commitments, or at least there is no violation of their commitments. In this settlement, all solidarities are recognized, and there is no solidarity actively weakening other solidarities.
2. Separation or contingency, which means separation of the solidarities by switching to particular solidarity depending on the situation.
3. Exchange or mutual dependency, which means there is an effort by solidarity to sustain other solidarities.
4. Compromise or hybridity, in which there is the acceptance of the existence of other solidarities at the same time.

The concept described above are used in this research to assess the institutional viability of water management practices in a subak using two conditions of the institutional viability concept proposed by Perri 6 (6, 2003). First, this research identifies the four solidarities in water management practice in a subak and the relationship between them. Water management practices in a subak are organized as a social system where there are rules to manage the irrigation, therefore, it can be identified the four solidarities from the practices and the dynamic between the four solidarities utilizing the concept of positive and negative feedback processes. Second, this research assess the presence of type of settlement that may exist to contain the conflict between the positive and negative feedback forces of solidarities in water management practices of a subak.

2.3 Operationalization

The objective of this research is to assess the institutional viability of water management practices in a subak under external pressures. From the concepts described previously in this chapter, this research creates a framework to guide this research (see Figure 3). This framework is the guideline for the analysis of research result. This research uses social technical practices of water management in a subak that encounters external pressure of water scarcity as the unit of analysis, therefore the first step starts by focusing on social-technical practices of water management in a subak that encounters external pressure of water scarcity. The choice to focus on the social technical practices of water management is because, in line with Nicolini's concept of practice (2011), this research proposes that water management practices in a subak is where different knowledge of the actors are made to work together in an agricultural landscape of subak, as water management integrates both social (the actors) and technical (water availability) aspects of managing water in dealing with water scarcity.

The second step in this research is to identify the presence of four basic institutional forms or solidarities, namely enclave, hierarchy, individualism, and isolate as described by Perri 6 (2003), that emerge from the water management practices of a subak in dealing with water scarcity. Water scarcity is used in this research to study water management practices in dealing with external pressure. The third step in this research is to identify the positive and negative feedback processes between those solidarities. The second and third steps are for the purpose of analyzing the first condition of institutional viability as proposed by Perri 6 (2003). The fourth and final step in this research is to examine types of settlement, namely toleration, contingency, exchange, and compromise as described by Perri 6 (2003), that may exist between the positive and negative feedback forces. This step is for the purpose of analyzing the second condition of institutional viability of water management practices in a subak under the external pressure as proposed by Perri 6 (2003).

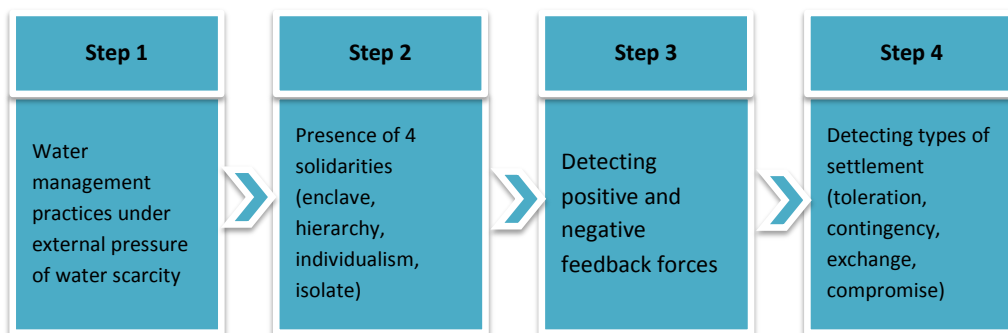


Figure 3. Conceptual Framework.

3. METHODOLOGY

This chapter presents the approach and methods applied in this research. It starts with the description of research area (section 3.1), then followed by the approach used to study social technical practices (section 3.2). Section 3.3, 3.4, and 3.5 present the methods applied in this research. Lastly, section 3.6 discusses the analytical strategy of the research result.

3.1 Research area

This research uses a case study of institutional viability of water management practices in a subak namely subak Deman. Subak Deman is a subak that belongs to a larger subak namely subak Penatahan in Penatahan village, Tabanan, Bali, Indonesia (see Figure 4). There are 73 paddy fields worked by 42 farmers in subak Deman. The size of all fields in subak Deman was 20.51 hectares. Most of the farmers in subak Deman are small-scale farmers who own paddy field less than 50-ares. The reason why subak Deman is chosen for this research is that this research wants to investigate the institutional viability of water management practices in a subak that under the external pressures. Case study is suitable for this research because it is “an intensive study of a single unit for the purpose of understanding a larger class of (similar) units” (Gerring, 2004, p. 342). Case study is also useful for understanding rich details (Gerring, 2004).

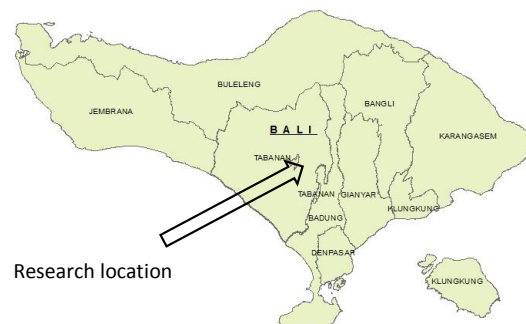


Figure 4. Research location.



Figure 5. Rice fields in subak Deman.

The case study of institutional viability of water management practices in subak Deman was conducted in a community of Balinese farmers in Penatahan village, Tabanan, Bali, Indonesia. The data collection was carried out in 3 months from the end of January until the end of April 2018. The field visit was spent at the rice fields of subak Deman (see Figure 5) while being hosted by a farmer family in Penatahan village.

3.2 Researching socio-technical practices of water management in subak Deman

Technography approach is used in this research to study the water management practices in subak Deman. Technography is a methodology that implies the use of certain methods to study the interaction between social (human) and technical (technology) aspects in the social science of technology (Jansen and Vellema, 2011). By using technography, this research is able to study the use of skills, tools, knowledge, and techniques of the actors in managing water and how they respond to the external pressure of water scarcity. The technography approach is used to understand the social technical practices of water management in subak Deman.

Jansen and Vellema (2011) explained that technography has three main dimensions. First, there is the dimension of making or doing to study the integration of technical with social aspects. In this dimension, technography focuses on how the actors use skills, tools, knowledge, and techniques in situated action (Jansen and Vellema, 2011). Thus, this research wants to study how and for what purpose the actors in subak use the skills, tools,

knowledge, and techniques in water management practices. Second, there is the dimension of distributed cognition. In this dimension, technography focuses on the mobilization and coordination of knowledge and skills within a group with a specific task of managing water. Jansen and Vellema (2011) said in the process of making, often appears there is no single member who has a complete understanding of all the steps and usually there are the organized distribution and coordination of works. This research wants to understand how the actors coordinate and organize different tasks of managing water and respond to the external pressure of water scarcity in subak Deman. Third, there is the dimension of the construction of rules. Jansen and Vellema (2011) said in this dimension technography studies how “group of actors use, construct, or transform sets of rules in the process of making” (p. 173). In this research, this dimension focuses on how the task group creates and applies the rules for managing water in subak Deman.

The technography methodology is suitable for this research as it is intended to study technical and social aspects of water management practices through interview and observation (Jansen and Vellema, 2011). In explaining water management practices in subak Deman, the dimensions of technography can be used to answer the three specific research questions. First, the question of how the actors manage the water distribution within subak Deman can be addressed within the dimension of making or doing. Second, the question of what and how rules are used to manage water in subak Deman can be addressed within the dimension of construction of rules. And third, the question of how the actors respond individually and collectively to water shortage problem can be addressed within the dimension of distributed cognition. In relation to analyzing the research result, this research utilizes the technography approach in the first step of conceptual framework to zoom in on the social technical practices of water management in subak Deman in dealing with the external pressure of water scarcity.

3.3 Content Analysis

Content analysis method was used in this research to analyze the customary rule book or awig-awig about water management practices in subak Deman. Since the language used in this customary rulebook is in Balinese, I hired the service of a local interpreter to help me translate the documents from Balinese to Bahasa Indonesia. I used content analysis to gain the context of water management practices in subak Deman. This method was used to support other methods in this research.

3.4 Direct Observations

Direct observation was used to observe how the water management practices are performed in everyday life in subak Deman. The observation was useful because the initial points of this research are the practices of water management and how the actors respond to the external pressure of water scarcity. Direct observation was used for answering the question of how the actors manage water distribution in subak Deman. However, as this research was conducted during the rainy season when water is available, there was limited chance to observe the water management practices in subak Deman in dealing with water scarcity. Observations were conducted three times during the day time of 21st February 2018, 29th March 2018, and 26th April 2018. Observations were focused on several aspects of water management practices:

Direct observations were focused on the several aspects of water management practices:

1. Observation on the water source and irrigation infrastructures in subak Deman.
2. Observation on water distribution from the river to the main canal then divided for three branches of canal and into the rice fields.
3. Observation on the regular monitoring activities of the irrigation canals conducted by the actors.

3.5 Semi-structured interviews

This research utilized semi-structured interviews as the main method for collecting data on water management practices in subak Deman when water scarcity occurs because the fieldwork was conducted during the rainy season. The key informants were interviewed to recall what they did during the previous dry seasons to understand water management practices during water scarcity situation. Semi-structured interviews were conducted by using the aid of an interview guide. The interview guide for the key informants contains the questions on their livelihood, their role in water management, water distribution mechanism in rainy and dry season, irrigation rules and enforcement of the rules, task group who specifically manage irrigation, and conflict resolution mechanism.

Semi-structured interview is used to answer the three specific questions in this research: (1) the question of how the actors manage the water distribution within subak Deman, (2) the question of what and how rules are used to manage water in subak Deman, and (3) the question of how the actors respond individually and collectively to water shortage problem. There are seven actors interviewed in this research: (1) Made Suwitra, as the pekaseh of subak Penatahan who has the highest authority in subak, (2) Ketut Sujana,

Made Suarna, and Ketut Sukiarsa as the three prajuru of subak Deman who are responsible to manage the irrigation directly in the field, (3) Sena and Westre, two elderly figures in subak Deman who has knowledge about past situation related to water scarcity, and (4) Ketut Setiawan, the head of priest in the village of Penatahan who has religious knowledge on subak. Made Suwitra was interviewed five times on 04th March 2018, 06th March 2018, 21st March 2018, 03rd April 2018, and 25th April 2018. Ketut Sujana was interviewed three times on 08th March 2018, 14th March 2018, and 11th April 2018. Made Suarna was interviewed one time on 12th March 2018. Ketut Sukiarsa was interviewed two times on 15th March 2018 and 16th April 2018. Sena was interviewed two times on 28th March 2018 and 24th April 2018. Westre was interviewed one time on 20th April 2018. And, Ketut Setiawan was interviewed one time on 18th April 2018. All interviews were conducted during the day time in Penatahan village.

3.6 Analytical Strategy

The data collected in this research is analyzed using the four solidarities that are derived from Neo-Durkheimian cultural theory (6, 2003). First, this research identifies the institutions of water management practices by the task group in subak Deman using the technography approach. Then, this research categorizes those institutions into four basic forms of solidarity, namely individualism, hierarchy, enclave, and isolate utilizing the meaning of each solidarity described in the Chapter 2 conceptual framework. After that, this research detects the positive and negative feedback dynamics of those four institutions. Positive feedback is identified by assessing the phenomenon of each solidarity that reinforces its characteristic. Negative feedback is identified by the effort of correcting or controlling of solidarity in resisting the positive feedback of other solidarities. Finally, this research analyzes types of settlement between positive and negative feedback forces in water management practices of subak Deman that allow all solidarities to co-exist.

4. RESULT

4.1 Technography analysis of water management practices in subak Deman

This chapter illustrates the empirical results of studying the water management practices in subak Deman. I analyzed water management practices where the social and material contexts interact in an agricultural landscape of subak Deman. This chapter starts with the first dimension of technography and describes how the actors use skills, tools, knowledge, and techniques in managing water in subak Deman, such as water distribution, irrigation monitoring, maintenance and improvement of irrigation structures, decision making of planting season, and rules enforcement. Section 4.1.2 turns the attention to the second dimension of technography and describes how the tasks of managing water are covered by different actors in subak Deman and how different knowledge brought together in the practices. Section 4.1.3 refers to the third dimension of technography, the construction, use, and transform of rules related to the water management by the actors in subak Deman. The last part (section 4.2) describes how the water is managed during the water scarcity situation.

4.1.1 The use of skills, tools, knowledge, and techniques

The geographical landscape of subak Deman was observed to be the hill type of terrain. I noticed that the irrigation system of subak Deman was built by following the contour lines of the slope and the water flowed through the canals from the higher to the lower area by the gravity power (Figure 6). The primary sources of water for farming were a small river called Pangkung Tebenan Pulus-pulus and the rainfall (observation, interview Made Suwitra, interview Ketut Sujana, interview Sena). The stream of water from the river was altered using a weir to make the water flows into the paddy fields through the canals (observation), as shown in Figure 7. The main canal in subak Deman was divided into three branches that irrigate three large fields, which are telabah sekauh for the west field, telabah setengah for the middle field, and telabah sekangin for the east field (observation, interview Made Suwitra). From these three branches of canal, the water was distributed through smaller canals to the paddy fields (observation).



Figure 6. The geographical landscape of subak Deman.

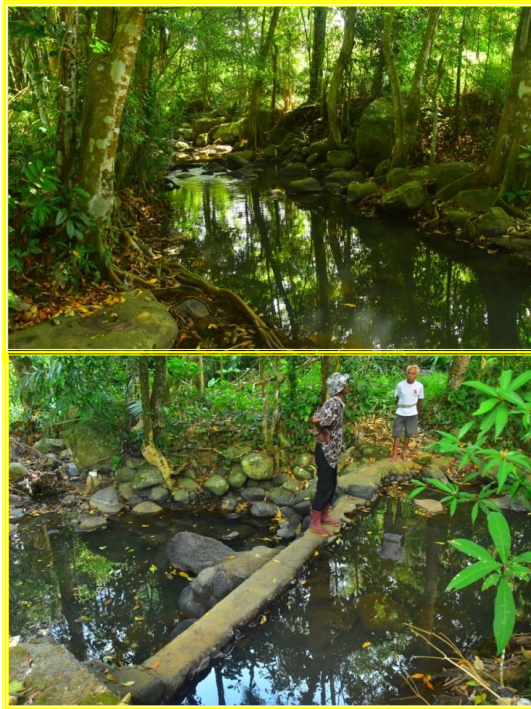


Figure 7. The small river (top) and the weir (bottom) in subak Deman.

To proportionally allocate the water among the paddy fields, the water was divided using irrigation division structures called *tembuku* as shown in Figure 8 (observation, interview Ketut Sujana). The *tembuku* in subak Deman was observed to be made from concrete. To determine the size of *tembuku*, subak Deman used a measurement called *tektek* for the water allocation (interview Made Suwitra). *Tektek* means the portion of water received by a paddy field and was determined by the size of the field (interview Made Suwitra). Ketut Sujana told me that in subak Deman one *tektek* is for a 60-ares size paddy

field and a 30-ares field receives half tektek. The width of a canal for one tektek was around the width of an adult's palm (observation). In total, the portion of water for all paddy fields in subak Deman was 23 tektek (interview Made Suwitra).



Figure 8. The tembuku in subak Deman.

There were two planting seasons for the farmers in subak Deman; first, January to May during the rainy season, and second, August to December during the dry season (interview Ketut Sujana, interview Made Suwitra). During the rainy season, there was no water problem for the farmers (interview Ketut Sujana). Meanwhile, during the dry season, usually the water was less available, and the only source of water for farming was the small river Tebenan Puluk-puluk (interview Ketut Sujana, interview Made Suwitra, interview Sena, interview Ketut Sukiarsa). There were several other subak in the upland area of subak Deman that used this river as a source of water for irrigation. Thus, during the dry season, there was a limited amount of water in this small river (interview Made Suwitra, interview Ketut Sukiarsa). The harvest failure because of the drought during the dry season was a common occurrence in subak Deman (interview Made Suwitra, interview Ketut Sujana, interview Sena).

Subak Deman was led by the leaders or the prajuru who were selected from the subak members (interview Made Suwitra, interview Ketut Sujana, interview Made Suarna, interview Ketut Sukiarsa). Three prajuru were selected in one term. The position of prajuru

was rotated among the farmers. The rotation was based on the ownership of three paddy fields in subak Deman, from the upland area to the downstream area (interview Ketut Sujana). The prajuru in subak Deman served for 2-years in one term (interview Made Suwitra, interview Ketut Sujana, interview Made Suarna). The only requirement to be selected as a prajuru was to own land in subak Deman. The selection was decided in a meeting after the harvest season that attended by the subak members (interview Ketut Sukiarsa). The position as prajuru was rotated among the subak members so that the members understand the role and for regeneration purpose of the leaders in subak (interview Ketut Sujana).

Meanwhile, the pekaseh served for 5-years in one term. For the position of a pekaseh, there was a maximum limit to serve for two terms in a row (interview Made Suwitra). The pekaseh was elected by all subak members in a meeting. All ten subak that belong to subak Penatahan nominated a farmer to be elected as a pekaseh. Then, the selection was decided with the voting mechanism by the subak members (interview Made Suwitra, interview Made Suarna, interview Sena). The position of pekaseh was a formal one, legally recognized by the government (interview Made Suwitra). The person who is elected as a pekaseh was usually considered by the subak members to be capable of managing the subak based on his previous experiences in organizations:

"The requirement to be a pekaseh are the skill, sociable, able to working with the community." (Ketut Sujana, 24/04/2018).

"To be a pekaseh does not have to be a prajuru first. The selection of pekaseh depends on the subak members. If the subak members agree, a common member can be a pekaseh. It depends on the person's past performance. His past performance is seen from the organizational positions he held before. That person has to be active in communities work in the village." (Made Suwitra, 06/03/2018).

"A pekaseh is voted directly. [The requirement] to be considered is his past performance." (Sena, 15/04/2018).

Once the farmers were selected as pekaseh or prajuru, they held a responsibility to manage the subak. The position of pekaseh or prajuru was seen as an obligation and community work. There was not any financial benefit for the position of prajuru and very little financial benefit from the government:

"Most farmers do not want to be a prajuru, but this position is rotated among the farmers. If I could choose, I do not want to be prajuru because I am too old, but this is my turn to be a prajuru. The position of prajuru is rotated among the farmers and who are selected cannot reject the role" (Ketut Sujana, 24/04/2018).

"There was a person who rejected the position [of prajuru]. He became a subject of gossip among the people, many years worked as a farmer but did not want to be a prajuru, this [role] is a service [for the community]. The role does not come with any financial benefits, this is social work." (Ketut Sukiarsa, 25/04/2018).

"The personal difficulty [as pekaseh] is the financial matter. There are so many responsibilities, but [I am] not supported with sufficient operational funding. The financial benefit is minimal. For example, a judge has to be safe financially. Even the sub-village head who does less work [than pekaseh] earns around 2 million rupiahs (€117) each month. Pekaseh only earns 200,000 rupiahs (€11) each month. Even the sub-village head though I earn more money than him because he sees me going everywhere, working many things." (Made Suwitra, 25/04/2018).

The current prajuru in subak Deman were selected in June 2017 (interview Ketut Sujana, interview Ketut Sukiarsa, interview Made Suarna). Ketut Sujana, Made Suarna, and Ketut Sukiarsa worked as farmers in subak Deman. Meanwhile, Made Suwitra was elected as a pekaseh in 2009 and currently served his second term until 2019. Every day when not busy with the task as a pekaseh, he also worked as a farmer in subak Deman (interview Made Suwitra).

According to what I observed and the interviews, the pekaseh and prajuru were the ones that organize the water management practices in subak Deman. The prajuru reported to the pekaseh about the situation in subak Deman in a regular meeting once a month. The pekaseh monitored subak Deman through these meetings. There was also a regular meeting between the pekaseh and the prajuru before every planting season to discuss the financial situation and the planning for planting, fertilization, irrigation, and religious ceremonies. This meeting was also attended by several subak members. The reason why not all subak members participate in this meeting was that some members lived in other villages. Thus the prajuru shared the result of the meeting with the members who did not attend the meeting.

The prajuru of subak Deman were the group that controls the irrigation system on the field (interview Made Suwitra, interview Ketut Sujana, interview Ketut Sukiarsa, interview Made Suarna). During the rainy season when the water was more available, the irrigation canals were kept open, so all farming fields received the water simultaneously (interview Ketut Sujana, interview Sena). The limited availability of water in subak Deman made the pekaseh and the prajuru implement the intermittent irrigation technique (interview Ketut Sujana, interview Sena). Intermittent irrigation was introduced in 2009 when the current pekaseh was elected (interview Sena). However, it was not fully adopted by all farmers (interview Ketut Sujana, interview Sena) and the pekaseh and the prajuru steadily guided the farmers to implement this method (interview Made Suwitra, interview Ketut Sujana). Initially,

the farmers in subak Deman irrigated their fields by always flooding them with water. This irrigation technique required much amount of water, and thus, the conflict of water between farmers was common (interview Ketut Sujana).

According to Made Suwitra and Ketut Sujana, paddy was a type of crop that needs water but did not require continuous irrigation. There were several phases in the growing process of paddy crop that requires less water. In subak Deman, the field was flooded during the first 21-days. After that, the field was drained for the fertilizing phase for three days. Then, the field was flooded again until the plant age was 35-days. Next, the field was drained again for three days for the second fertilizing phase. After that, the field was flooded until the plant reached the age of 60-days. Next, the plant started to produce rice, and the field was drained until the harvest time when the plant was 106-days old. During this time, the field was irrigated occasionally to keep the soil mushy (interview Ketut Sujana, interview Sena). Made Suwitra said that if the fields were continuously flooded, the rat and fungal pests would increase.

The prajuru monitored the three branches of the canal in subak Deman every day (interview Ketut Sujana, interview Ketut Sukiarsa). They ensured the water flows unobstructed through the three canals (Figure 9). They also checked if there are any damages to the canals. If there were any damages to the irrigation system, the prajuru made a financial assessment of the damage and used the subak fund to finance the repair cost. If the subak did not have any fund, then the repair cost was shared by the farmers whose lands were affected by the damage. The prajuru also mobilized those farmers to do ngayah or collective work to repair the damage (interview Ketut Sujana).



Figure 9. Monitoring an irrigation canal in subak Deman.

The routine maintenance work of the irrigation system in subak Deman was conducted before every planting season. This maintenance work was a part of a religious ceremony called Mapag Toya, in which all irrigation canals were repaired and a gratitude ritual was held at the empelan or weir near the river Tebenan Puluk-puluk (interview Ketut Sujana, interview Ketut Sukiarsa, interview Made Suwitra). Several days before the ceremony, the prajuru conducted detailed monitoring of the three branches from the lowest area to the weir in the highest area and checked the parts of the irrigation system that need to be repaired. During the mapag toya ceremony, the prajuru worked together with the subak members to fix the irrigation system (interview Ketut Sujana, interview Ketut Sukiarsa, interview Made Suarna).

The prajuru made the decision when to start the planting season in subak Deman. During the rainy season, the water was abundant, and the prajuru did not have any difficulties to make this decision. However, during the dry season, the prajuru made the decision based on the availability of water in river Tebenan Puluk-puluk. The river Tebenan Puluk-puluk was the only water source for the irrigation in subak Deman during the dry season. However, there was a dam in the upland area of subak Deman that belongs to subak Umuh Laka. When subak Umuh Laka needed water for the irrigation, the dam sluice blocked the flow of water in the river and altered its direction to the farming fields of subak Umuh Laka. The implementation of intermittent irrigation in subak Deman made it flexible for the prajuru to decide on the starting date of planting season, especially during the dry season. The farmers in subak Deman started the planting when subak Umuh Laka did not use the water from the river (interview Ketut Sujana, interview Ketut Sukiarsa).

There were rules related to irrigation that have to be followed by all farmers in subak Deman. Most of these rules were written in awig-awig or a customary rulebook, but there were also the unwritten rules or perarem (interview Made Suwitra, interview Ketut Sujana). The awig-awig was written in traditional Balinese language, and I translated it with the help of a local translator. Awig-awig was a formal rule book, and I noticed it was legalized by the government officials on the 25th of January 2002. According to Made Suwitra, the content of awig-awig was agreed by all subak members and government officials. Meanwhile, the unwritten rules or perarem in subak Deman were established by the prajuru and agreed by the members. Perarem in subak Deman contained the rule about the mutually agreed amount of fine for violating the awig-awig. Perarem could be changed by the prajuru depending on the economic situation (interview Made Suwitra, interview Ketut Sujana).

The pekaseh and prajuru enforced the irrigation rules for the farmers and imposed the fine for any violations (interview Made Suwitra, interview Ketut Sujana). If there was a

violation of the rules, the person who violates the rule has to pay the fine. If the person refused to pay the fine, the violator's belongings could be confiscated until the person pays the fine. If the violator still refused to pay, then the violator would not be eligible to buy any fertilizers with subsidized price from the subak. Finally, if the violator still refused to pay, the ultimate punishment was the blockade of the irrigation canal to his field (interview Made Suwitra). The money collected from the fine became the source of income for subak Deman (interview Ketut Sujana).

According to the awig-awig, the obligations and prohibitions related to the irrigation in subak Deman were:

- Obligation to participate in ngayah or collective works related to subak (article 5 section 2b),
- Obligation to pay the fee for maintaining and repairing the irrigation system (article 24 section 3),
- Prohibition of stealing the water and disturbing the tembuku or water division structures (article 6 section 1a), and
- Prohibition of disturbing the irrigation canals (article 25 section 1).

The violation of the irrigation rules, for example, water stealing sometimes caused conflict between farmers. The prajuru mediated the dispute between farmers and imposed a fine on the farmer who violated the rule. However, sometimes the prajuru was not able to resolve the conflict. The prajuru then informed the pekaseh about the conflict, and the pekaseh took the role to mediate the conflict. The conflict was handled privately, but if it continues, then the pekaseh might hold a meeting with the subak members to resolve the conflict.

The pekaseh was the only task unit that link subak Penatahan with the government offices, either through the implementation of government program and training or the financial aid and funding for the irrigation system (interview Made Suwitra, interview Ketut Sujana). If there was damage to the irrigation system that is too severe or too expensive to be handled by subak Deman, the prajuru communicated with the pekaseh about the problem (interview Made Suwitra, interview Ketut Sujana). The pekaseh could request the financial allocation from the government for the repair cost. For example, in 2016 the pekaseh requested the financial allocation from the government to build a small reservoir and a water tower in Subak Deman, as shown in Figure 10. This infrastructure was to deal with the water scarcity issue during the dry season in subak Deman. The size of the reservoir was 20-meters in length and 10-meters in width, with the depth of 1.5-metres. The reservoir

collected the water during the rainy season and by using a water pump machine, the water was distributed to the water tank. From the tank, the water was distributed through pipes to the main canal.



Figure 10. The small reservoir and water tank in subak Deman.

The pekaseh was also the only person who often received agricultural training from the government and had the role to distribute the knowledge to the prajuru. After the pekaseh completed training from the government, he copied and distributed the study material to all prajuru (interview Made Suwitra). The pekaseh and the prajuru often held meetings, and during these meetings, he conveyed the knowledge to the prajuru:

“Prajuru do not receive any training from the government. But they are capable of doing their jobs because we often hold meetings, I transfer the knowledge that I get [from the training] to the prajuru in those meetings. Including the knowledge that I learned from other subak, I share with them. That is my duty as their leader. I cannot be the only one who has the knowledge; my subordinates must also have the knowledge. As a pekaseh, I have to learn new knowledge from government officers, other pekaseh, or even common farmers that have a knowledge.” (Made Suwitra, 28/03/2018).

The pekaseh and the prajuru learned their skill to manage the irrigation from their experience as farmers. They had become a farmer at a young age, started when they helped their parents in the paddy field during the childhood (interview Made Suwitra, interview Made Suarna). The pekaseh and prajuru also always followed the rules in awig-awig as the guidance in managing the irrigation (interview Made Suwitra, interview Ketut Sujana, interview Ketut Sukiarsa). The pekaseh did not learn from the previous pekaseh, but he had experience as the prajuru in subak Deman (interview Made Suwitra). There was a system that can be followed for the future:

"We already have a system that can be followed by the next pekaseh. He does not learn from me directly, but sees how I work." (Made Suwitra, 25/04/2018).

"I learned the skills to be a prajuru by copying the previous prajuru, saw how they work. I have been working as a farmer for a very long time, so it becomes usual for me. The culture has been that way, we all just follow it, as well as the water distribution, it cannot be changed." (Ketut Sukiarsa, 25/04/2018).

4.1.2 Distributed cognition and coordination of tasks

The three prajuru of subak Deman organized the functions of managing subak Deman among themselves (interview Ketut Sujana, interview Ketut Sukiarsa, interview Made Suarna). Ketut Sujana held the role as the head of subak Deman and the treasurer. He led the meetings with the subak members and managed the subak financial. Ketut Sukiarsa held the role as the secretary and helped the kelian with the treasurer work (interview Ketut Sujana, interview Ketut Sukiarsa). Made Suarna held the role as the juru arah or the message sender from the kelian to the subak members. He informed the members about meetings and delivered the message from the kelian to the members (interview Made Suarna). These three prajuru only had one regular meeting time in each planting season, usually after the harvest. But, there were several unscheduled meetings between them, mainly if there were any urgent matters, such as the government program for the subak and the problems with the irrigation system (interview Ketut Sujana).

Ketut Sujana decided on the starting date of a planting season (interview Ketut Sujana). He took into consideration the availability of water in the river Tebenan Puluk-puluk in making this decision. Ketut Sujana decided the planting time by synchronizing the planting time of subak Deman with the usage of water in subak Umuh Laka. Before every planting season, he traveled to the upper area of subak Deman and observed the crops in paddy fields of subak Umuh Laka:

"So when subak Umuh Laka is entering the harvest season, we have to start planting because it means that the river is not being dammed, so the water in the river is plenty. We know that by checking the condition of the crops in Umuh Laka, whether it has turned yellow or not. I am the one who usually checks it. If it has turned yellow, it means [subak Umuh Laka] almost start harvesting and does not need water." (Ketut Sujana, 26/04/2018).

The task of monitoring the three branches of canal was done by the three prajuru together since they worked at the field every day (interview Ketut Sujana, interview Ketut Sukiarsa). Ketut Sujana monitored the east branch canal or telabah sekangin. Ketut Sukiarsa monitored the middle canal or telabah setengah. And, Made Suarna monitored the west canal or telabah sekauh. During the routine monitoring, the prajuru checked the water

debit in the canal. They removed any obstructions that disturbed the water flow (interview Ketut Sujana, interview Ketut Sukiarsa). If there were any damages to the irrigation system, Ketut Sujana and the members whose lands were affected assessed the damage and counted the necessary cost for the repair. Usually, if it was possible, Ketut Sujana used the subak fund to pay for the repair; however, if the fund was not enough, then the farmers affected by the damage paid the rest of the needed repair cost by sharing it (interview Ketut Sujana). If the damage was too severe and the subak did not have any fund to repair the damage, Ketut Sujana consulted the pekaseh of subak Penatahan for assistance (interview Ketut Sujana). Depending on the financial situation of subak Penatahan, the pekaseh might use the fund of subak Penatahan to repair the damage or submitted a request to the government office for the funding (interview Made Suwitra).

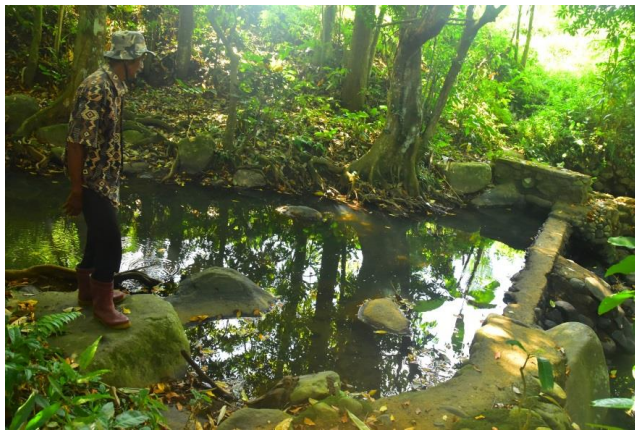


Figure 11. Ketut Sujana monitored water availability in the weir.

Made Suwitra as the pekaseh, followed several procedures to request the funding to repair or improve the irrigation system from the government (interview Made Suwitra). First, he contacted the irrigation office in Penebel district to have an officer checked the damage. The government officer visited subak Deman and assessed the repair cost. Based on the assessment, Made Suwitra then wrote a funding proposal and submitted it to the irrigation office in Penebel district. The irrigation office in Penebel district then forwarded the request to the irrigation office in Tabanan municipality. This process usually took a year before the subak received the fund, but often there was no response at all (interview Made Suwitra). Therefore, during that time Ketut Sujana applied temporary and affordable solution for the damage (interview Made Suwitra, interview Ketut Sujana). Ketut Sujana collected the money from the members and organized the collective work to repair the damage temporarily. The temporary solution usually did not last long and had to be repeated several times until the permanent repair work was applied (interview Made Suwitra).

Once in each planting season after the harvest, a prajuru conducted a routine and detailed monitoring of the irrigation system (interview Ketut Sujana, interview Ketut Sukiarsa, interview Made Suarna). During this process, a prajuru checked the condition of all three branches of canal all the way to the weir in the upland area took a note about any damages. This monitoring task was done by one prajuru, and the work was rotated for each planting season (interview Ketut Sujana, interview Ketut Sukiarsa). All three prajuru then had a meeting with the subak members and organized a plan for the repair and maintenance work. In this meeting, the prajuru organized the time for the collective work, the tools that the members must prepare and if there were any damages, the fee that the members must share. During the collective work, all prajuru and the members worked together to clear up the irrigation canals and repair any damages.

All three prajuru monitored the implementation of rules by the members in subak Deman. If there was a member who violates a rule, Ketut Sujana reprimanded the violator privately and asked him to pay the fine (interview Ketut Sujana). He told me the reason why this was done in private was to keep the good relationship with the violator by not shaming him in public. Ketut Sujana was also responsible to resolute any water conflict between subak members. However, he was also depended on the pekaseh to enforce the rules and resolve the conflict, for example when a member refused to pay the fine for violating a rule. According to Ketut Sujana, the strict figure of Made Suwitra helped to enforce the rules in subak Deman:

"The pekaseh is strict, easily angry, the members here already know that he often gets angry. During a meeting, he is very strict, dares to reprimand anyone who violates the rules. I am glad that our pekaseh is very strict. It is easy for me to manage the members. If there are any members violate the rules, I can ask pekaseh to reprimand him." (Ketut Sujana, 24/04/2018).

Meanwhile, Made Suwitra felt that the prajuru were more tolerant toward violations of rules. He felt that he has a responsibility to enforce the rules in subak Deman:

"The difficulty for me as a pekaseh is I always be involved in handling any violations in subak." (Made Suwitra, 25/04/2018).

"I already copied awig-awig and gave them to all prajuru, but many of them do not read it, so they do not know about the rules. Many prajuru do not dare to reprimand the member who violates the rules." (Made Suwitra, 23/04/2018).

Made Suwitra was the only one who able to interact officially with the government offices because he was legalized as pekaseh by the government. To improve the infrastructure of the irrigation system in all subak that belongs to subak Penatahan, including subak Deman, Made Suwitra could request financial aid from the government offices

(interview Made Suwitra, interview Ketut Sujana, interview Ketut Setiawan, interview Sena). As the pekaseh, he managed the financial allocation from the government by himself. He was also the intermediary between the government and subak Deman in the implementation of any government programs. He received agricultural training from the government and distributed the knowledge to the prajuru of subak Deman. The prajuru then shared the knowledge with the subak members.

The pekaseh supervised the prajuru in managing the irrigation in subak Deman. Made Suwitra also regularly held meetings with the prajuru every month. During the meeting, he discussed with the prajuru about the issues that subak Deman encounters, the implementation of any government program, and the enforcement of rules. He also took a hands-on approach in overseeing the water management in subak Deman. He lived in subak Deman area and worked as a farmer there. Thus he monitored subak Deman regularly every day. The reason why he did this was that he felt that the prajuru did not perform their duties as they should be:

“Right now many prajuru are not hardworking. Instead, I am the one who monitors the field. When I was a prajuru, I monitor the field actively, checking the irrigation, applying for the funding from the government to fix the infrastructure. That is why I told current prajuru; I was a prajuru once, but not like the way you are working now.” (Made Suwitra, 26/04/2018).

4.1.3 The construction of rules of water management

The actors who are responsible to manage water in subak Deman were Made Suwitra as the pekaseh, and Ketut Sujana, Ketut Sukiarsa, and Made Suarna as the prajuru. They worked as farmers in subak Deman and the position of pekaseh and prajuru was their additional responsibility. Ketut Sujana, Ketut Sukiarsa, and Made Suarna manage the irrigation directly in the field through practices of monitoring the irrigation, maintaining irrigation and organizing repair works if there is damage, enforcing rules and imposing fines, and deciding the planting schedule. The responsibilities of the prajuru are limited to the inside of subak Deman. Meanwhile, Made Suwitra supervised water management practices by the prajuru and interacted with external actors outside of subak Deman. His roles in water management practices related to the outside world of subak Deman included handling severe damage of irrigation that cannot be managed by the prajuru by requesting government funding, implementing government program, and managing government funding. He was also responsible to manage any conflicts that cannot be solved by the prajuru.

The river Tebenan Pulus-pulus was essential to the irrigation system in subak Deman. The water from this river was used for farming activities exclusively, and any non-farming usages of water were not allowed (interview Ketut Sujana). Moreover, only the farmers of subak Deman were permitted to use the water from the irrigation canals. The farmers paid the fee for the water they received. The prajuru established that the farmers must pay 60.000 rupiahs (€3) for one tektek of water for each planting season. The money collected was managed by Ketut Sujana and used to finance the religious ceremonies.

The water distribution arrangement of the three branches of canal was permanent; the east canal irrigated the east field, the middle canal irrigated the middle field, and the west canal irrigated the west field:

“The irrigation was designed since a long time ago, and it was not allowed to be changed. For example, it is not allowed if there is a farmer who uses water from east canal wants to change by using the middle canal because it will reduce the amount of water received by the farmers that use the middle canal.” (Made Suwitra, 06/03/2018).

Ketut Sujana, Ketut Sukiarsa, and Made Suarna monitored the irrigation system in subak Deman regularly every day. They checked the flow of water only in the three branches of canal and ensured that the water flows in those canals (interview Ketut Sujana, interview Ketut Sukiarsa, interview Made Suarna). This routine was less problematic during the rainy season, but during the dry season when the water was limited or not available in the canals, they often checked the canals all the way to the river Tebenan Pulus-pulus in the upland area. If the water was not flowing in the canals, they investigated the cause. If there were any damages to the field inlets, Ketut Sujana organized the repair work of the damage with the members.

The damage of the irrigation system in subak Deman was handled by Ketut Sujana. He assessed the damage together with the members who are affected by the damage. The fund was collected by sharing the repair cost among the members. The cost was only for the repair materials and not for the payment of the repair workers, as the subak members themselves who worked collectively for the task. The repair cost was shared only among the members whose fields are affected by the damage, for example, if they used the same canal that is damaged. The sharing cost was determined by the size of the fields affected, so the repair cost was proportionally shared, as the farmers who own larger size field paid more than the farmers who own smaller size field. Then, all three prajuru with the affected members organized and participated in the collective work for the repair.

If the damage was too severe and the cost was too expensive, Ketut Sujana informed Made Suwitra to solve the problem. Made Suwitra as the pekaseh requested funding from the government for the repair, but this process usually took a year before the funding was granted. Meanwhile, Ketut Sujana applied the temporary solution to handle the damage, for example using pipes to irrigate the water from the canal. The cost for this temporary repair work was also shared by the affected members.

The regular maintenance work was conducted before every planting season as a part of Mapag Toya ceremony. The three prajuru mobilized the subak members to participate in a collective work to remove any obstructions in the canals and repair any damages. Before this maintenance work, a prajuru monitored the three canals from downstream to the upland where the weir is located. This monitoring routine was done to organize the tools and materials for the collective work. All subak members were obliged to join the collective work, and if there was a member who skipped the work without any explanation, then Ketut Sujana imposed a fine on the member (interview Ketut Sujana, interview Ketut Sukiarsa, interview Made Suarna).

Made Suwitra as the pekaseh managed the funding from the government to develop the infrastructure in subak Penatahan. He had the initiative to put aside the remaining fund from the government as an emergency funding for the subak (interview Made Suwitra). He did not inform the prajuru and subak members about the remaining fund. Although this fund was not exclusively for subak Deman, Made Suwitra could use the fund if there were damage to the irrigation system that could not be handled by Ketut Sujana. He managed this fund by himself but informed the prajuru and the subak members about the existence of the subak treasury (interview Ketut Sujana, interview Made Suwitra, interview Sena). Every year, usually in June, the pekaseh reported the financial status of the subak in an annual meeting with all prajuru and subak members.

One of the essential rules related to irrigation in subak Deman was the obligation to participate in collective work or ngayah. Ngayah was a form of collectivity in subak Deman, and it was considered very important. The prajuru mobilized the subak members as the workforce during the collective work for any maintenance and repair works of the irrigation system (interview Ketut Sujana, interview Ketut Sukiarsa). Made Suwitra always demanded the prajuru to be strict in enforcing the obligation of ngayah:

“In subak togetherness is very important, ngayah is for mutual benefit. So the leaders have to be strict and have the courage to reprimand any members who made a fault, do not just be silent.” (Made Suwitra, 23/04/2018).

"My experience as a leader, the direction of the organization, to the right or the left, north or south, the leader decides [it]. But we let the members know the advantages and disadvantages. It is the same with herding ducks, some ducks want to go to left or right, but it depends on us where the ducks go. If we do not enforce the rules in subak, it means that we are controlled by the subak members. If there is a member who does not want to be managed, then please take my role, I said. It is easier for me to be controlled than to control." (Made Suwitra, 23/04/2018).

Aside from using authority, sometimes the pekaseh also used the spiritual belief to enforce the rules since the subak members were religious people:

"There was one time a member refused to pay a fine. I made a personal ceremony at the subak temple so that the curse like in the past did not happen. I informed the priest about the member who refused to pay the fine, he was scared and then paid [the fine]. This is a trick as a subak leader." (Made Suwitra, 25/04/2018).

Since the violation of the collective work rule was common in subak Deman, I investigated the reason behind this practice. The average farmers in subak Deman owned or worked the paddy field of 20-are (interview Sena, interview Ketut Sukiarsa). This size of the field produced 1.2 ton of unhulled rice. The market price for 1.2 ton of unhulled rice was 4.4 million rupiah (€258). The farmers also spent 1.2 million rupiahs (€70) on the production cost of 20-are size field. So, the net income for the farmers was around 3.2 million rupiah (€188) for a six month of work. Since most farmers owned small size fields, they usually had another job as a source of income. The most common second job for the farmers was laborer that paid 150,000 rupiahs (€7) for a day work.

Ketut Sujana decided the amount of fine for the violation of the obligation to participate in collective work in subak Deman. He decided the amount by referring to the daily wage of laborer job in the village, as this was the common second job for the farmers. This job paid 150,000 rupiahs (€7) for a day work. He set up the amount of fine for not participating in collective work to 50,000 rupiahs (€3) for half-day work and 100,000 rupiahs (€5) for a full-day work. He said to me if he set up the amount of fine too low, the subak members would prefer to pay the fine instead of doing the collective work (interview Ketut Sujana). The amount of fine could be changed if Ketut Sujana feels that the amount is not suitable with the economic situation in the village.

According to Ketut Sujana, it was not always easy to enforce the obligation of collective work in subak Deman, especially when dealing with younger farmers:

"It is harder to manage younger farmers; they are easy to get angry. But I have to be strict to keep the order". (Ketut Sujana, 24/04/2018).

It was difficult to enforce the rules where the good relationship is important in daily life. Ketut Sujana depended on the strictness of Made Suwitra in doing this (interview Ketut Sujana). Often, he handed over the punishment of a violation to Made Suwitra. According to Made Suwitra, it was important for the leader to understand the awig-awig in enforcing the rules while maintaining the good relationship with the members:

“When a leader is selected [to hold the position], he has to read the awig-awig to understand the duties of a leader. This is very important to manage the water according to awig-awig. If there is a member complaint, a leader must have a source to explain to that member. If the leader does not use awig-awig, he could be blamed by the member.” (Made Suwitra, 06/03/2018).

“Sometimes there is a highly educated subak member who feels that he knows better than me. So I use the awig-awig to give him an explanation. For example, there is a subak member who used to be a high school principal.” (Made Suwitra, 06/03/2018).

“Awig-awig is a rule that legalized by the Tabanan regency government. It was signed by the subak leader, head of sub-village, head of the village, head of the district, the regent, and the regional court of justice. It means that we have to refer to awig-awig because it is recognized by law. If we refer to the awig-awig, we are protected by the law. Sometimes when we talk to elderly people, they feel they know better than us. So, if there was a violated rule, I copied the page [in the awig-awig] that explains about it, then I gave it to them, so they read it. If we do not show them the awig-awig, we could be accused of making up that rule. Since we are younger [than the elderly people], if we tell them directly without showing them the awig-awig, it looks like we patronize them and it is not polite.” (Made Suwitra, 23/04/2018).

In deciding the starting time of the planting season, Ketut Sujana paid attention to the weather condition and the harvest situation of subak Umuh Laka in the upland area of subak Deman. During the rainy season, he decided to start the planting season in January. The water was plenty in the river Tebenan Puluk-puluk because it was a rainy season. Meanwhile, the planting time during the dry season was started in August; however, August usually was the driest month in a year. When there was rain in June or July, Ketut Sujana decided to move forward the start of the planting season to that time. In the growing process of the paddy crops, the first 21-days was the phase when the fields have to be flooded continuously. He scheduled the planting season based on the implemented intermittent irrigation technique so that when the dry season arrived, the paddy crops did not need much water during that time.

Furthermore, if there was no rain during the dry season, Ketut Sujana regularly monitored the harvest situation of subak Umuh Laka in the upland area. When subak Umuh Laka entered the harvest time, the water was available in river Tebenan Puluk-puluk until the upcoming planting season in subak Umuh Laka. Moreover, to make the farmers planting in

uniform so that they irrigated the fields together, Made Suwitra as the pekaseh made a rule that each farmer must complete the planting phase in two weeks. This rule was made so that all fields in subak Deman are uniform in using the water (interview Made Suwitra). The three prajuru monitored the farmers of subak Deman and made sure they followed this rule. If there was a farmer did not follow this rule, Ketut Sujana would impose a 100,000 rupiah (€6) fine on the violator (interview Ketut Sujana). The pekaseh was very strict with this rule that he threatened not to give any future government funding for the subak who does not comply with this rule (interview Made Suwitra).

4.2 The water management in water scarcity situation

This section describes the activities of water management practices in subak Deman during the external pressure of water scarcity situation. While all activities in rainy season were still practiced during water scarcity situation in dry season, there were several activities that occur only in dry season to deal with water scarcity. These activities were practiced so that water management still works despite the threat of water scarcity. Subak Deman often faces water scarcity problem, particularly during the dry season (interview Made Suwitra, interview Ketut Sujana, interview Westre, interview Sena).

Out of ten subak that belongs to subak Penatahan, subak Deman was the only subak that regularly faced water shortage problem during the dry season (interview Made Suwitra, interview Ketut Sujana, interview Ketut Suliastira, interview Sena, interview Ketut Setiawan). Aside from the fact that subak Deman only depended on the rainfall and a small river as the water sources for irrigation, the people I interviewed believed that the constant farming problems, either water scarcity or pests problems in subak Deman were caused by a curse. The curse happened because there was a violation of a ceremony in the early of 1990s (interview Sena, interview Made Suwitra, interview Ketut Sukiarsa, interview Westre, interview Ketut Setiawan). The violated ceremony was called ngelawoh. The ngelawoh ceremony was celebrated every 30-years, and during this ceremony, the people in the region believed that Ida Batara or the spirit of the ancient king of Bali visited his territory, including subak Deman. During the ceremony, all farming activities were prohibited. The farmers were ordered to attend the ceremony to welcome Ida Batara who was manifested by a priest. However, when the ceremonial group that brings Ida Batara entered the paddy fields area of subak Deman, several farmers were harvesting their crops because it was a harvest season. Ida Batara decided not to pass through the farming fields area of subak Deman and took another route. Since then, the harvest failure, either caused by water drought or pests problem, constantly befell subak Deman (interview Sena, interview Made Suwitra, interview Ketut Setiawan, interview Ketut Sujana).

During the dry season, usually from July to August, the pekaseh and the prajuru of subak Deman managed the irrigation just like during the rainy season. However, they faced water scarcity problem in the dry season and exercised several practices to deal with the issue. Usually, July and August were the months when water scarcity situation occurred (interview Ketut Sujana). During the dry season, the farmers in subak Deman depended on the water flowing from the upstream to the river Tebenan Puluk-puluk as the water source for irrigation. However, if there was no water at all in the river Tebenan Puluk-puluk, the farmers in subak Deman did not cultivate any crops. The similar situation like this happened in 2012 in subak Deman (interview Ketut Sujana, interview Made Suarna, interview Made Suwitra). The severe water drought occurred again in 2016, but during the dry season that year, there was a small amount of water in the river. The farmers still planted their fields with paddy crops; however, the fields only produced half of the usual harvest because of the lack of water.

The three prajuru monitored the three canals regularly just like during the rainy season; however, in the dry season, they also checked the availability of water in the river of Tebenan Puluk-puluk every day (interview Ketut Sujana, interview Made Suarna). If there was a low volume of water in the river, Ketut Sujana implemented the water rotation system in subak Deman (interview Made Suwitra, interview Ketut Sujana, interview Made Suarna, interview Ketut Sukiarsa). The water rotation system could also be implemented after the farmers informed the prajuru that water drought had occurred in their fields. The prajuru then checked the fields, if the soil turned white with cracked texture; it means that the fields need water. Based on the availability of water in the river, Ketut Sujana decided whether the water rotation system should be implemented or not (interview Ketut Sujana).

Usually, the water rotation system was implemented when in the middle of the planting season there was a water drought problem, and the amount of available water in the river was limited. If the irrigation canals were kept open like during the rainy season, the water would not reach the fields in the lowest area (interview Ketut Sujana). The water rotation system was applicable to the intermittent irrigation technique that was adopted by the farmers in subak Deman. Paddy fields did not always have to be flooded (interview Made Suwitra, interview Ketut Sujana). There were the phases that the fields have to be flooded, but there were also the phases when the fields should not be flooded. If the fields were flooded all the time, the crops could be damaged. But when the fields were not flooded, the soil should be kept mushy (Figure12) by irrigating the fields occasionally.



Figure 12. Example of mushy soil.

The three prajuru held a meeting with the subak members before implemented the water rotation system (interview Ketut Sujana, interview Ketut Sukiarsa). During this meeting, the prajuru explained to the members about the water drought situation and the necessity to apply the water rotation system. The decision about the starting days of the water rotation and the duration for each turn were also made in this meeting. Usually, for a field with the size of 60-are that used one tektek of water, the duration was 24-hours. However, this depended on the availability of water in the river, and Ketut Sujana assessed the necessary duration:

“Water rotation system was done by scheduling the irrigation. The purpose is so that all fields receive water. This was done for the collective purpose because the debit of water in the weir is low. The duration of one turn is 24 hours for one tektek. But, it depends on the availability of water. If there is not enough water, the duration for one turn could be decreased, for example only for 12-hours.” (Ketut Sujana, 24/04/2018).

One day before the water rotation system was applied, Made Suarna as the message sender informed the subak members (interview Ketut Sujana, interview Made Suarna). The water rotation system was applied by scheduling the irrigation for the paddy fields, started from the fields in the lower area to the fields in the upper area (interview Made Suwitra, interview Ketut Sujana, interview Ketut Sukiarsa). The irrigation system in subak Deman was observed to be a simple one, there were not any sluice gates and to slow down or stop the flow of water, the simple technique of blocking the canal with mud was used (Figure 13). The duration for each turn was usually 24-hours, and during this time, the water from a branch of canal was flowed exclusively for the scheduled fields, while the inlets for other fields were dammed using the mud (interview Made Suwitra, interview Ketut Sujana). In subak Deman, all three branches of canal implemented the water rotation system simultaneously, started from the field at the lowest area to the field at the highest area, and after this cycle, it was repeated (interview Ketut Sujana). The prajuru managed the schedule of the water rotation

system. According to Made Suwitra, the reason the water rotation system started from the lowest fields first was to distribute the water fairly:

“In the water rotation system, the paddy fields in the lower area will receive the water first. It is because the debit of water is decreasing as it flows to the lower area and the fields in the lower area receive less water than the fields in the upper area. By starting the water rotation system for the fields in the lower area, we can make sure that those fields receive enough water. Meanwhile, the fields in the upper area have better access to water since they are closer to the main canal.” (Made Suwitra, 28/03/2018).



Figure 13. The technique to block the canal.

The water rotation system was implemented since Made Suwitra was elected as the pekaseh in 2009. The purpose of the water rotation system was to prevent water stealing and water conflicts in subak Deman. Initially, water stealing and water conflicts between farmers were common. After the water rotation system was adopted, water conflicts and water stealing rarely happened in subak Deman (interview Ketut Sujana). Water stealing was committed by blocking the canal so that the water flows exclusively into a field. If any farmers steal the water and it was reported to Ketut Sujana, he reprimanded the violator. However, although in the awig-awig or the rulebook water stealing was prohibited, Ketut Sujana did not impose a fine for the violation of this rule. He told me that the farmers would be ashamed if they are caught doing this as they would become a subject of gossip in the village (interview Ketut Sujana, interview Ketut Sukiarsa).

When the water rotation system was being implemented, there was water watching practice called matelik (interview Ketut Sujana, interview Ketut Sukiarsa). Water watching was surveillance of the irrigation canals to prevent water stealing. Water watching was

conducted by the farmers whose fields were receiving water during the water rotation system. Water watching or *matelik* was done usually at night, as during this time water stealing was more likely to happen (interview Ketut Sujana, interview Ketut Sukiarsa). The farmers who conduct *matelik* equipped themselves with a flashlight to prevent water stealing by the farmers whose fields were not on schedule to receive water. The *prajuru* supervised the implementation of water rotation but did not participate in the water watching (interview Ketut Sujana, interview Ketut Sukiarsa). Each *prajuru* supervised each canal; Ketut Sujana was responsible for the east canal, Ketut Sukiarsa was responsible for the middle canal, and Made Suarna was responsible for the west canal.

I observed a farmer who did water stealing. When I asked Ketut Sujana about this, he told me that it is not water stealing, but water borrowing. Made Suwitra also told me the same thing. They explained to me that the difference between water stealing and water borrowing depends on negotiation between farmers based on the availability of water in the *subak*. It was considered water stealing if there was no agreement of farmers to lend water (interview Ketut Sujana, interview Made Suwitra). Water borrowing was allowed by the *pekaseh*, *prajuru*, and *subak* members. Water borrowing technique was implemented if the fields were in need of water and other fields that use the same canal had enough water (interview Made Suwitra). The farmer(s) who want to apply the water borrowing technique informed the other farmers who use the same canal first, and then blocked the canal so that the water flowed exclusively to his field. The duration of the water borrowing depended on the size of the field and the debit of water; usually, it took 24-hours to irrigate a 60-are field. After the field that borrows the water finished, the farmer removed the blockade to let the water flow normally. However, if the farmer did not inform other farmers, this was considered water stealing, and the *prajuru* would punish the farmer (interview Ketut Sujana).

The *pekaseh* also implemented the insurance program from the government to compensate the farmers if there was a harvest failure in *subak* Deman, for example, if it was caused by water drought. This insurance program compensated the farmers if there was at least 75 percent damage to the crops during a harvest failure (interview Made Suwitra, interview Ketut Sujana). This was useful because the farmers would receive financial compensation that they could use as the capital for the next planting season. In this insurance program that subsidized by the government, the farmers paid 36.000 rupiahs (€2) per hectare before every planting season. The *pekaseh* organized the insurance program and asked the *prajuru* to collect the insurance payment from the farmers before the planting season. If there was a harvest failure, an officer from the insurance company accompanied by the *pekaseh* and the farmer assessed the damage of the crops. If the damage was at

least 75 percent, the insurance company compensated the farmers six million rupiahs (€352) for one hectare of land.

4.3 Summary

The social technical practices of water management in subak Deman are constituted through a series of interconnected activities. The actors who are responsible for water management in subak Deman are the pekaseh and the three prajuru. The knowledge and task of water management practices are distributed among these actors. These actors have different scope of responsibility in their roles. The prajuru are responsible for the task of water management inside subak Deman. Meanwhile, the pekaseh is responsible to overseeing the water management practices in subak Deman, as well as interact with the external actors, for example the government. The practices of prajuru in managing water in subak Deman include deciding the starting date of planting season by paying attention to water availability, monitoring and organizing maintenance works of irrigation system, and enforcing rules and imposing fines for any violations. During water scarcity situation, there are other water management practices performed by the prajuru, which are deciding and implementing water rotation system and supervising water watching to prevent water stealing. Meanwhile, the practices of pekaseh in managing water in subak Deman include supervising the task of prajuru, handling conflict and damage of the irrigation system that cannot be managed by the prajuru, implementing government program, and managing government funding. However, this research also found other practices of water management that perform by individual farmers. These practices are water borrowing, water stealing, and not participating in collective work of irrigation repair or maintenance. These practices of water management are used for identifying the presence of four solidarities in the next chapter.

5. INSTITUTIONAL VIABILITY OF WATER MANAGEMENT PRACTICES IN SUBAK DEMAN

This following chapter assesses the institutional viability of water management practices in subak Deman. Following from the empirical description in the previous chapter, this chapter starts by describing the presence of four solidarities in water management practices in subak Deman using Neo-Durkheimian cultural theory. The next section discusses the positive and negative feedback between the four solidarities of water management practices. The last section elaborates the identification of types of settlement that may exist between the positive and negative feedback of those four solidarities.

5.1 Presence of four solidarities in water management practices

This section describes indications of the presence of four solidarities in water management practices in subak Deman, using Neo-Durkheimian cultural theory (6, 2003). These four solidarities are enclave, hierarchy, individualism, and isolate. Enclave is high social integration-low social regulation solidarity with the emphasis on collectivity that advocates equality. Hierarchy is high social integration-high social regulation solidarity with bureaucratic culture that emphasis on the rules and procedures. Individualism is low social integration-low social regulation solidarity that emphasis on self-regulation with competitive behavior. Isolate is low social integration-high social regulation solidarity with fatalist culture that accepts fate as it is and relies to external power to change the fate. Moreover, following from the description of the presence of four solidarities, this research will discuss the positive and negative feedback of institutional dynamic between the four solidarities in water management practices in subak Deman.

5.1.1 Enclave

The case study presents several indications of the existence of the enclave form of solidarity in water management practices in subak Deman. All farmers in subak Deman were Balinese with a religious belief in Hinduism. Concerning the water management in subak Deman, the pekaseh and the prajuru emphasized on the equality condition for all farmers in managing the irrigation. The pekaseh and prajuru devised and enforced a rule so that the farmers started the planting season together at the same time. Thus, the fields were irrigated simultaneously. For a fair distribution, water was allocated using a measurement called *tektek*, with one *tektek* of water is for a 60-ares rice field. To apply collective irrigation of the rice fields, the prajuru also guided all farmers to adopt intermittent irrigation considering the nature of paddy crops that do not need constant irrigation.

The water scarcity risk was shared among all farmers by implementing the water rotation system. The water rotation system was applied by irrigating the fields from the lowest area to the fields in the highest area for the purpose of fairly distributing the water. During water rotation implementation, there was water watching conducted by the farmers to prevent water stealing. The maintenance and repair cost of the irrigation system was also shared proportionally by the farmers. Proportionally means that only the members who were affected by the damage paid for the repair cost. Moreover, the sharing cost was determined by the field size of the farmers. It means that the farmers who own larger fields paid more than the farmers who own smaller fields. The reason was that larger fields consume more water. As for the repair work, the farmers whose lands were affected by the damage worked collectively for the task.

As a community, there was also a regular meeting between the prajuru and the subak members before the planting season to organize the routine maintenance work of the irrigation system and report the financial situation of subak Deman. There were also other meetings that incidental, for example, to discuss water drought problem to apply the water rotation system. Meanwhile, there was also a regular meeting between the pekaseh and the prajuru every month to discuss the problems in subak Deman. There was also a regular meeting between the pekaseh, the prajuru, and the subak members after the harvest of each planting season. During this meeting usually, the pekaseh reported the financial status of subak Penatahan, as the main subak of subak Deman. However, not all subak members attended this meeting because some of them lived in other villages. The prajuru shared the result of the meeting to the members who did not participate.

5.1.2 Hierarchy

The case study presents several indications of the presence of hierarchy in water management practices in subak Deman. The pekaseh and prajuru emphasized following the rules and procedures in managing the irrigation. The prajuru enforced the rule of access that only the farmers are allowed to use water from the irrigation canals. The prajuru made the decision of the planting schedule based on the water availability. During the dry season, if there is rain in June, the prajuru might decide to start the planting season at that month, instead of wait until August. The prajuru also scheduled the planting season by synchronizing with the usage of water in subak Umuh Laka in the upland area of subak Deman because when subak Umuh Laka did not use water, the water was available in river Tebenan Puluk-puluk.

The three prajuru conducted the routine monitoring of the irrigation every day. Meanwhile, the maintenance work was organized by the prajuru before every planting

season, and all members must participate in the collective work for the maintenance. The prajuru enforced the rule that obliged the members to participate in collective work, both for maintenance and repair of the irrigation system. They imposed fine for the violation of this rule. Stealing water was also prohibited by the prajuru, although there was no fine for violation of this rule. The prajuru also regulated water watching during the implementation of the water rotation system to prevent water stealing. As the subordinates, the prajuru reported the situation of subak Deman to the pekaseh regularly every month. This was how the pekaseh supervised the duty of the prajuru in enforcing the rules in subak Deman. Often, the pekaseh was also involved in reprimanding or imposing fine on any violations of rule in subak Deman.

5.1.3 Individualism

The case study presents several indications of the presence of individualism in water management practices in subak Deman. Although rarely happened, during the dry season there were several cases of water stealing practice conducted by individual farmers. Water stealing was related to non-uniformity of irrigation technique used by the farmers in subak Deman. Some farmers still assumed that their fields have to be constantly flooded, in contrast with the effort of the pekaseh and the prajuru to implement intermittent irrigation technique for all farmers. However, water borrowing practice was allowed, and it was based on negotiation between the farmer who wants to borrow water and other farmers who obtained water from the same canal. Moreover, during the collective work for maintenance or repair work of the irrigation system, there were also farmers who chose not to participate, usually because they preferred to work their second job for additional daily income. As the position of pekaseh was formally recognized by the government, the pekaseh also individually tried to improve the irrigation infrastructures in subak Deman by submitting a funding request to the government. An example of this effort was the construction of a small reservoir and a water tank in 2017. This reservoir could be an alternative water source for irrigation in subak Deman if water drought occurs. Lastly, the pekaseh individually managed the remaining fund from government projects as the subak emergency fund. This emergency fund was useful to repair a sudden damage to the irrigation system; since usually it took a long process before government funding was granted.

5.1.4 Isolate

The case study presents several indications of the presence of isolate in water management practices in subak Deman. During the dry season, all farmers, including the pekaseh, the prajuru, and subak members coped with the uncertainty of water availability by keep planting using whatever water that is available, even if it means that the harvest would

be less than usual, for example during the drought in 2016. If there was no water at all, they did not cultivate any crops. Usually, they looked for another job as daily paid laborer if this event occurs. There was a lack of effort by the prajuru to find alternative sources of water for irrigation in subak Deman to deal with water scarcity during the dry season. However, the pekaseh also implemented a contingency plan to deal with water scarcity. He regulated the farmers to join an agriculture insurance program that was subsidized by the government. This insurance program would compensate farmers whose fields have at least 75 percent of damaged crops because of water drought. The financial compensation gave farmers the financial resource needed for the next planting season. The prajuru also powerless if there was heavy damage to the irrigation system that they cannot handle and depended on the pekaseh to find the solution to repair the damage, either by using the fund of subak Penatahan or requesting the fund from the government.

5.1.5 Conclusion of the four solidarities

The description in the previous section shows the presence of four solidarities in water management practices in subak Deman. Table 1 presents the summary of four solidarities in water management practices in subak Deman. The description of the presence of four solidarities is used in the next section to detect the dynamic between those solidarities in water management practices in subak Deman.

Table 1. Four types of solidarity in water management practices in subak Deman

	Low social integration	High social integration
High social regulation	Isolate Keep planting and following the order of the prajuru during water scarcity. Lack of effort to find alternative water sources. The prajuru depends on the pekaseh to solve major irrigation problem. Implementation of agricultural insurance program.	Hierarchy Rules of access to water. Clear procedure of deciding the schedule of planting season. Routine monitoring of irrigation. Enforcing rule of collective work. Prohibition of water stealing. Line of authority between pekaseh, prajuru, and subak members.
Low social regulation	Individualism Water stealing practice. Water borrowing practice. Non-uniform in irrigation technique. Some farmers did not participate in collective work. Pekaseh has the initiative to construct reservoir for irrigation through government funding. Pekaseh manage remaining allocated government funding as subak emergency fund.	Enclave Community of Balinese farmers. Planting and irrigation simultaneously. Fair allocation of water for farmers. Pekaseh and prajuru guide the adoption of intermittent irrigation. Water rotation during the water scarcity situation. Water watching during water rotation implementation Maintenance and repair cost was shared proportionally. Collective work to maintain and repair the irrigation system. Routine meeting between pekaseh, prajuru, and subak members.

Source: Adapted from *Institutional viability: A neo-Durkheimian theory*, by Perri 6 (2003)

5.2 Detecting the positive and negative feedback between four solidarities

Following from the description of the presence of four solidarities in the previous section, this research examines the institutional dynamic, in the form of positive and negative feedback, between those four solidarities. This section describes the positive and negative feedback forces between four solidarities of water management practices in subak Deman. Positive feedback is identified when solidarity of water management practices in subak Deman constantly reinforce its characteristic by accessing resources and energy. The uncontrolled positive feedback might cause disorganization of the system of water management practices in subak Deman as the water management practices' function fail to perform its capacity. Negative feedback is identified when solidarity resists the positive feedback of other solidarities by controlling or correcting them. The uncontrolled negative feedback might also cause negative effect in the form of gridlock when two conflicting solidarities are equal in power.

5.2.1 Positive feedback

With regards to the enclave solidarity, the case study shows that there is no clan within water management practices in subak Deman. Instead, water management practices are organized as one enclave. During water scarcity, the prajuru implement water rotation system in subak Deman. The purpose of this method is to fairly ration water for all farmers. The negative effect of this allocating water method is if there is low availability of water, it is possible that all rice fields do not receive enough water. Thus, it may lead to the situation where the fields produce less harvest than usual, for example during the water drought situation in 2016.

With regards to the hierarchy solidarity, the case study shows that the pekaseh and prajuru heavily emphasize the enforcement of rules in water management practices. There is a planting schedule regulated by the pekaseh and prajuru. Another rule that regulated by the pekaseh and prajuru is the obligation of the farmers to participate in collective work and prohibition of water stealing. The prajuru routinely monitoring the irrigation to ensure the farmers comply with the rules. The farmers have to follow the rules, otherwise, they will be fined. Perri 6 (2003) argued that if the hierarchy solidarity keeps reinforcing itself, it could lead to over-regulation. In line with this argument, heavy emphasis on rules and procedures in water management in subak Deman could mean that the subak might become too rigid and unable to adapt to a drastic change of situation. For example, during water scarcity situation the prajuru will implement water rotation system, instead of finding alternative sources of water for irrigation.

With regards to the individualism solidarity, the case study shows that there are several individualism water management practices in subak Deman. Although it is prohibited, water stealing was still conducted by some farmers in subak Deman. This practice usually occurs during the situation of water scarcity. Moreover, during the collective work for irrigation maintenance, some farmers do not participate, although there is a fine for this violation. These practices of individualism might cause disorganization in water management in subak Deman. Water stealing could cause conflict between farmers and not participate in collective work means that the irrigation structures, such as weir and canals will be neglected.

With regards to isolate solidarity, the case study shows that there are several isolate water management practices in subak Deman. In the severe water drought situation, the prajuru regulate the farmers to keep planting although there is an uncertainty of water availability during the planting season. They feel that water availability is a matter of fate. Moreover, the prajuru do not searching alternative water sources to deal with water scarcity

situation, instead, they depend solely on river Tebenan Pulus-pulus for irrigation. If there was heavy damage to the irrigation structures that they could not handle, the prajuru rely on the pekaseh to solve the issue. These practices of isolate solidarity might cause the farmers in subak Deman to be unable to survive water scarcity situation. This situation happened in 2012 when all farmers did not cultivate any crops during a severe water drought.

5.2.2 Negative feedback

The case study presents several identified negative feedback that emerges when solidarity corrects or controls uncontrolled positive feedback of another solidarity that may disorganize the water management practices in subak Deman. First, the uncontrolled positive feedback of enclave solidarity is corrected by the individualism, isolate, and hierarchy solidarities. The negative feedback by the individualism solidarity on the enclave solidarity can be identified from the practice of pekaseh to find alternative source of water for irrigation in subak Deman, for example by constructing a small reservoir to deal for reserving water that can be used during water scarcity situation. The negative feedback by the isolate solidarity on the enclave solidarity can be identified from the implementation of the agricultural insurance program for the farmers in subak Deman. The financial compensation of the insurance program could reduce the financial loss suffered by the farmers because of harvest failure caused by water scarcity. Meanwhile, the negative feedback by the hierarchy solidarity on the enclave solidarity can be identified from the procedure conducted by the prajuru in deciding the planting schedule based on the rainfall availability and the usage of water by subak Umuh Laka in the upland area of subak Deman. By synchronizing with these two factors, the prajuru could avoid water scarcity situation.

Second, the uncontrolled positive feedback of hierarchy solidarity is corrected by the individualism solidarity. The negative feedback by the individualism on the hierarchy solidarity can be identified from the practice of water borrowing by the farmers. Unlike water stealing, the practice of water borrowing is allowed by the pekaseh and prajuru. However, it is based on negotiation between an individual farmer who wants to borrow water with other farmers who use water from the same canal. The practice of water borrowing is important for a farmer whose field is in need of water while other farmers of the same canal have enough water in their fields. Other farmers might reject the request of a farmer to borrow water; however, if their fields are also in need of water.

Third, the uncontrolled positive feedback of individualism solidarity is corrected by the hierarchy and the enclave solidarities. This negative feedback by the hierarchy solidarity can be identified from the imposition of a fine by the pekaseh or prajuru for the farmers who did not participate in collective work. The pekaseh or prajuru also reprimand the farmers who

conduct water stealing, although there is no fine for this violation of the rule. Meanwhile, the negative feedback by the enclave on the individualism solidarity can be identified from the practice of water watching to prevent water stealing during the implementation of water rotation system. Another practice of this negative feedback can be identified by the practice of the pekaseh and prajuru in guiding all farmers to implement intermittent irrigation method for the purpose of uniformity in irrigation of the rice fields.

Fourth, the uncontrolled positive feedback of isolate solidarity is corrected by the individualism solidarity. The negative feedback by the individualism solidarity can be identified from the practice of the pekaseh to construct a small reservoir in subak Deman through government funding to deal with water scarcity issue during the dry season. As the pekaseh is the only individual who has access to government, he also has the capability to request funding if there is any damages to the irrigation system that cannot be handled by the prajuru. Moreover, the remaining fund from the government is solely managed by the pekaseh as the subak emergency fund. This emergency fund might be used by the pekaseh if there are any damages to the irrigation system in subak Deman.

5.3 Detecting settlements between positive and negative feedback

Following from the elaboration in the previous section, this section describes the settlement that exists between the positive and the negative feedback in water management practices in subak Deman. Perri 6 (2013) identified four different types of settlement or solidarities coexistence, which are toleration, contingency, exchange, and compromise. The identification of existing settlement between positive and negative feedback forces in water management practices in subak Deman is presented in Table 2.

Table 2. *Type of existing settlement in water management practices in subak Deman*

Settlement	Presence	Description
Toleration	Identified	Each solidarity is allowed to exist within a specific practice, e.g., agricultural insurance practice of isolate is recognized.
Contingency	Not identified	Water management practices in subak Deman are not operated as one single solidarity in a specific time, then switching to another solidarity depending on situation.
Exchange	Identified	There are efforts of solidarities to sustain another solidarity, e.g., hierarchical enforcement of the procedure to decide planting schedule in order to sustain enclave irrigation of rice fields simultaneously.
Compromise	Identified	There is an acceptance of the existence of solidarity by another solidarity at the same time, e.g., water borrowing is allowed by the pekaseh and prajuru to prevent it turns into water stealing.

Source: Adapted from *Institutional viability: A neo-Durkheimian theory*, by Perri 6 (2003)

First, toleration type of settlement between positive and negative feedback is identified within the water management practice of subak Deman. Each solidarity is recognized to exist within specific practices of water management in subak Deman. The case study shows that hierarchy solidarity is recognized through the enforcement of rules, such as the obligation of collective work and prohibition of water stealing. Enclave solidarity is recognized through the practice of water rotation during water scarcity situation. Individualism solidarity is recognized through the practice of water borrowing that is allowed by the pekaseh and prajuru. The pekaseh also works individually in looking for government funding to improve irrigation infrastructures in subak Deman. And lastly, isolate solidarity is recognized through the practice of agricultural insurance to deal with the possibility of harvest failure caused by water scarcity. The farmers also cultivate their rice fields depending on water availability and keep planting if there is a low amount of water, although the harvest will be less than usual.

Second, contingency type of settlement between positive and negative feedback is not identified within the water management practices in subak Deman. The water management practices do not switch to a specific solidarity in a situation. Instead, all four solidarities still operate in every situation. During water scarcity, water management practices are organized as an enclave through the implementation of water rotation system, but the hierarchical enforcement of prohibition of water stealing, individualism practice of pekaseh managing subak emergency fund, and isolate practice of the implementation of agricultural insurance program also operate.

Third, exchange type of settlement between positive and negative feedback is identified within the water management practices in subak Deman. The case study shows that there are efforts by solidarity to support other solidarities, such as the hierarchical enforcement of the procedure in deciding the planting schedule by the prajuru to sustain the enclave practice of irrigating the rice fields simultaneously. Another example is the implementation of enclave practice of water rotation and water watching to support the hierarchical enforcement of water stealing prohibition. Meanwhile, the individualism practice of the pekaseh in requesting government funding to improve irrigation infrastructures in subak Deman sustain the isolate practice of the farmers to keep planting rice fields even when in water scarcity situation. Another example is the isolate practice of the farmers to keep planting as long as water is available sustains the hierarchical enforcement of irrigation rules and the enclave practice of sharing water proportionally.

Fourth, compromise type of settlement between positive and negative feedback is identified within the water management practices in subak Deman. There is an acceptance of restraint by solidarities to resist other solidarities. The case study shows that the individualist practice of water borrowing is allowed by the hierarchical pekaseh and prajuru as long as it is negotiated between the farmers and does not turn into water stealing. Meanwhile, the enclave practice of water rotation system is in line with the isolate solidarity of the farmers to keep planting as long as water is still available and the hierarchy solidarity of enforcing the prohibition of water stealing, and the individualism solidarity of the pekaseh in managing subak emergency fund individually to repair the sudden damage to the irrigation system.

5.4 Summary

This chapter assesses the institutional viability of water management practices in subak Deman under external pressure of water scarcity following from two conditions of institutional viability proposed by Perri 6 (2003). This research found that the first condition, in which the presence of four solidarities and specific relationship between them, is met, as enclave, hierarchy, individualism, and isolate solidarities are present and there are interactions between them through the positive and negative feedback processes. Moreover, this research found that the second condition, in which the presence of one or more types of settlement that allows all four solidarities to co-exist, is also met, as this research identifies toleration, exchange, and compromise between four solidarities in water management practices in subak Deman. Thus, following from the institutional viability concept proposed by Perri 6, this research argues that institutions of water management practices in subak Deman are more likely to be viable under external pressure of water scarcity.

6. DISCUSSION AND CONCLUSIONS

6.1 Discussion

The description in the previous chapter offers some evidence that the institutions of water management practices in subak Deman are more likely to be viable under the external pressure of water scarcity. The institutions of water management practices in subak Deman meet the two conditions of institutional viability as proposed by Perri 6. First, there is the presence of four solidarities, namely enclave, hierarchy, individualism, and isolate and interactions among those four solidarities through positive and negative feedback processes. Second, there is the presence of three types of settlement to contain the conflict between positive and negative feedback processes to allow all four solidarities to co-exist. Those three types of settlement are toleration, exchange, and compromise.

In line with the two conditions of institutional viability proposed by Perri 6, this research argues that each solidarity is needed so that water management practices in subak Deman could function its capability as a system. Each solidarity has its own strength and weakness in dealing with the external pressure of water scarcity. Enclave solidarity is useful to share water resources equally for all rice fields. It also means that there is a risk sharing mechanism of water scarcity among the farmers through water rotation system. However, if there is too much emphasis on collectivity the water management practices may also vulnerable if agreement between the farmers to share water is fails to be achieved. This situation could lead to the emergence of smaller enclaves of farmers inside water management practices in subak Deman that disrupt the system. Hierarchy solidarity is useful to deal with water scarcity by referring to the rules and procedures, such as the procedure to decide the start of planting season to avoid water scarcity situation. However, if there is too much emphasis on the rules and procedures and a sudden change, such as unpredictable water drought takes place that disturbs water management practices, it could also mean that water management practices might not be able to adapt.

Individualism solidarity is useful in the swiftness of dealing with water scarcity in subak Deman, for example the practice of pekaseh in managing subak emergency fund to repair emergency damage to the irrigation system. However, the competitive and individualistic nature of this solidarity could cause chaos in water management practices in subak Deman if practice such as water stealing intensifies uncontrollably. Isolate solidarity has its own usefulness in water management practices in subak Deman. If there is not any solution available to deal with water scarcity, the practice such as implementation agricultural insurance program could give water management practices in subak Deman to survive water

scarcity situation until the next planting season. However, the passive nature of this solidarity could cause the system not capable to survive without the help from external actors.

Domination of one solidarity upon other solidarities in a way that undermine those solidarities could lose the adaptability and flexibility of institutions in water management practices in subak Deman to deal with the external pressure of water scarcity. The co-existence of all four solidarities through three types of settlement as proposed by Perri 6, gives institutions of water management practices in subak Deman the versatility to deal with water scarcity.

6.2 What if other external pressure emerges in the future?

The insight in this research shows the presence of all four solidarities and three types of settlement in water management practices in subak Deman. This next section uses the insight the conceptualization of this research to make assumption if other external pressure emerges for water management practices in subak Deman.

To illustrate this situation, I will give a background to the situation in subak Deman. I conducted this research after previously did a research for an internship on the situation in Catur Angga Batukaru area five years after the inscription of subak as a UNESCO World Heritage Site. Subak Deman is located in Catur Angga Batukaru area, one of the UNESCO World Heritage Sites. Since the recognition of subak as a cultural landscape World Heritage in 2012, Catur Angga Batukaru area has experienced an increase in tourism activities. However, tourism activities are mostly still centered on subak Jatiluwih, around 15 kilometers from subak Deman. Subak Deman has the potential for tourism as the area has several attractions that may attract tourists, such as rice terraces landscape, hot springs, Balinese cultural activities, and meditation facilities. There are also several homestays constructed by local people in this area. To support the World Heritage policy, the local government regulated a rule in 2013 that prohibit farming land conversion into other purposes in Catur Angga Batukaru area.

The increase in tourism activities might cause tension to water management practices in subak Deman. For instance, the increase of tourism facilities, such as hotels and restaurants might decrease water availability for irrigation in subak Deman. However, the rules regulated by the government prohibit the conversion of farming lands; thus, it is likely that they will continue to work as farmers or water stealing practice occurs more frequently. The new economic opportunities emerge from the increase of tourism might also tempt the farmers to spend more time outside of farming activities. It is likely the practice such as not participate in collective work will increase. Another possible change emerged is the farmers might stop

Comment [SV1]: Here you speculate; show that your research is used to look forward, so make connection between insights and conceptualisation for this

farming altogether, and new farmers from nearby area replace them. This practice is very common in subak Deman. The record I acquired from the pekaseh shows that 80 percent of the farmers in subak Deman are contract farmers who cultivate rice fields of other people.

The tensions emerge from the increasing pressure of water scarcity, and more farmers do not participate in collective work might lead to the positive feedback of less socially integrated solidarities, namely the individualism and isolate, that could disturb the water management practices in subak Deman. The positive feedback of the individualism solidarity could increase because new farmers join as the subak members, thus they are less integrated socially. The new subak members might have to adapt to the rules in subak Deman, thus it means they are also less regulated socially. The positive feedback of the individualism solidarity might also increase because the current farmers spend more time outside of water management practices and do not participate in collective work. It could also increase because more farmers conduct water stealing as the pressure of water scarcity increases. Meanwhile, the positive feedback of the isolate solidarity might intensify due to the hierarchical rule that regulates the farmers to keep planting the rice fields while water availability decreases. The prajuru will regulate the farmers to keep planting as usual because they believe that they do not have any choices aside of continue the farming practice. In this sense, they cope with the situation and become passive in dealing with water scarcity. The uncontrolled positive feedback of individualism and isolate solidarities could undermine the hierarchy and enclave solidarities.

Following from the argument of Perri 6 (2003), the situation of undermined hierarchy and enclave by the individualism and isolate solidarities means that the institutional viability of water management practices in subak Deman is less likely to be available as it could lead to disorganization of water management practices in subak Deman. Thus, what would be done by the pekaseh and prajuru if those situations arise? As the hierarchical figures in subak Deman, the pekaseh and prajuru might enforce rules to control or correct the uncontrolled positive feedback of individualism and isolate solidarities. The purpose of this practice is to keep water management practices in subak Deman as one enclave. In dealing with the new members of subak, the pekaseh and prajuru might intensify the number of subak meeting and irrigation monitoring. Meanwhile, to deal with the practice of the farmers who do not participate in collective work and water stealing, the pekaseh and prajuru might increase the amount of fine for violation of these rules. In the enclave solidarity, the prajuru might also intensify water watching practice to prevent water stealing practice. Another possible practice of individualism solidarity to control the uncontrolled positive feedback of the individualism and isolate solidarities is the pekaseh will request government funding to construct irrigation infrastructures to deal with water scarcity, for example building water

Comment [SV2]: Evaluate work of Perri 6, how was it useful or was it too complicated or can you add something to it?

pump as alternative water source for irrigation. It is also possible that the pekaseh and prajuru will negotiate with other nearby subak that have more water to distribute their excess of water through a canal for irrigation in subak Deman. These practices described in this paragraph are the types of settlement to allow all four solidarities to co-exist together in water management practices in subak Deman.

This research considers the work of Perri 6 (2003) to be useful to explain the institutional dynamic between positive and negative feedback forces of four solidarities in water management practices in subak Deman that encounters external pressure of water scarcity. The work of Perri 6 is helpful to understand how institutions in social organization adapt to the risk that threatening the system. The concept of institutional viability could also useful to increase the viability of a specific institution by assessing the two conditions that would enable it to be viable, which are the presence of solidarities and their interaction through positive and negative feedback forces, and types of settlement that exist to contain the conflict between those forces.

6.3 Conclusions

In this research, I answered the research question: *“To what extend and how do the institutional features of water management practices in the subak system stay intact under the condition of external pressures?”*. I created an in-depth case study of water management practices in subak Deman, using social-technical practices as the unit of analysis. I studied the social technical practices by using three dimensions of technography approach. I highlighted four steps to assess the institutional viability of water management practices in subak Deman. First, focusing on water management practices in subak Deman to identify the solidarities. Second, identifying the presence of four solidarities emerged from water management practices. Third, assessing the institutional dynamic between those four solidarities through the positive and negative feedback processes. Fourth, assessing the types of settlement between the positive and negative feedback processes.

The main finding about the institutional viability of water management practices in subak Deman is that it is more likely to be viable under external pressures. Following Perri 6's theory on institutional viability, this research presents two evidences why the institution of water management practices is viable. First, water management practices in subak Deman shows the presence of the four basic institutional forms or solidarities, namely enclave, hierarchy, individualism, and isolate. Second, as the four solidarities clash with each other through the positive and negative feedback processes, this research found that there are three types of settlement that exist to contain the conflict between those positive and negative feedbacks, which are toleration, exchange, and compromise.

This research utilizes water management practices as the unit of analysis. By doing that, this research is able to study knowledge of water management that materializes in interconnected practices. Moreover, this research also understands that water management practices in subak Deman is an integration of social and technical aspects of managing water and by utilizing the three dimensions of technography approach, this research is able to study the use of skills, tools, knowledge, and techniques by the actors in water management in subak Deman. The second dimension of technography (the distributed cognition and coordination of tasks) is also in line with the concept of interconnected practices in this research. Meanwhile, the third dimension of technography (the construction of rules) enables this research to study the institutions that emerge from the water management practices in subak Deman.

This research may contribute to the study of water management practices by turning the attention toward the institution of water management practices using the concept of institutional viability proposed by Perri 6. This research might be useful to design viable institution in water management practices. However, this research might be improved with future research to measure the institutional viability.

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APPENDIX – INTERVIEW QUESTIONS FOR DATA COLLECTION

A. Interview with the pekaseh

1. How do you deal with the government in solving irrigation problem?
2. What is the source of water for irrigation in subak Deman? Who else use this source beside subak Deman?
3. How is the situation of water availability here?
4. When was the last water drought?
5. Who can get water for irrigation in this subak?
6. Who does monitor the irrigation system?
7. What are the rules related to irrigation in this subak?
8. What are the obligations of subak members?
9. How do you deal with conflict of water?
10. What is the problem related to irrigation in this subak?
11. How do you deal with the irrigation problem?
12. How do you maintain the irrigation system?
13. Is there regular meeting in this subak? When? Who attend the meeting? What do you discuss during the meeting?
14. How did you get your position?
15. What are your duties?
16. In relation of water availability, what are decisions you have to make?
17. What are the skills needed in your position?
18. Who are involved in water management in subak?
19. From whom did you learn your job?
20. How do you deal with violation of rules?

B. Interview with the prajuru

1. What is the source of water for irrigation in subak Deman? Who else use this source beside subak Deman?
2. How is the situation of water availability here?
3. When was the last water drought?
4. When is the time rice fields need to be irrigated?
5. Who can get water for irrigation in this subak?
6. Who else use this source beside subak Deman?
7. How is water allocated during rainy season?
8. How is water allocated during water scarcity?
9. Who does monitor the irrigation system?
10. What are the rules related to irrigation in this subak?
11. What are the obligations of subak members?

12. How do you deal with conflict of water?
13. What is the problem related to irrigation in this subak?
14. How do you deal with the irrigation problem?
15. How do you maintain the irrigation system?
16. Is there regular meeting in this subak? When? Who attend the meeting? What do you discuss during the meeting?
17. How did you get your position?
18. What are your duties?
19. In relation of water availability, what are decisions you have to make?
20. What are the skills needed in your position?
21. Who are involved in water management in subak?
22. From whom did you learn your job?
23. How do you deal with violation of rules?
24. How are tasks coordinated among prajuru?