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RESEARCH ARTICLE

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Absence of legislation and the quest for an effective mode of governance in agricultural water management: An insight from an irrigation district in central java, indonesia*

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Abstract

This paper explores the historical and contemporary governance of water users' associations (WUAs) in an irrigation district in Central Java, Indonesia. The historical governance was explored through in-depth interviews with the chief and board members of the WUAs, farmers and government officials, who have more than 30 years of experience in irrigation. The contemporary WUAs' governance was assessed through a survey of 34 WUAs covering an area of 7872 ha. The results show that the WUAs have experienced significant changes in governance, from hierarchical to community-based (*Swakelola*) and provider-based network style (*Lelang*). The survey revealed that there is an improvement in farm infrastructure under the current governance since the WUAs can provide sufficient funds to rehabilitate and maintain the irrigation networks without relying on outside actors. Also, the current WUAs' governance seems to increase land productivity, but it needs to be verified by future research. Finally, the insight in this study is useful in the effort to build sustainable agricultural water management.

KEYWORDS
agricultural water management, community-based network, hierarchical governance, provider-based network, water management right, WUA governance, Résumé

Résumé

Cet article explore la gouvernance historique et contemporaine des associations d'usagers de l'eau (AUE) dans un district d'irrigation du centre de Java, en Indonésie. La gouvernance historique a été explorée à travers des entretiens approfondis avec le chef et les membres du conseil d'administration de l'AUE, des agriculteurs et des représentants du gouvernement, qui ont plus de 30 ans d'expérience en irrigation. La gouvernance contemporaine des AUE a été évaluée grâce à une enquête sur 34 AUE couvrant une superficie de 7872 ha. Les résultats montrent que l'AUEs a connu des changements importants dans

*L'absence de lois et la recherche d'un mode de gouvernance efficace dans la gestion de l'eau agricole: un aperçu d'un district d'irrigation dans le centre de Java, en Indonésie.

la gouvernance, passant d'un style de réseau hiérarchique à communautaire (*Swakelola*) et à fournisseur (*Lelang*). L'enquête a révélé une amélioration des infrastructures agricoles sous la gouvernance actuelle, car les AUEs peuvent fournir des fonds suffisants pour réhabiliter et entretenir les réseaux d'irrigation sans dépendre d'acteurs extérieurs. De plus, la gouvernance actuelle de l'AUE semble augmenter la productivité des terres, mais elle doit être vérifiée par de futures recherches. Enfin, la perspicacité de cette étude est utile dans l'effort pour construire une gestion durable de l'eau agricole.

MOTS CLÉS

gouvernance de l'AUE, gouvernance hiérarchique, réseau communautaire, réseau basé sur le fournisseur, droit de gestion de l'eau, gestion de l'eau agricole

1 | INTRODUCTION

Since its inception in the 1980s, the management of agricultural irrigation through irrigation management transfer (IMT) and participatory irrigation management (PIM) has become a central institutional issue in irrigation studies worldwide. More than 131 studies have been conducted to assess the effectiveness of this policy, which has been adopted by more than 60 countries (Senanayake et al., 2015). Most of these studies attempted to assess the effectiveness of IMT/PIM using performance variables, both technical and organizational. These growing numbers of studies show that less than half of the entire cases were categorized as a success. However, despite the ongoing debate on the effectiveness of this policy, IMT/PIM is still the central framework to manage agricultural irrigation at the tertiary level and below in many countries.[1]

The management transfer policy in Indonesia was started in the early 1980s through several pilot projects, but the plan was legalized in 1989 (Indonesian National Committee of the International Commission on Irrigation and Drainage (INACID), 2017). Previously, only small irrigation schemes (tertiary irrigation systems (TISs)) were transferred to farmers; however, during the 1998 financial crisis, primary and secondary irrigation systems were also transferred to farmers. However, the government realized that moving primary and secondary irrigation systems to farmers was not feasible. Thus, starting in 2004, the government took back the responsibility for primary and secondary irrigation systems but left the responsibility for tertiary irrigation with farmers. The primary reason for the transfer policy was to lighten the burden on the government budget from managing such extensive irrigation systems. Also, the transfer policy was aimed at stimulating farmers' participation in irrigation systems.

As in many other countries, the Indonesian government accompanied transfer policy with participatory irrigation management (PIM) policy to improve farmers' participation in irrigation management. The primary form of PIM is the establishment of water users' associations (WUAs) at the tertiary level. The WUAs are responsible for the management and operation of TISs, which were previously managed and operated by the village government. The purpose of the participatory policy is to establish self-reliant WUAs, both financially and technically, in managing TISs (INACID, 2017). However, to realize that purpose, the Indonesian government only aimed at empowering WUAs through the legalization of the formal aspect of WUAs. Also, the government did not act further in stimulating the effective governance of WUAs and how their institution should be arranged. Institutional innovation is crucial to enhancing the performance of WUAs, as has been empirically addressed in several irrigation studies.

Study of the governance and institutional arrangements of WUAs has attracted considerable attention. Good governance is recognized as the key solution to solving the global water crisis (Pahl-Wostl et al., 2012). The effort to establish good governance is carried through institutional innovation, which is a process to change institutions to ensure connectivity with the ecological system and provide sustainable learning for the people in it (Bromley, 2012). Several studies have reported that institutional innovation has enhanced the performance of WUAs. In China, contracting and collective action have improved maintenance expenditure, timeliness of water deliveries and rate of fee collection (Huang et al., 2010; Zhang et al., 2013). Also, the new institutional arrangement in Spain's groundwater resources has emerged as effective governance (Rica et al., 2012). The

[1]In Indonesia, 'tertiary irrigation system' is an irrigation system serving less than 500 ha of land, usually covering only one village.

similarity in both cases is that the WUA officials are motivated to gain economic incentives by managing irrigation. China's WUAs obtain incentives by saving water, while in the Spanish case, the WUAs gain incentives in the form of infrastructure claims by acting collectively.

IMT and PIM create conditions in a TIS where the farmer has significant authority to rule the WUA with little or no state involvement. Dixit (2004) defines this condition as absence of legislation in economic activity. Further, he adds that in this condition, economic actors will set up their institution to satisfy the needs of all actors in the system. Currently, the condition of the TIS in Klambu Wilalung mostly resembles the state of absence of legislation, where the farmers have considerable freedom to govern themselves and are experimenting with governance of the WUA. The experimentation will continue until the farmer community has found the best governance that is suitable for their characteristics and can overcome the challenges of irrigation management. In the literature of common-pool resources management, study of the evolutionary process of governance as well as the factors that drive the evolution is of paramount importance. Thus, this study will focus on the evolution of governance of TISs as well as assessing the historical and the contemporary mode of governance of the TIS in Klambu Wilalung. The essential feature of the TIS in Klambu Wilalung is that it has experienced various modes of governance over the past 70 years, starting with hierarchical, network-collective action and network-provider governance. Hence, it will provide a crucial insight into the evolution of TIS governance.

This paper will present, first, the evolution of TIS governance in an irrigation district (ID) in the Jratunseluna River basin in Central Java, Indonesia. Jratunseluna River basin is one of the vital irrigation schemes in Indonesia, which receives water supply from Kedung Ombo, the largest reservoir in Indonesia. Understanding the evolution of governance is crucial in ensuring the success of WUA institutional reform (in particular, PIM), since institutional development is path dependence and is part of institutional evolution that is unique to a specific TIS and has taken place long before the implementation of transfer policy (North, 1990). Also, it is crucial in the effort to view the farmers, water users, and community as the subject of this process and in seeing institutional change as an organic process that is actively shaped by the community (Meinzen-Dick, 2014). Second, the paper will assess the characteristics of the current WUA's governance in which contracting has been intensively used. However, different from the Chinese and

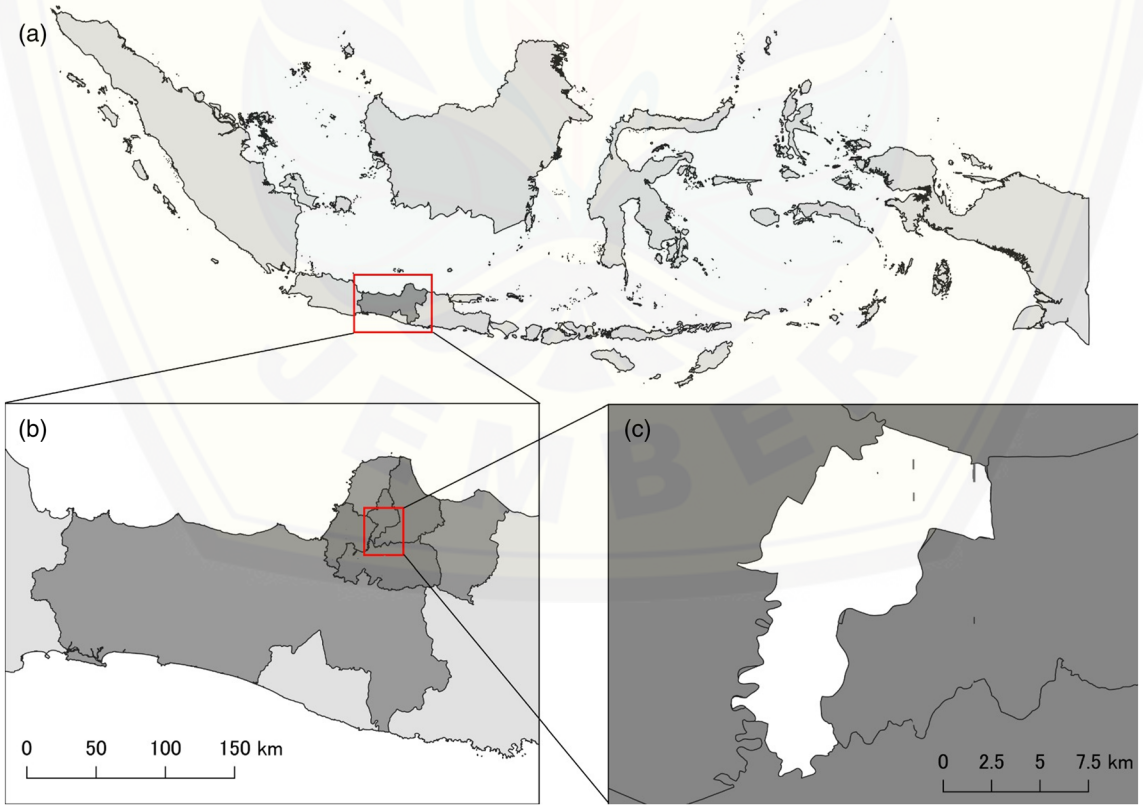

FIGURE 1 Map of the study area: (a) Province of Central Java relative to Indonesia, (b) districts of Kudus, Pati, Demak and Grobogan relative to the province of Central Java, (c) Klambu Wilalung ID (the area highlighted in white) relative to the four districts [Colour figure can be viewed at wileyonlinelibrary.com]

Spanish cases, the contracting party in the study area has an incentive to manage the WUA through collecting the irrigation water fee.

2 | DATA

This study was conducted in Klambu Wilalung ID for a period of 5 years from 2012 to 2017. Klambu Wilalung is one of five IDs served by the Kedung Ombo, the largest reservoir in Indonesia in terms of agricultural land served. It serves an area of 64 365 ha, of which 7872 ha are in Klambu Wilalung (Rondhi et al., 2015). The Klambu Wilalung ID is located in the districts of Kudus and Grobogan in the province of Central Java. It consists of 34 WUAs (P3A or *Perkumpulan Petani Pemakai Air* in local terms), which spread out in 20 villages within 2 subdistricts (Rondhi et al., 2017). There are 30 WUAs in Kudus which cover 16 villages. The other 4 WUAs are located in Grobogan and cover 4 villages. Figure 1 shows the study area relative to the province of Central Java.

In-depth interviews were conducted to obtain information about the evolution of irrigation governance. Specifically, we asked about the type and characteristics of past water governance in the study area. An annual reassessment was done during the study period using the same questions and procedure to ensure consistency of information.[2,3] The primary respondents of the interviews were the chairman and management of the WUAs. As an addition, we also collected data from village leaders, government officials and farmers. We obtained information on the governance of the irrigation system (both past and present) and the factors affecting its selection. The respondents had had experience in irrigation management for more than 30 years and had lived in different sociopolitical periods. Furthermore, we also collected information from relevant publications, such as academic papers and official documents.

The survey of each WUA in Klambu Wilalung was conducted to assess the characteristics of governance under the *Swakelola* and *Lelang* systems. The questionnaire gathered information on broad aspects of the WUAs. It consisted of data on the features of the farming systems, socio-economic characteristics of the WUAs, on the governance, and on operation and maintenance aspects of WUAs. The extensive coverage of the data allows for a comprehensive comparison of various aspects of irrigation governance under the *Swakelola* and *Lelang* systems. Thus the data are representative of every part of the ID, both in the head and tail areas. Also, we participated in an auction process and interviewed farmers on their perspective on the performance of both *Swakelola* and *Lelang* systems. Table 1 shows general information about the survey.

The survey revealed that the *Swakelola* and *Lelang* systems had been implemented since 1990. However, *Swakelola* was the dominant governance before 2006. *Lelang* had gained popularity since 2006 with more than half of the WUAs (18) in Klambu Wilalung applying it, and in 2016 the number rose to 23. Currently, *Lelang*-WUAs manage 4070 ha (80% of the total area in the ID) of land, with an average operation area for each WUA of 177 ha. Meanwhile, *Swakelola*-WUAs manage only 1070 ha, with an average land for each WUA of 97 ha. The average governing period for *Lelang* is shorter than for *Swakelola*, 4 and 5 years, respectively. However, in terms of size, *Lelang*-WUAs are larger than *Swakelola*-WUAs with an average number of board members of eight and seven members respectively. Also, *Lelang*-WUAs have more farmers than *Swakelola*-WUAs, with an average number of farmers per WUA of 330 and 109, respectively. Average land productivity is also higher in land managed under *Lelang* for both the first and second seasons. The average rice yield for the first and second seasons in *Lelang*-WUAs is 7.3 and 5.5 t ha^{-1} respectively, while it is only 7 and 4.6 t ha^{-1} for *Swakelola*-WUAs. Finally, Figure 2 shows the distribution of the *Swakelola* and *Lelang* systems.

3 | ABSENCE OF LEGISLATION AND WATER GOVERNANCE

We define absence of legislation as the absent or limited state intervention in the management of irrigation in the TIS. Previously, the term 'lawlessness' was introduced by Dixit (2004) to describe a condition where a formal government's apparatus is absent in an institutional environment to regulate society's affairs, particularly economic activity.[4] The primary concern in absence of legislation is

[2]Although some of the respondents felt it strange to be asked the same questions, this reassessment was critical in validating the historical reconstruction of the institutional change.

[3]This procedure is termed 'repeated observations' (Mills *et al.,* 2010), which are repetitions of observations of the same item/focus that occur in single or multiple cases, whether in time series or cross-sectional manner. We use *reassessment* rather than *repeated observation,* because we were not following the institutional changes directly from the beginning, instead we explored the previous changes (those occurring before our study period) based on farmers' knowledge and experience and assessed the consistency of information using *annualre-assessment.*

[4]In fact, Dixit used the term 'lawlessness' to represent absent or limited state intervention in an economic activity. However, in this paper, we chose 'absence of legislation' instead of lawlessness as an appropriate term.

TABLE 1 General information of the survey on the *Swakelola* and *Lelang* systems

Aspect		*Lelang*		*Swakelola*		Description
1	***Number of WUAs***					
	2016	23	(67)	11	(33)	Number of WUAs (percentage)
	2006	18	(52)	16	(48)	Number of WUAs (percentage)
	1996	3	(9)	31	(91)	Number of WUAs (percentage)
2	Irrigated area (ha)[a]	4070	(177)	1070	(97)	Total (average)
3	Governing period (yr)	4		5		Average per WUA
4	Board members	202	(8)	77	(7)	Total (average per WUA)
5	Farmer members[b]	6930	(330)	1200	(109)	Total (average per WUA)
6	1st season rice yield	7.3		7		in t ha^{-1}
7	2nd season rice yield	5.5		4.6		in t ha^{-1}

[a]The total area from the survey was 5130 ha, which is different from the official data (7872 ha). This difference may be due to farmland conversion and the inaccurate conversion of *bahu* to hectares since some WUAs reported land area in *bahu*, the local measurement for land area.
[b]There were three WUAs (two *Lelang* and one *Swakelola*) who did not provide their number of farmers.

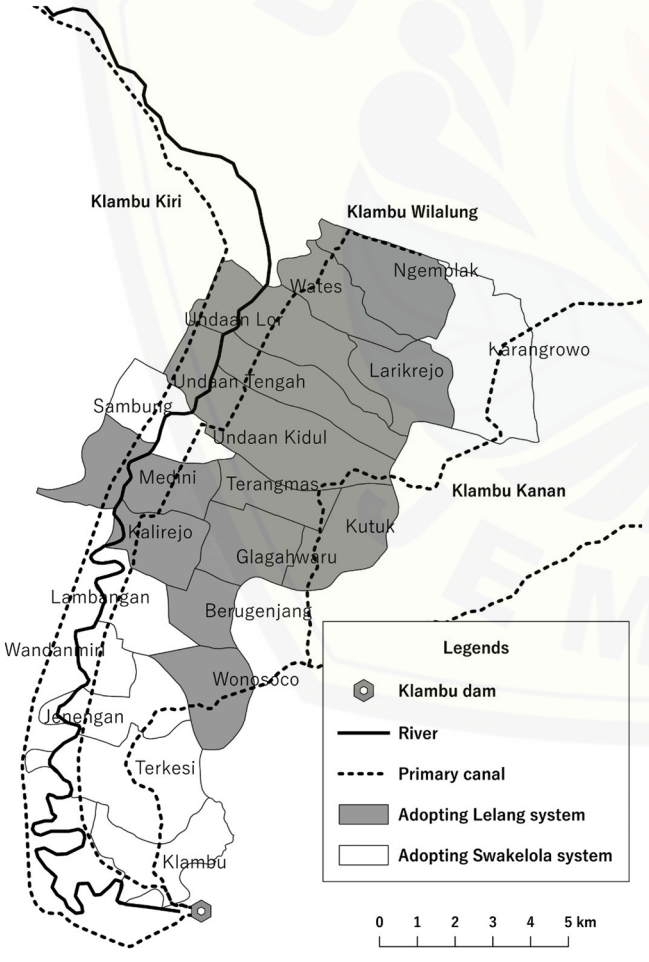

FIGURE 2 The distribution of WUAs adopting *Lelang* (highlighted in dark gray) and *Swakelola* (highlighted in white) in Klambu Wilalung ID

who should provide the rules of economic activity and how to formulate these rules in the absence of government. Furthermore, he added that the focus of the absence of legislation is more on the microeconomic level of individual transactions rather than on the macro aspects of economic policy such as fiscal, monetary, regulatory and trade policy. In the case of governance, absence of legislation focuses on the interaction among distinct decision-making units. Based on this definition, the absence of legislation fits the context of water management in the study area where the interaction among farmers, WUA boards, village government and higher irrigation officials shape the formation of the TIS governance.

Several studies have addressed the issue of absence of legislation in the management of natural resources. These studies can be grouped into two categories: a group which reported that absence of legislation had created an undesirable outcome, and one which reported a beneficial outcome of absence of legislation. The Kenyan water sector is an example of the former. In the Kenyan case, centralized governance limits administrative capacity and reduces the formal control of local authorities, resulting in informal water management where upstream users become the de facto beneficiaries of water (Baldwin et al., 2016). Also, the absence of legal support and authority to prevent farmers from illegally accessing the man-made reservoir in Mazandaran, Iran, has led to deterioration of the facility and reduced its storage capacity (Mirzaei et al., 2017). However, the state of absence of legislation has opened up a new opportunity for economic

growth for Somalia. The Somalian case is possible since the presence of state government not only fails to add social welfare, but also reduces the welfare below the condition of state absence (Leeson, 2007). In this context, the Somalian case is included in the latter group.

Similar to the Somalian case, the present study belongs to the latter group. However, the condition is not an absolute absence of legislation, as in the Somalian case. Instead, it is more similar to the Iranian and Kenyan cases where government existed, but with limited capability and authority. The present study demonstrates that the absence of legislation in the management of TISs has driven the farmer community to form a more sustainable mode of governance in terms of farm infrastructure funding and maintenance activity.

4 | THE INSTITUTIONAL EVOLUTION OF AGRICULTURAL WATER MANAGEMENT IN KLAMBU WILALUNG ID

In this section, we develop an explanation of the evolution of irrigation governance from the 1950s to the present.

4.1 | The 1950s–1976: the *ulu-ulu* period

During this early period of Indonesian independence, political instability caused weakening of the government body previously established in the colonial period responsible for water management (Booth, 1977b). In the colonial period, irrigation was controlled entirely by the government, the irrigation authority was established through village level and the *ulu-ulu* was the irrigation authority responsible for managing irrigation.[5] Although the chain of coordination was weakening and most of the provincial level irrigation authority had ceased to function causing conflict over water rights and canal regulation between many villages (Hansen, 1971), the *ulu-ulu* reserved their right to manage irrigation at the village level.[6]

In our study area, the *ulu-ulu* was responsible for distributing water in the rainy season, and the operational area of the *ulu-ulu* was a lower administrative area below the village (*Dusun*). Village officials or farmers elected the *ulu-ulu*.[7] In this period there was still no water fee paid by farmers, since all the water came from rainfall, and the *ulu-ulu* received the right to cultivate village-owned land (*bengkok*) instead of a salary. Since there was no water fee and water was easily obtained in that period, farmers perceived the economic value of water to be very low, and the state conducted coordination of the entire irrigation system through village officials (especially the *ulu-ulu*). It was not until the central government established a national plan to achieve self-sufficiency in rice production that the demand for water in the dry season increased and gave rise to *Dharma Tirta* to accommodate it.

4.2 | 1976–1990: *Dharma Tirta* period

Dharma Tirta was the first implementation of transfer and participatory management policy. However, it was a modification and evolution of the *ulu-ulu* system rather than a new set of irrigation institutions. Although *Dharma Tirta* has its general model specification, the *Dharma Tirta* General Regulations issued by the Provincial Government of Central Java provided a legal-administrative framework designed to encourage local organizational initiative in adapting the model to village irrigation conditions (Duewel, 1984).[8] *Dharma Tirta* was officially introduced in 1971 and established as Central Java's official WUA model. The main features of *Dharma Tirta* that distinguish it from the former *ulu-ulu* system are: (i) the addition of dry-season water delivery; (ii) improvements in farm-level technology and organizational structure; (iii) the stipulation of rights for each individual *Dharma Tirta* to collect water fees and/or other financial procedures to cover the cost of providing water in the dry season.

Dharma Tirta was officially introduced in 1971 and adopted by province-wide village-level irrigation. However, adoption of *Dharma Tirta* only occurred in those villages that had access to primary and secondary irrigation canals. Later in 1975, the revised edition of 1971 Dharma Tirta regulations emphasised the role of *Dharma Tirta* as a social organization, the main objective of which was to promote the welfare of the water user community and individual farmers. The *Dharma Tirta*'s operating principle in this revised regulation was *gotong royong* or cooperation among farmers to achieve common goals

[5]For a detailed description of Indonesian irrigation management in the colonial era, see Booth (1977a, b)).

[6]This was due to the fact that *ulu-ulu* was a village official, so his position was maintained.

[7]In fact, *ulu-ulu* has its origin in the effort of the colonial government to group farmers according to tertiary units since 1907, in which the *ulu-ulu* was selected by farmers as their representative (Pasandaran, 2015).

[8]In his article, Duewel (1984) gives a detailed explanation on the nature of *Dharma Tirta*.

and removing the economic motive in the management of *Dharma Tirta*. In Klambu Wilalung, the *Dharma Tirta* was established in 1976, after the revised decree was issued, since there was no technical irrigation system in this area. The establishment of *Dharma Tirta* was promoted by village officials and day-to-day operation was undertaken by *Dharma Tirta* officers, consisting of former *ulu-ulu* or a new member from the farmers. This system of management was called *Swakelola* or self-managed organization by cultivating farmers.[9] The main objective of *Dharma Tirta* in this area was to obtain water from the Juana River by using a water pump and distributing it to farmers' plots. Since the cost of this service was high, *Dharma Tirta* received an *in-kind* incentive in the form of rice (Rondhi et al., 2015).

In the *Dharma Tirta* period, there were three main features worthy of attention. First, there was an increase in farmers' participation in irrigation management. This was indicated by the election of farmers as *Dharma Tirta* officers. Second, the role of the state (village official) was decreasing, indicated by the removal of *bengkok* as an incentive for irrigation officers. Third, there was an increase in irrigation water fees. The water fee was 12.5% of the rice harvested in the second season.[10] The high water fee was related to the absence of irrigation infrastructure. However, the water fee decreased when the government built Kedung Ombo and created the subsequent irrigation districts, including Klambu Wilalung. The construction of Kedung Ombo brought a drastic change in the irrigation system and will be discussed in the next section.

4.3 | 1990–2005: the construction of Kedung Ombo and P3A

The critical factors in Indonesian irrigation, especially in Java, are the massive construction of reservoirs and other irrigation infrastructures, starting from the early independence period through the New Order era under the 'Green Revolution' programme (Pasandaran, 2007). The construction of Kedung Ombo was completed in 1990, and it has had a massive impact on the subsequent irrigation systems. There were two notable changes in irrigation institutions after the construction of the Kedung Ombo. First, it was easier to obtain water compared to the *Dharma Tirta* period. Hence the water fee was decreased gradually but in a significant way. In that period the proportion of rice given as water fee decreased from 12.5 to only 4%, and the WUA has an additional duty to put 30% of the collected water fee aside as an infrastructure fund. Second, the government changed the name of the WUA from *Dharma Tirta* to P3A (*Perkumpulan Petani Pemakai Air* or water users' association). The board members and operating principle of the WUAs remained the same, although there was a change in name.

Fifteen years later, there was growing concern among farmers about the deterioration of the tertiary irrigation infrastructure. Moreover, farmers became suspicious of WUA board members and began questioning the use of the collected water fee. Although farmers have insisted that the WUA has an additional duty to establish irrigation infrastructure, however, the collected water fee is insufficient to cover the cost of construction. Hence, in 2005, the village officials started to introduce *Lelang* in one of the villages studied (Undaan Tengah). Since then, the use of *Lelang* grew significantly from only 3 WUAs before 1996 to 18 in 2006 (Table 1). Principally, *Lelang* is an auction of the right to manage the WUA, and the highest bidder wins the chair of the WUA (Rondhi et al., 2017). The following section will discuss this type of governance.

5 | *SWAKELOLA* AND *LELANG*: CONTEMPORARY IRRIGATION GOVERNANCE IN KLAMBU WILALUNG ID

In Indonesia, the WUA replaced the role of the village government to manage TISs. We found that WUAs manage all the TISs in Klambu Wilalung ID; the differences lie in the governance of each WUA. Based on the survey, there are two general modes of governance of WUAs, *Swakelola* and *Lelang*. *Swakelola* has been established since the *Dharma Tirta* period. Meanwhile, *Lelang* had just been implemented in 2004 by one WUA. However, at the time of the survey, 23 out of 34 WUAs in Klambu Wilalung had adopted *Lelang* as their mode of governance. Hence, it is crucial to assess the characteristics of each form of governance, especially *Lelang*, and why the farmers' community chose to change the way of governing the WUAs.

In *Swakelola*, farmers elect the chair and board members by voting at a general meeting. The candidate with the most votes becomes the chair of the WUA. Also, the governing period of the chair is decided at this meeting. Candidacy, both for the chair and board members, is open only for the farmers who

[9]A 'cultivating farmer' is one who actively cultivates the land in the *Dharma Tirta* operational area.

[10]In local terms this system is called *moro* in which the total rice production is divided into eight parts, with one-eighth for *Dharma Tirta* and the rest for the farmer.

TABLE 2 The characteristics of WUAs under *Swakelola* and *Lelang*

Feature	*Lelang*	*Swakelola*	Description
Condition for the chair and board members			
Have to be a cultivating farmer	20 (87)	11 (100)	Number of WUAs (percentage)
Do not have to be a cultivating farmer	3 (13)	0	Number of WUAs (percentage)
*Infrastructure fund*a,c,d (*in Indonesian rupiah*)			
Total value yr^{-1}b	1 640 000 000	528 000 000	For all WUAs
Average value WUA^{-1} yr^{-1}	71 300 000	48 000 000	Average per WUA
Average value ha^{-1} yr^{-1}	392 000	572 000	Average per WUA
Irrigation water fee (*in Indonesian rupiah*)			
Potential total water fee yr^{-1}	424 000 000	160 000 000	Average per WUA
Potential total water fee ha^{-1}	1 900 000	1 910 000	Average per WUA
Fixed payment (using money) (P1)	8 (35)	1 (9)	Number of WUAs (percentage of group)
Average value (P1)	722 000	266 000	Rp $ha^{-1}yr^{-1}$
Fixed payment (in kind) (P2)	4 (18)	5 (45.5)	Number of WUAs (percentage of group)
Average value (P2)	2 660	2 240	Kilograms of harvested rice ha^{-1} yr^{-1}
Proportional payment (in-kind) (P3)	11 (47)	5 (45.5)	Number of WUAs (percentage of group)
Average value (P3)	11.8	14.4	% of harvested rice ha^{-1} yr^{-1}
Maintenance activities			
Length of works	24	154	Days WUA^{-1} yr^{-1}
Work intensity	4.9	6.8	Hours day^{-1} WUA^{-1}
Labour use	14	11	Men WUA^{-1} ha^{-1} yr^{-1}
Source of labour			
Board member	10 (43)	10 (91)	Number of WUAs (percentage of group)
Hired labour	10 (43)		Number of WUAs (percentage of group)
Member farmer	3 (14)	1 (9)	Number of WUAs (percentage of group)
Pest control activities			
Length of works	37	76	Days WUA^{-1} yr^{-1}
Work intensity	4.9	5.9	Hours day^{-1} WUA^{-1}
Labour use	23	26	Men WUA^{-1} $season^{-1}$
Source of labour			
Board member	13 (56)	11 (100)	Number of WUAs (percentage of group)
Hired labour	2 (9)	0	Number of WUAs (percentage of group)
Member farmer	8 (35)	0	Number of WUAs (percentage of group)

[1a]We deflated the value of the infrastructure fund in *Lelang*-WUA and the water fee for *Lelang*-WUA that used rice as water fee using the price of rice to obtain the rice equivalent amount of the bidding money. After obtaining the rice equivalent amount, we standardized the amount in 2016 rupiah, by multiplying the rice equivalent amount by the 2016 rice price, which is Rp. 4343 kg^{-1}.
[2b]The infrastructure fund for *Swakelola*-WUA that uses harvested rice as water fee is also standardized.
[3c]The infrastructure fund in *Swakelola* is 30% of the collected water fee.
[4d]We use the farm-gate price of rice for 2008 (Rp. 2386 kg^{-1}), 2010 (Rp. 3012 kg^{-1}), 2011 (Rp. 3659 kg^{-1}), 2013 (Rp. 4022 kg^{-1}), 2014 (Rp. 4214 kg^{-1}), 2015 (Rp. 4547 kg^{-1}) and 2016 (Rp. 4343 kg^{-1}), and we obtained it from the Statistical Agency of Central Java.

cultivate land in the WUA's operational area—the cultivating farmer. All the WUAs in *Swakelola* require that the chair and the board of the WUA must be cultivating farmers (Table 2). After the election, the WUA has two primary responsibilities and an additional task. Managing irrigation (water allocation, O&M, water fee collection) and establishing farm infrastructure are the two primary responsibilities of the WUA. Also, the WUA has an additional task of pest management for member farmers.

In return for managing irrigation, the WUA board members have the right to collect irrigation fees. There

are three methods of payment of the irrigation fee; fixed payment using money and harvested rice and proportional payment using harvested rice. The amount and the method of determining the fee also vary for each TIS. Some WUAs implement a fixed payment method, while others use a proportional payment. The irrigation fee was paid only in the first and second season. In each season, the WUA should allocate 30% of the collected water fee as an infrastructure fund. The remaining 70% is used to cover the operational costs of the WUA as well as the salary of the board members. At the end of the governing period, the accumulated infrastructure fund is used to build farm infrastructure.

The second mode of governance is *Lelang*. *Lelang* emerged as a model of governance because most of the planned farm infrastructure required a large sum of money, and the infrastructure fund from *Swakelola* was insufficient to cover the cost of infrastructure. Also, the farmers suspected that the board of the WUA had not made proper use of the infrastructure fund in *Swakelola*. Although *Lelang* has been applied since 1990, it was only in 2005 that it gained considerable attention from the majority of WUAs. The primary feature of *Lelang* is that the chair of the WUA should provide an upfront payment for an infrastructure fund to be eligible for candidacy. In *Lelang*, the eligibility for candidacy is becoming looser, and it no longer requires that the chair should be a cultivating farmer. Currently, there are three WUAs under the leadership of a non-cultivating farmer. The chair is then auctioned at the general meeting; the candidate with the highest bid is selected as the chair of the WUA and has the right to choose the WUA board members. The meeting also decides on the type and specification of infrastructure and the governing period of *Lelang*. The emergence of *Lelang* shows that farmers are experimenting with the way the WUAs should be governed. Under *Lelang* management, the majority of farmers reported that there has been a significant improvement in farm infrastructure. The type of infrastructure varies, such as canal lining, small bridges, farm roads and drainage facilities.

Table 2 provides the characteristics of *Swakelola* and *Lelang* from various aspects. The essential feature of *Swakelola* and *Lelang* is the necessity for a WUA to build farm infrastructure. The average infrastructure fund for each WUA under *Lelang* is Rp 71 300 000 yr^{-1}, and for *Swakelola* is Rp 48 000 000 yr^{-1}. The average infrastructure fund for each hectare of operational area under *Swakelola* and *Lelang* are Rp 392 000 and Rp 572 000 yr^{-1} respectively. The infrastructure fund in *Swakelola* is larger than in *Lelang*. However, the infrastructure fund in *Lelang* is available at the beginning of the governing period, and it can be built early. Also, some infrastructure requires a large sum of the fund that can only be gained through *Lelang*. In *Swakelola*, the infrastructure fund is available at the end of each governing period, or after the accumulated infrastructure fund is sufficient for the planned infrastructure. The payment of infrastructure fund in *Lelang* is an all-in-advance payment, and in *Swakelola* is credit payment (Zhang et al., 2014). In an all-in-advance payment, the vendor, in this case, the farmer community, benefits from the immediate use of the money, but the trade-off is that the value is smaller than in credit payment.

The incentive for the chief and board members to manage a WUA is the right to collect irrigation water fees. The annual water fee potential for each WUA under *Swakelola* and *Lelang* are Rp 424 000 000 and Rp 528 000 000, respectively. Each hectare of land under *Lelang* is potentially worth Rp 1 900 000 yr^{-1}, and Rp 1 910 000 yr^{-1} for *Swakelola*. These values indicate that WUAs under *Lelang* are more economically oriented than under *Swakelola*. Both *Swakelola* and *Lelang* prefer to use in-kind payment rather than monetary payment. There are 65% of *Lelang*-WUAs and 91% of *Swakelola* WUAs that have implemented in-kind payment. However, the use of fixed and proportional payment is relative, both in *Swakelola* and *Lelang*. In *Lelang*, 53% of WUAs use fixed payment and the remaining 47% use proportional payment. Similarly, 56.5% of WUAs in *Swakelola* use fixed payment and 45.5% prefer proportional payment. It might be because of the stable value of rice in the rural area of Indonesia as a cash commodity.

Also, the WUA has a responsibility to maintain the irrigation facilities. Maintenance activity uses one of three types of labour: WUA board members, hired labour or member farmers. The board members of the WUA in *Swakelola* are mostly involved in maintenance activities; 91% of *Swakelola*-WUA reported that board members took over maintenance activity. Meanwhile, only one WUA had all its member farmers participating in the maintenance of irrigation facilities. In contrast with *Swakelola*, although board members are still responsible for the maintenance works in 43% of the WUAs, almost half of the WUAs in *Lelang* use hired labour for maintenance works, while only a small proportion of WUAs mobilize member farmers for maintenance works. The maintenance works in *Lelang* are shorter and lighter than in *Swakelola*. The average length of works in *Lelang*-WUAs is 24 days yr^{-1}, much smaller than 154 days yr^{-1} in *Swakelola*. Also, the average work hours in *Lelang* is 4.9 h day^{-1} compared to 6.8 h day^{-1}. However, *Lelang*-WUAs use more labour than *Swakelola*-WUAs, with average labour of 14 and 11 men yr^{-1}, respectively.

In addition to maintenance works, WUAs in *Swakelola* and *Lelang* have an additional task to control

pest attack. Although not directly related to irrigation, the work is a service provided by the WUA to the farmers and is crucial in the evaluation of WUA performance. The length and the work intensity of pest control are similar to maintenance activity, where *Swakelola*-WUAs work many more days and longer hours. However, average labour use is more extensive than in maintenance activities. Average labour use for *Swakelola* and *Lelang* is 23 and 26 men yr^{-1}. Consequently, the use of hired labour decreased significantly, with only two WUAs that use hired labour for the works. It is due to the tremendous labour need of pest control works that even *Lelang*-WUAs prefer to mobilize member farmers for the works.

6 | DISCUSSION

The central theme of this study was to analyse the evolution of WUA governance. The analysis of historical and contemporary governance of WUAs in Klambu Wilalung demonstrates that in the past 70 years, the WUAs have experienced dramatic changes in governance. The analysis revealed that there were three periods of governance shift from the 1950s to 2019. In the early independence of Indonesia, the state took over the governance of all public affairs, including irrigation. It was marked by the *ulu-ulu* period, where TISs were managed by the village government through *ulu-ulu*. The second period of governance was initiated by the issuance of the first water law in Indonesia, UU No. 11/1974. It then became the basis of the formation of *Dharma Tirta*, a participatory farmer organization. In *Dharma Tirta*, there was a shift from government-led to farmer-led governance, and it marked the beginning of participatory management of irrigation in Klambu Wilalung. The construction of Kedung Ombo marked the third period of shift. Also, the WUAs' name was changed from *Dharma Tirta* to P3A. P3A is the contemporary governance of WUAs, consisting of *Swakelola* and *Lelang*.

Each period of governance shift demonstrates that there was a shift from hierarchical to network governance. The *ulu-ulu* system can be characterized as a hierarchical style where regulations were based on formal rules; steering is based on the authority, and power derived from position in the hierarchy (Pahl-Wostl, 2019). The introduction of PIM has changed WUA governance to network style. The *Dharma Tirta* and early P3As are characterized as network governance where regulation originated from informal institutions in the farmer community (*gotong royong*), the steering is based on trust and voluntary agreement, and power derived from the role in the network (Pahl-Wostl, 2015). In contemporary governance, the network can be grouped into two categories, provider-based (*Lelang*) and community-based (*Swakelola*) governance (Tenbensel, 2005). The *Lelang* is categorized as provider-based since the right to manage WUAs is auctioned, and the WUAs provide irrigation services to gain an economic incentive. Also, it is evident in the labour used for maintenance and pest control works. The *Swakelola* is categorized as community-based governance since the chief and the board members of the WUA must be cultivating farmers, members of the farmers' community. Also, it is the farmers who choose the chief and the board members of the WUA at the general meeting. However, although they have experienced significant changes, the WUAs still preserve the principle of mutual agreement at the general meeting (*musyawarah*) to decide how they should be governed. It emphasizes the importance of path dependence in institutional evolution, where the principal value of the community is preserved, although there were many changes in the features of the organization.

The institutional reform of irrigation is crucial in water resource management policy. Currently, the reform is focusing on achieving sustainable agricultural water management to support food security (Gany et al., 2019). The essential feature of the evolution of irrigation governance in Klambu Wilalung is that the WUAs now attain a mode of governance where they can provide a sustainable infrastructure fund. As shown in Table 2, both in *Swakelola* and *Lelang*, the WUAs can provide on average Rp 381 000 and Rp 931 000 ha^{-1} yr^{-1} compared to the standard infrastructure fund from the government, which is Rp 1 200 000 ha^{-1} (Directorate of Agricultural Irrigation, 2019). The WUA's infrastructure fund is potentially larger than the standard infrastructure fund from the government since the WUA's fund is available every year, compared to the average 5–10 years of infrastructure fund from the government.[11] Irrigation infrastructure is vital to increase farm yield, which directly increases food security. Also, the availability of irrigation infrastructure in Indonesia reduces the perceived impact of climate change (Rondhi et al., 2019) and increases farmland value, which prohibits farmland conversion (Rondhi et al., 2018).

Furthermore, the average rice yield in the study area is 7 t ha^{-1}, which is higher compared to another area in Java (East Java), where it was only 6.1 t ha^{-1} in a rural area and 4.9 t ha^{-1} in the periurban area (Rondhi et al., 2019). It raises the question of whether the governance of WUAs affects agricultural yield, and

[11]According to the regulation of the Indonesian Ministry of Home Affairs, a particular organization and/or society can receive supporting funds from the government only once in a period of 3 years.

whether WUA governance in the studied area (*Swakelola* and *Lelang*) increases land productivity. The question is worth analysing for future research but is beyond the scope of the current study. The insight gained in this study might be useful in the effort to build sustainable governance of irrigation, especially WUAs.

7 | CONCLUSION

The study describes the evolutionary path of the WUA's governance in Klambu Wilalung ID, Central Java, Indonesia. In seven decades, the WUAs have experienced significant changes in their governance, from the hierarchical, community-based network and provider-based network. The participatory management policy has limited state involvement in the governance of the WUAs, a condition which is termed 'absence of legislation'. In this condition, the farmers' community has considerable freedom to guide the WUA and shape its governance. The assessment of contemporary governance (*Swakelola* and *Lelang*) of WUAs shows that the current government has improved farm infrastructure in the tertiary irrigation system. Also, the current governance makes it possible for WUAs to provide sustainable funds for modernization and maintenance of irrigation networks without relying on outside actors such as the government, NGOs or donor organizations. Land productivity under *Swakelola* and *Lelang* is potentially higher compared to other areas. However, the scope of this study is limited to providing a nuanced explanation of whether WUA governance affects land productivity. Finally, insight from this study is useful for understanding the evolution of WUA governance and provides a unique form of governance.

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