The Co-Production and Sustainability Policies: Multi- Case Study in Water Management Policies in Thailand

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Abstract

Co-production and sustainability are intertwined concepts, especially in water management. Co-production is a powerful tool for promoting sustainability by fostering collaboration between government representatives and community members to organize public services professionally. This study aimed to 1) comprehensively examine co-production in water management in Nan and Phayao Provinces and 2) investigate co-production models in policy formulation and implementation. It focuses on two case studies: Ban Tun Sub-district in Phayao Province and Rong Ngae Village in Nan Province, Thailand. This study adopted a qualitative research design, utilizing the methods of document analysis, in-depth interviews, and non-participatory observation. Data triangulation was employed to ensure data validity, and a semi-structured interview was utilized as the data collection tool. Content analysis and qualitative data analysis software were used to analyze the data. The findings revealed full co-production, influenced by norms and cultures, existing policies, and knowledge that collectively informed the relationships among the communities, stakeholders, and agencies working in the water management sector. The co-production model combined top-down and bottom-up policymaking, guided by Van Meter & Van Horn's implementation model, promoting stakeholder collaboration for sustainable water management. Recommendations included 1) expanding knowledge and capacity-building for stakeholders in water management, encompassing existing knowledge bases and new technologies, and 2) developing explicit guidelines and improving communication channels to promote co-production.

Keywords: Co-production, Sustainability policy, Water management, Nan Province, Phayao Province

Introduction

The issue of sustainable development has gained significant attention from international agencies in recent years, with the United Nations (UN) playing a central role in advancing this

agenda. The UN has established a set of Sustainable Development Goals (SDGs), which aim to achieve a sustainable future for all by addressing various economic, social, and environmental challenges facing the world today. Water resources are a critical global issue and have been incorporated as one of the SDGs, namely, the sixth goal: 'clean water and sanitation' (United Nations, n.d.). This goal aims to ensure universal access to clean water and sanitation and promote sustainable water management practices. In Thailand, the Thai Water Resources Master Plan (2018-2037) has been developed to guide the country's water resource management efforts over the next two decades. The plan outlines several key objectives, including ensuring that every village has access to sufficient clean water for consumption, maintaining a stable water supply for production purposes, reducing flood damage, maintaining water quality within established standards, and promoting sustainable water management through the participation of all relevant sectors (The Office of National Resources. (n.d.). By achieving these objectives, Thailand can significantly contribute to the attainment of the SDG related to water resources and support sustainable development efforts on a global scale.

Water resources in Thailand have been in crisis in many areas for a long time, with wide-ranging impacts on both economic and social dimensions. The problem can arise from issues with both drought and flooding. Drought and flooding may occur alternately every year, or both occur in a year. This is due first to problems of the geographical environment and second to problems caused by human actions (Kijne, 2003). Moreover, there are problems with access to water sources and water storage for consumption. Effectively managing water resources to ensure adequate availability for the populace in a given region constitutes a fundamental public service, as it is the government's responsibility to provide access to potable water for consumption and hygiene purposes. An ample water supply must also be made available to support agricultural activities. However, for effective water management, there is a need to focus on a citizen-centric approach (Tissamana & Amornsiripong, 2019). In Nan and Phayao Provinces specifically, there have been issues with water demand and supply balance and the impact of climate change on water resources (Khamsorn, 2019; Chuenchum, 2016) However, community-based water management and community collaboration in water resource management for sustainability are effective in the case study of the Royal Initiated Project in Thailand's southern region (Distanont, 2018). The principal issue that needs to be addressed is more community participation in water management. Increasing the level of community participation can improve the efficiency of government water management (Adams, 2006). This can be achieved through co-production, a collaborative process between government, civil society, and the private sector in which all stakeholders work together to define and solve problems related to water resources management (Armitage, 2011). Furthermore, prior research has demonstrated a significant interdependence between the concepts of sustainability and co-production. (Nuamchareon & Sattakorn, 2019)

To address these challenges, there is a need for co-production approaches to water management in Thailand. Co-production approaches involve engaging stakeholders and experts to jointly develop and implement water management policies considering all stakeholders' diverse needs and interests. By involving stakeholders in the water management

process, co-production can help to build trust and legitimacy, promote social learning, and improve policy responsiveness (Luyet, 2012). Co-production is a proposed framework for community-level water management at the policy level that can promote the effectiveness, efficiency, and success of administration by involving people and other sectors in the co-production of public services. This research aims to go beyond participation and empowerment by identifying a water management pattern or model and offering practical guidelines for communities, local governments, or other government agencies to use to create water management innovations. This can be achieved by using community mechanisms or public service users as participants to achieve sustainability in policy and management. This study is based on a multi-case approach that focuses on the practice of co-production and sustainability policy in water management by drawing lessons from successful projects in sustainable water management. It aims to study the relationship between co-production and sustainability policies. It provides guidelines for policy formulation and implementation in practice, with people as the co-producers of public services and the government organizations responsible for organizing. The study selected two cases with similar geographical and socio-economic contexts in Thailand: Community Water Management Group in Ban Tun subdistrict, Mueang District, Phayao Province (hereafter Ban Tun subdistrict), and Water Management in Ban Rong Ngae village, Woranakorn Subdistrict, Pua District, Nan Province (hereafter Ban Rong Ngae village). From the study of preliminary documents, the success of both case studies involved community involvement and policy-making processes, with the public or public service users being the key actors as displayed in the conceptual framework.

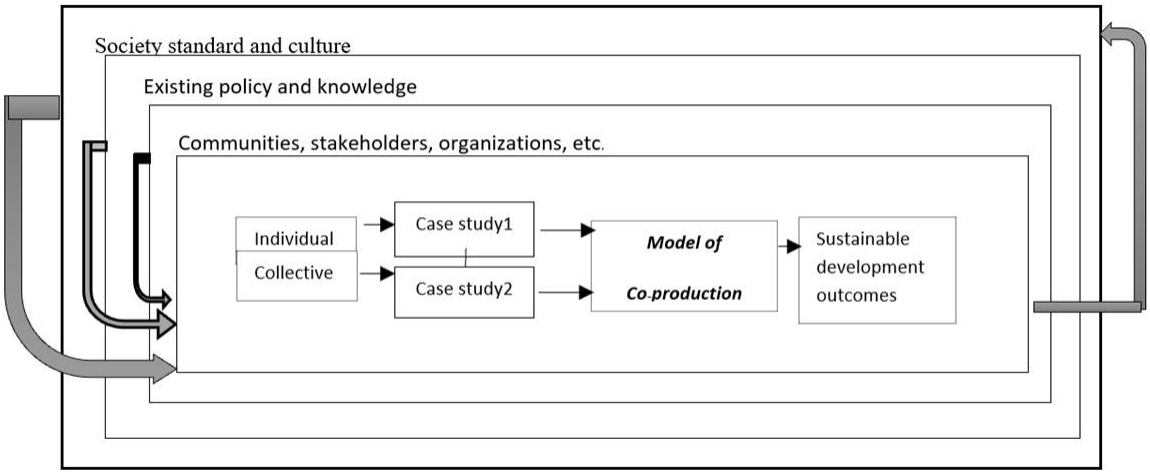

Figure 1 Conceptual Framework of the study adapted from a holistic conception of co-production through design.
Source: Wyborn et al. (2019)

Literature review

Co-production from the policy- making and public service perspective involves arranging numerous services. It is a long-term relationship between a professional service deliverer and a service user or other members of the community, who provide crucial resources to the service (Bovaird, 2007, p. 847). However, Brudney and England (1983, p.59) defined co-production according to the framework of public policy, which means a combination of activities, in which representatives of government agencies and citizens work closely to organize public services as part of a typical public service process based on professionalism. The co-production of service recipients or consumers of public services voluntarily to expand the quality or quantity of government services. Therefore, co-production is a form of public service where the government and citizens work together to produce public goods and services (Wyborn et al., 2019). The co-production forms are individual and collective groups of citizens (Brudney & England, 1983). In addition, roles and interactions between professional service providers or a service deliverer and a service user or other members of the communities can take several forms. For example, full co-production is where professional service deliverers and service users have a relationship in fully functioning co–delivery and co-designing public services (Boyle & Harris, 2009), as shown in Table 1.

In terms of public service delivery, there is no apparent separation between the production of public services and the consumption of the services in public policy and service delivery. Public service is related to activities or services organized by the government to meet the needs of the people (Bormanan, 2004, as cited in Boonrattanamaitri, 2015.) Public service is a product designed and manufactured by public policymakers and public service organizers in conjunction with professionals and consumed by the service user; it is a contemporary concept that tries to adjust the status of the service user alone to become a co-shaper, co-producer, and evaluator of that service (Radnor, 2014). Therefore, co-production represents a collaborative and participatory process in which professionals and service users/community jointly engage as co-planners during policy formulation and co-deliverers of services throughout policy implementation.

To comprehensively study co-production, it is crucial to consider policy formulation models like Top-down, Bottom-up, and combined policy-making models, as well as policy implementation models such as Pressman and Vildavsky's implementation model or Van Meter and Van Horn's implementation model. The top-down model involves policy decisions made at the highest government level and cascaded down, while the bottom-up model emphasizes local community and stakeholder involvement in shaping policies (Hill & Hupe, 2009). A combined policy-making model integrates both approaches, recognizing the importance of central guidance and local participation. These models provide frameworks for understanding policy development, governance levels, stakeholder involvement, and decision-making processes. The Van Meter and Van Horn model highlights factors influencing successful policy implementation, including clear standards, resource allocation, organizational characteristics, implementers' attitudes, effective communication, and socio-economic and political contexts. Addressing these factors improves policy implementation and

desired outcomes (Van Meter & Van Horn, 1975). Sustainable water management requires integration and collaboration among various sectors, including public, private, and community stakeholders. A comprehensive and holistic approach is needed to address the complexities of water management. This research focuses on co-production in policy formulation and implementation of water management through a multi-case study. The study investigates collaboration between the government, service users, and other stakeholders in water management. Key areas of concern include ensuring water supply, fair allocation, watershed conservation, flood management, and water quality (Maiklad, 2014).

Table 1 Users and professionals' roles in the design and delivery of services

		Responsibility for design of services		
		Professionals as sole service planner	**Professionals and service users/ community as co-planners**	**No professional input service planning**
Responsibility for delivery of services	**Professionals as sole service deliverers**	Traditional professional service provision	Professional service provision but users/ communities in planning and design	Professionals as sole service deliverers
	Professional and users/ communities as co-deliverers	User co-delivery of professionally designed services	**FULL CO-PRODUCTION**	User/ community delivery of services with little formal/ professional
	Users/ Communities as sole deliverers	User/ community delivery of professionally planned services	User/ community delivery of co-planned or co-designed services	Self-organized community provision.

Source: Boviard, 2006 (cited in Boyle & Harris, 2009).

Methodology

This study investigates the co-production model, policy formulation, and policy implementation in sustainable water management in a multi-case study and it explores the co-production factors that affect the sustainability of the policy for sustainable development in the field of the two case studies. The case selection adopts two of Thailand's best practices in community water management. This qualitative research uses in-depth interview, and non-participant observation techniques, and applies triangulation to confirm and assess the data's accuracy. The interviews in the research were semi-structured, and the information obtained from the interviews was transcribed in text form for further content analysis using NVivo. Moreover, the research method was introduced with the following steps:

Participants

The key informants were selected by purposive sampling and using the snowballing method. The researcher specifically chose to participate directly in water management in the community, such as the village water management committee, community leaders, villagers, etc., by allowing the first key informant to guide the selection of the next informants. The researcher divided the study into three groups, namely, the public administrators, the group of practitioners and public service users, and the group of other public service contributors. Twelve participants were invited to in-depth interviews: six for the Ban Rong Ngae village case and another six informants for the Ban Tun sub-district case.

Data collection and research tool

The data collection was divided into two phases. First, the researcher studied secondary data from documents on case studies in each aspect of the research. Next, in-depth interviews and group discussions were conducted, while non-participant observations were carried out when the villagers were implementing some water management services. The data collection was facilitated using a semi-structured interview form as the primary tool.

Data Analysis

Data analysis begins with typology and taxonomy, followed by content analysis and inductive analysis to determine the co-production pattern in formulating policies for implementing sustainability policies in the water management of the two case studies and the factors of co-production that affect the sustainability of the policy for sustainable development in water management. NVivo software was used to analyze qualitative data.

Results and discussion

1. The phenomenon of the co-production approach in water management in the Nan and Phayao Provinces of Thailand

Thailand has three levels of administrative services: central, provincial, and local. It was found that the co-production model in public policy formulation and public policy implementation in the multi- case study occurred at all three levels. The central government, directly responsible for producing public services, played a role in public policy formulation. Government agencies within the scope of the central administration functioned as producers

and policymakers. They were primarily responsible for seeking solutions to problems, from deciding on policy options to the policy approval and promulgation process. Therefore, the central government is responsible for policy matters, such as policies, that is, the water management master plans. In the operational process, the provincial and local administrative organizations must function as public service providers or professional service deliverer per the rules of authorization and decentralization of the Thai government administration. However, co-production is a revolutionary change in the provision of public services by increasing the role of the service recipients or the public to function as co-designers for policy-setting and jointly serving the public or implementing policies. From these two case studies, the researcher investigated the roles and duties of the service recipients, in this case, water users. According to the study, the design and planning process, which is the process of making public policy, also occurred at the community level. In this case, the policy refers to setting rules and regulations for community water management. Moreover, in the policy implementation process, the scope of policy implementation in community water management involves implementing the water management regulations and rules to achieve the intended objectives. The pattern of co-production in water management policy formulation and policy implementation showed the effects of full co-production resulting from the norms and cultures and existing policies and the knowledge that built up the relationship among communities, stakeholders, and agencies working with water management.

1.1 Water management in Ban Rong Ngae Village

The Ban Rong Ngae community represents a traditional Tai Lue rural settlement that strong emphasizes cultural and traditional preservation. The community is characterized by a public with a shared sense of kinship, as evidenced by the prevalence of the "Netthip" surname, which is common among many families and often indicates a direct or distant familial relationship with common ancestors. The water management regulations in Ban Rong Ngae reflect a commitment to preserving these long-standing traditions, which have been passed down through generations. Despite the changing times, the community has endeavored to update these regulations to suit the current era, while maintaining its cultural heritage. As such, Ban Rong Ngae serves as an exemplary model for the preservation of traditional culture and community values, as shown in the excerpt:

> "*The community possesses a unique and distinctive culture, which is leveraged to govern and manage the village. Villagers are encouraged to participate in various_activities highlighting the community's religion, culture, language, dress, and cuisine. The community successfully integrated old cultural practices related to water management, such as appointing a Dame manager to oversee the check dam on behalf of the villagers. The villagers appoint this manager themselves, indicating an elevated level of trust and cooperation within the community*" (*25 November 2020)*

The Ban Rong Ngae community has successfully implemented a sustainable water management system based on the principles of Mangrai Customary Law, a traditional legal system established by King Mangrai. This system, which has existed for over 1,400 years, is integral to the community's cultural and historical traditions. By adhering to these guidelines, such as community participation and collective efforts during the rice farming season, the community ensures a reliable water supply for agriculture. Their commitment to sustainable water management serves as a model for other communities and highlights the importance of community investment in maintaining and improving the water management system. The Ban Rong Ngae community's success demonstrates the efficacy of their long-standing practices in achieving sustainable water management. This is reflected in the quotation,

> *"Every year, it seems that dredging has to be undertaken by the community for cooperation, without being hired. There is no budget; the guests and owners do it themselves, and all water users must come together*." *(November 25, 2020).*

The Ban Rong Ngae community's commitment to collaborative efforts and sense of ownership towards their water management system has led to a strong and sustainable system that has been in place for generations. They undertake maintenance activities, promoting a shared sense of responsibility and collective action among community members. The Ban Rong Ngae community's active participation in surveying and defining water management problems is crucial to their sustainable water management practices. Their involvement allows them to contribute their knowledge and experience towards developing a long-term plan for the sustainable use of their water resources. By participating in this process, the community's perspectives and priorities are considered, leading to a more effective and sustainable water management system that adapts to changing environmental conditions and recent technologies. This collaborative approach highlights the community's commitment to preserving their traditional water management practices while ensuring the sustainable management of their water resources for future generations.

Forming a water management plan for the Ban Rong Ngae community involves various stakeholders, including the village headmen, villagers, and local administrative organizations. The plan is prepared through the village community process, which is organized monthly, and reflects the needs and priorities of the community while addressing the challenges and opportunities in managing their water resources. The community's collaboration with the local administrative organization allows for leveraging resources and expertise to develop a comprehensive and sustainable water management plan. The monthly community meetings provide a forum for discussing and addressing various community issues, including water management, and allow flexibility in responding to emerging issues. The community-led process takes a holistic approach to addressing challenges and ensures that solutions benefit the community. It is testified by the quote hereafter.

> *"After receiving the policy from the district, came to hold a meeting of the village community" (24 November 2020).*

It suggests that the Ban Rong Ngae community is proactive in responding to policies and directives from the district government. The community is engaged in regular communication and consultation with local authorities and is willing to come together to discuss critical issues affecting the village. This approach to governance reflects the community's commitment to participation and collaboration in decision-making processes. By engaging with local authorities and holding regular meetings, the community can ensure their voices are heard, and their needs are considered when policies are developed and implemented.

The Ban Rong Ngae community practices a collaborative approach to water management, with the joint determination of water user rules through community meetings. They adhere to traditional principles of water management outlined in the Mangrai Customary law while recognizing the need to adapt to changing socio-economic conditions. The community also produces guidelines for water management through consensus on standard rules during drought or other water-related issues. While direct stakeholder involvement in policymaking appears to be limited and top-down policy formulation is prevalent, the community participates in discussions to reach a consensus on standard water management rules during drought or other water-related issues. Other sectors, such as local government organizations, public agencies, volunteers, the private sector, universities, and non-profit organizations, support the community's efforts to manage water resources sustainably. The findings highlight the importance of community involvement and balancing traditional practices with modern realities in developing practical and sustainable water management strategies.

1.2 Water management in Ban Tun Subdistrict

In community economic development, cultural capital is vital in strengthening the local economy. Ban Tun sub-district community has effectively utilized cultural capital and local wisdom to improve their economic well-being in various ways. One of the most visible examples of cultural capital is the integration of the production and service groups in Ban Bua Village in Ban Tun sub-district. Integration is the foundation of the community's problem-solving process, mainly when issues that affect the community arise. This underscores the significance of cultural capital in community development, as it enables community members to come together and pool their resources to address common challenges, thus fostering social and economic resilience.

The Ban Tun Sub-district communities have a participatory and culturally embedded approach to resource management, holistically addressing water, forest, and soil resources. Their efforts are seen as a successful model for mountain watershed management, with conservation practices contributing to sustainable development. The watershed management of Ban Tun Sub-district, Muang District, Phayao Province, is considered a successful model for mountain watershed management. In Ban Tun, the water source originates from the top of Doi Luang, flowing through the village's lowland farming areas before eventually reaching Kwan Phayao, a large freshwater lake in the northern region. The community's commitment to preserving natural resources is deeply ingrained in their way of life, and they work collectively

to identify and resolve issues for the benefit of all members. This participatory and culturally rooted approach is vital for sustainable resource management.

The Ban Tun community's water management system is based on the traditional knowledge and practices passed down from generations. Before the water flows into Kwan Phayao, the villagers use a sophisticated system of mine canals and channels to divert the water into the rice fields. The water is stored in non-permanent sluices built using stones or sandbags, which can be easily removed to release the water when needed. During the harvest season, the villagers of Ban Tun utilize the knowledge base of their water management system to gradually bring water out of the rice fields through lower channels. This system has been passed down from generation to generation and is still preserved and used as a model for water management in the community. The villagers understand the importance of maintaining their water resources, not just for agricultural purposes but also for their daily lives. By managing the mine canal system and using Tang Na, a conveyor channel, they can divert water into the rice fields efficiently. The Ban Tun community's sustainable approach towards water management involves preserving their traditional knowledge and practices and creating innovative solutions to manage water resources. The use of non-permanent sluices and the "Shark's Mouth" water divider are examples of such innovations. The Shark's Mouth water divider, in particular, is a creative solution that addresses the issue of water distribution to areas that are hard to reach. By experimenting with stacking stones, the community was able to develop a water distribution system that could serve more than 1,500 rai of agricultural land and benefit more than a hundred farmers. This community innovation highlights its ingenuity in adapting to changing circumstances and using local resources to solve problems.

Figure 1 The Shark's Mouth water divider, Folk Wisdom Innovation in Water Management by the Ban Tun Sub-District Community

Establishing water user groups at various levels, such as the ditch/pipe, canal, and canal network levels, highlights the community's effort to ensure effective water management. These groups are responsible for developing and implementing rules and regulations for water sharing, including criteria for collecting contributions from members. Water users must pay a fee of ten baht per rai per season and twenty baht per rai in the dry season or contribute rice to the group. The funds collected are used for various purposes, including maintenance of the water management infrastructure, and providing financial assistance to members in need. Currently, the group has accumulated around 6,000 baht in its funds, demonstrating its financial sustainability and ability to support the community's needs.

The community actively participates in policy formulation for water management, contributing to the establishment of common rules and consensus-building in addressing water-related challenges. Their involvement enhances the contextual appropriateness of policies and fosters inclusive governance, transparency, and accountability. Other sectors, such as local government, public agencies, volunteers, the private sector, universities, and NGOs, also play vital roles in supporting sustainable water management. They provide technical expertise, financial resources, enforcement, monitoring, education, research, and capacity building. The collective engagement of these sectors ensures a comprehensive and integrated approach to water management, securing the long-term sustainability of water resources.

2. Co-production model in policy formulation and implementation in community water management from multi-case study.

The limited policies and knowledge bases on water management in community agriculture are primarily influenced by the social and cultural norms of the two case studies. However, with changing physical and social environments and technology integration, water management policies have become more complex and involve multiple stakeholders and agencies. Hence, it is crucial to incorporate the community's traditional knowledge and practices while exploring innovative and sustainable approaches to water management. Collaborative efforts between different sectors, such as local government organizations, public agencies, volunteers, the private sector, universities, and NGOs, can provide valuable insights and support in addressing communities' current and future water management challenges. Jensantikul (2022) highlighted the key features of civic education promoting participation in social policy-making processes and encouraging collaboration between the government and NGOs. They work together to improve the quality and quantity of services.

To ensure the success of the co-production of water management policies, it is important to consider the relationship roles between the villagers as service recipients and the government agencies responsible for providing water management services. Collaboration and participation between these two groups are necessary to achieve effective water management in the community. Government agencies should also consider each community's unique social and cultural contexts when developing policies and implementing them. It is essential to involve the community in the decision-making process, as they possess valuable knowledge and experience that can be used to create sustainable water management policies. Additionally,

land development and utilization must be considered in parallel with forestry action, as these factors directly impact the community's water management practices. Overall, successful water management policies require collaboration and participation from all stakeholders involved, including the government, communities, and other related agencies. In the same manner, key success factors in water management for sustainability require self-reliance and self-efficiency of the population, democratic participation, community engagement, a collaborative approach and partnership, and a leadership and contingency approach (Nuamchareon & Sattakorn, 2019). The government agencies directly responsible for the case studies are local Provincial government units consisting of provincial governors, district chiefs, village headmen, Royal Irrigation Department, Marine Department, Royal Forest Department, etc. Some agencies have a direct mission in water management in Thailand, for instance, Hydro Informatics Institute (Public Organization) and Utokapat Foundation.

The nature of community participation or co-production of water management is multifaceted. The stakeholders who participate in production have different roles and characteristics of participation, such as providing support resources, labor, granting subsidies, giving materials, or providing knowledge. For instance, the villagers can contribute their knowledge and experience in traditional water management techniques, while public agencies can provide technical expertise and equipment for modern water management practices. In addition, non-profit organizations (NGOs) and universities can assist in research, education, and capacity building. The private sector can also support community-based water management initiatives through corporate social responsibility (CSR) programs or collaboration with local communities. Therefore, successful co-production of water management policies requires a collaborative effort of all stakeholders, including the community, government agencies, NGOs, universities, and the private sector.

The knowledge and techniques of water management in the community have been passed down through generations and are deeply rooted in the cultural and social practices of the community. For instance, the development of Mangrai Laws, formulated based on the principles of water management in the Ban Rong Ngae community, has been instrumental in guiding other communities in managing their water resources sustainably. While the community-based water management system is primarily based on the traditional knowledge and practical know-how passed down from generation to generation, the complexity of modern water management requires additional knowledge and support from external agencies. Co-production is thus a contemporary practice that considers a participatory process in the design and planning of public services (Jensantikul, 2022). Large-scale infrastructure such as reservoirs and dams often require specialized technical knowledge and equipment that may not be available within the community. In such cases, collaboration between the community and external agencies is necessary to ensure effective water management. The community needs training and knowledge transfer from specialized agencies to develop the capacity to manage more complex systems. This highlights the importance of a multi-stakeholder approach and the need for collaboration and cooperation between different actors for sustainable water management.

To discuss further, the full co-production of villagers and communities in the case studies played a key participatory role in providing government services as the co-production model in formulating and implementing water management policy. Full co-production represents the power of individuals and communities; as Santhitiwanich (2015) mentioned, local public services that citizens as beneficiaries of the services have voluntarily participated in the service delivery, which has developed into a long-term relationship that leads to a more effective public service provision than what the government did alone. Full co-production needed effective citizenship and individual empowerment in terms of economics, politics, and the social rights of citizens; without these conditions, community members would not be able to co-produce the services. Full co-production promoted the social growth of the community both economically and socially. The concept of full co-production went beyond service recipients's public participation or collaboration. Co-production supports the principle of equal partnership. It changes the dynamics between civil servants and ordinary people whereby the scope of the work is not divided into clear categories. It also brings together knowledge and skills from learning experiences. As such, co-production has the potential to transform types of public service into promoting equal participation between public agencies, private organizations, civil societies, and the communities; in addition, co-production in public services is also a factor in ensuring sustainability. Furthermore, co-production also results in better operating results, prevents problems, and better utilizes rare resources. It also helps the growth of the social networks that support it (Boyle & Harris, 2009).

However, the study's results showed that the co-production in the multi-case study was established at the beginning stage of development, leading to full co-production. In the contexts of the communities of the case studies, they focused on self-reliance; in the meantime, they attracted the participation of all sectors to collaborate with the communities. Nonetheless, limitations in various aspects, such as human resources and specific state laws may hinder the co-production results; the collaboration may still need to be fully formed as an equal partner. Both case studies showed the potential for the community to be developed into equal partnerships, for example, the development of community gathering into water user organizations. This would enable the community to join the upper legal water management boards, that is, provincial ones. This will change the form of water management public service. Being a legal organization offered enough potential to join the management of higher levels of water management as a representative. In the community context, the community can demonstrate the potential to be the key factor that will attract organizations to participate in the production of community water management.

The roles and duties of various public agencies corresponded to the national strategies and public policies on water management. Similarly, the roles and duties of the people who participated in co-producing public services in water management were about these strategies and policies. Community water management tasks can be broken down into sub-issues based on the activities and tasks in each area. Each party performed within the scope of their authority but in a collaborative manner. Their roles corresponded to Boyle and Harris' (2009)

explanation that co-production is neither consultation nor volunteering or individual budgets; instead, co-production promotes equal participation.

Table 2 Co-production model in water management in policy formulation and implementation

		Policy formulation	Policy implementation
Full coproduction	**Professionals and service users/ community as co-planners**	combined policy-making models - Central Guidance and Direction and Local Contextualization -Integrated Decision-Making -Policy Dialogue and Deliberation -Capacity Building and Training	
	Professional and users/ communities as co-deliverers		The policy implementation model developed by Van Meter & Van Horn (1975) - Standards and targets of policies / measures and policy objectives -Resources -Characteristics of the implementing organizations -The attitude of the implementers -Communication between relevant organizations and implementation activities -The social environment, economic and political

The study reveals that co-production in policy formulation in sustainable water management requires a combined policy-making approach characterizing central guidance and direction and local contextualization, integrated decision-making, policy dialogue and deliberation, capacity building, and training for effective policy implementation. This approach emphasizes collaboration among diverse stakeholders, including the community, government agencies, NGOs, universities, and the private sector. By adopting a multi-stakeholder approach,

the mixed approach enhances the sustainability and success of water management policies. Similarly, the Van Meter and Van Horn (1975) policy implementation model aligns with service deliverers' co-production by emphasizing setting policy standards, considering resources, understanding implementing organizations, recognizing implementers' attitudes, fostering communication, and acknowledging the social, economic, and political context. This model provides a framework to improve water management policy implementation, promoting collaboration among stakeholders for sustainability.

Conclusion and recommendations

In summary, full co-production refers to a collaborative process where professionals and service users/community actively participate as co-planners and co-deliverers of services throughout the policy formulation and implementation. The co-production model integrates top-down and bottom-up policymaking approaches in the context of water management in Nan and Phayao Provinces. This means that while there is central guidance and direction from higher-level authorities, it is combined with the involvement of local communities, NGOs, and other stakeholders. The aim is to create policies that reflect the diverse needs and perspectives of the community and ensure effective implementation on the ground. By adopting a combined policy-making approach and drawing on the policy implementation model proposed by Van Meter & Van Horn (1975), the co-production model in these provinces aims to enhance collaboration, coordination, and engagement among stakeholders for more sustainable and successful water management outcomes. The existing policy and knowledge base of a multi-case water management study in Ban Rong Ngae village and in Ban Tun sub-district were formed from social and cultural norms. The existing policies and knowledge bases are characteristic of the water rules that the communities adhere to. However, when the physical and social environment changes, the community needs help managing alone. Policies in water management occur on both national and international levels. Therefore, there was a need for co-production, which would provide a move away from new practices or services. This gave rise to new groups of stakeholders. Co-production takes place in policy formulation and implementation processes, and the nature of the co-production varies according to different activities.

To optimize stakeholder engagement, it is imperative to foster an environment that encourages the involvement of all groups and individuals, thereby empowering them to collaborate equally. This necessitates a participatory approach initiated from the outset and consistently maintained throughout the entire process, in line with established objectives, and characterized by inclusivity. Recommendations for policymakers and implementers, including public and private agencies, civil societies, communities, and individuals, are 1) to expand knowledge and capacity-building for stakeholders in water management, encompassing existing knowledge bases and new technologies. 2) Promoting co-production requires the development of explicit guidelines and improved communication channels, clarifying roles and responsibilities, and facilitating effective collaboration and better communication. These efforts contribute to robust, sustainable water management policies that address stakeholder

needs better. Future research should focus on deepening the understanding of the interplay between co-production and sustainable development in water management and exploring factors that promote sustainable outcomes.

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