

Revealing the Economic Challenges on Adaptive Sacred Water Resource Management in Balinese Community

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Abstrak

Studi ini membahas tantangan ekonomi yang dihadapi masyarakat lokal dalam mengelola sumber air, khususnya sumber air untuk kebutuhan ritual atau sakral, dengan fokus pada studi kasus di wilayah SARBAGITA, Bali. Penelitian ini menggunakan analisis kualitatif untuk menyelidiki interpretasi masyarakat Bali terhadap pengelolaan air adaptif pada sumber daya air suci. Dari analisis yang dilakukan, terlihat bahwa tantangan ekonomi pengelolaan sumber air suci masyarakat Bali dipengaruhi oleh ketidaksesuaian sistem tata kelola air dan kekuatan ekonomi industri pariwisata, yang keduanya saling berinteraksi sehingga berdampak pada menurunnya kualitas dan kuantitas sumber daya air, di sisi lain masyarakat Bali sangat bergantung pada air untuk praktik keagamaan. Pengambilan keputusan oleh perwakilan adat diperlukan karena pengelolaan adaptif diwujudkan dalam diri masyarakat adat melalui kearifan lokal. Memahami pengetahuan dan nilai-nilai air tradisional sangat penting untuk mengatasi tantangan ekonomi guna mencapai pengelolaan sumber daya air yang efektif.

Kata kunci: tantangan ekonomi; pengetahuan tradisional; pengelolaan adaptif; sumber air suci

Abstract

This study discusses the economic challenges that local communities face when managing water sources with ritual or sacred purposes, with a focus on the Balinese case study, especially in the SARBAGITA area. This study uses qualitative analysis to investigate the Balinese interpretation of adaptive water management of sacred water resources. According to the results of the analysis, the economic challenges of managing sacred water sources in the Balinese community are influenced by unsuitable governance systems and the economic power of the tourism industry, both of which interact to affect declining water resource quantity and quality. Meanwhile, the Balinese community relies heavily on water for religious practices. Decision-making by customary representatives is required because adaptive management is manifested in indigenous peoples through local wisdom. Understanding traditional water knowledge and values is critical for overcoming economic challenges and accomplishing effective water resource management.

Keywords: economic challenge; traditional knowledge; adaptive management; sacred water resource

Introduction

Sacred water sources are revered across various cultures and religions, often serving as a focal point for religious and spiritual practices. Wijzen (2022) highlighted the role of these sources in promoting sustainable water management and the harmonious coexistence of humans and water. These water sources are frequently associated with sacred stones, trees, ponds, lakes, and springs. Water is a natural symbol of purification, and religious people have used it to remove uncleanness, whether ritually or morally. Production and consumption have become increasingly complex in the modern world. This level of complexity requires a large amount of water to function. This causes water scarcity due to a mismatch between supply and

demand for water and has become a common problem in urban society (Luo et al., 2020; Pandey, 2021). Markolf et al. (2018) then stated that in order to build sustainability, actors, social networks, and institutions must increase their adaptive capacity. In essence, the social component is required as the core of adaptive management of complex systems, in addition to technological innovation (Arnold et al., 2017).

In the context of contemporary Bali, the dynamics of water utilization and management affect the tourism industry, which is at the center of socioeconomic and cultural changes that in turn have an impact on water use in the Balinese Hindu community (Wright, 2018). Wijayanti et al. (2020) mentioned that Denpasar's ricefield lands dropped by 230,6 hectares between 2018

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and 2019. According to that data, the current and past ricefields that remained in Denpasar in 2019 were around 1.939,4 hectares, while the entire ricefield area in 2018 was up to 2.170 hectares. Ricefields shrank from 2.170 hectares to 1.939,4 hectares in 2018 as a result of an inexorable agricultural land-use shift in Denpasar, this phenomenon is closely related to traditional water management known as *subak*. According to Lombard (2005), there is a shift in rituals from the cosmic framework and the society that supports it, to become just a spectacle that has completely removed its sacredness, in order to satisfy the expectations of tourists who visit because they are attracted to the complex culture of Bali, as well as to earn money.

Furthermore, tourism consumes 65 percent of the total clean water consumption, and the majority of the water supply to support the tourism industry is extracted from groundwater (Cole and Browne, 2015). Prior to the COVID-19 outbreak, Bali suffered from overtourism. Overtourism contributes to water scarcity, environmental degradation, sanitation issues, overcrowding, loss of authenticity, and rising living costs. The influx of 6 million international and domestic tourists each year has placed a significant strain on the island's limited resources (Saraswaty et al., 2022). Tourism accounts for 80% of Bali's GDP, with non-Balinese investors accounting for approximately 85% (Cole & Browne, 2015).

The management of water, especially groundwater, as well as patterns of consumption, simultaneously increase the vulnerability of the Balinese Hindu community for the future. This vulnerability arises because management is related to the local governance of water resources and several processes that shape the socio-economic relations of the Balinese Hindu community with groundwater, namely ritual practices, fulfilling their basic needs, and irrigation systems (*subak*). All three maintain a complex relationship between land, water, and local peoples. It can be said that from the rapid development of tourism, Bali is a local manifestation of global challenges (Wright, 2018) with trade-off in the use of groundwater for ritual practices, irrigation, tourism and meeting daily water needs.

The trade-off in trying to obtain enough water has resulted in efforts to turn water into

an economic commodity (Buchs et al., 2020). Meanwhile, according to Principle 4 of The Dublin Principles, water is an economic good with critical social aspects for achieving efficient and equitable use, as well as encouraging the conservation and protection of water resources. Water allocation schemes frequently distribute resources based on historical spiritual rights, relational aspects, and incomplete data. As for the Balinese people, water temples play an important role in securing water resources (Cole and Browne, 2015). The rapid development of the tourism industry and concerns about the legislative processes governing spatial planning in Bali have impacted water resources, especially sacred water resources.

According to Ghosal and Ruj (2022), community-managed water systems show that empowering communities in water management leads to socioeconomic well-being, aiding in achieving sustainable development goals. The dynamics of the problems arising from the adaptive and sustainable utilization and management of sacred water sources in the urban community of Denpasar City and its surroundings have received little attention. There is an urgent need for research on the socio-economic aspects of the utilization and adaptive management of sacred water sources based on local wisdom for the sustainability of sacred water. This study then highlights that the Balinese Hindu's understanding of traditional water knowledge and values is critical to overcoming economic challenges to accomplish effective water resource management.

Theoretical Framework

Adaptive Management on Groundwater Resources

Adaptive management has received attention as a method for dealing with the complexity and uncertainty inherent in resource management processes since the 1970s. This concept has been specifically used in the field of water resource management. Adaptive management is a resource management approach that assumes that resource management takes place in the face of incomplete knowledge and unpredictable social and ecological interactions (Akamani, 2016).

According to Thomann et al. (2022), adaptive management is a learning-by-doing process for managing complex systems based on existing governance. The process of experimenting with, monitoring, and adapting management

strategies in response to new information and changing conditions is known as adaptive management. Structured decision-making in an adaptive management process provides a systematic and transparent process for identifying and evaluating alternative policies. Adaptive management begins with activities that align and support predetermined governance objectives (Murphy & Weiland, 2014).

The literature on groundwater resources has increasingly highlighted the nature of institutions that impede successful adaptive management, such as the absence of enabling regulations and public policies, as well as inadequate consideration of various socioeconomic values in adaptive management processes (Akamani, 2016). Previous studies on groundwater resource management have tended to focus on processes and institutions for regulating the use of water resources, whereas adaptive management has focused on the continuous learning and adaptation of the implementation of governance points accompanied by monitoring and evaluation (Gleeson et al., 2020; Thomann et al., 2020).

Given the inherently unpredictable and uncertain nature of interactions between human activities and ecosystems, adaptive management, which evolved from resilience theory, is centered on learning models. However, these two new strategies share the goal of establishing a self-correction function in natural resource management systems for long-term use in complex environments. Both frameworks are still evolving to improve the translation of research/theory into practice, owing to the growing importance of combining uncertainty and predictability in water governance (Lee et al., 2022).

The deliberative and iterative phases are involved in the adaptive management of sacred water resources. The deliberation phase includes key elements such as stakeholder engagement, goal setting, designing management alternatives monitoring protocols. The iterative phase link together these key elements through decision-making processes, follow-up monitoring, and assessing uncertainty and management effectiveness (Thomann et al., 2020).

Local Wisdom, Adaptive Sacred Water Management and Economics

Curran and Mascher (2016) investigated jurisdictions in New South Wales (NSW,

Australia) and British Columbia (BC, Canada) that were reforming their water law regimes to explicitly include adaptive management. In the context of changing hydrology around the world, many national and subnational governments will implement similar reforms in the coming decades, and they may look to the experiences of NSW and BC to refine their own water law reform approaches.

The PIKUL Association (*Perkumpulan PIKUL & Knowledge Sector Initiative*, 2016) discovered that most groundwater resource management departed from or was in symbiosis with sustainable local traditions in the East Nusa Tenggara. In particular, traditional values, systems, and institutions for local resource control and management can be adopted in the institutionalization of groundwater resource management. Furthermore, the suitability of community-acceptable technology, both technically and financially, is an important factor in ensuring the sustainability of community-based resource management. Management of customary institutions responsible for water resource sustainability based on local knowledge/wisdom requires special attention.

Traditional '*qanat*' systems in the Middle East and North Africa, also known as '*khetaras*' in Morocco, '*foggara*' in Algeria, '*karez*' in Central Asia, '*afraj*' in Oman (Molle & Closas, 2020) and the '*subak*' system in Bali (Kohdrata & Sutrisna, 2011) are notable examples of community management involving groundwater. According to Varady et al. (2012), groundwater resource governance institutions must be able to adapt to uncertainty and survive in a social-ecological system.

The managerial discourse and popular consciousness in Bali, social and economic development, remost rhetorically identified with cultural continuity (Warren, 1993). Water resources have never been considered a resource that includes "open access" for Balinese Hindus, until now water has been considered a blessing from the gods (Hauser-Schäublin, 2011). In Balinese Hindu society, the management of groundwater utilization does not focus on technology or infrastructure innovation but on institutions in the form of customary laws (*awig-awig*), which focus on communal welfare and are then carried out by local people in adaptive sacred water management practices.

Adaptive sacred water management based on local wisdom, particularly from informal

Balinese customary institutions, tends to be autonomous based on human relations with physical and non-physical environments (Wright, 2018). This condition can cause cognitive dissonance in water management from legal institutions that emphasize the absolute conceptualization of water as an economic commodity, particularly in areas where water is still thought to have cultural value (Gondo et al., 2019).

From an economic standpoint, optimal and rational management is defined as users first allocating water to the most valuable uses and then to the least valuable uses (Dawoud, 2020). In the context of water use and management, rationality refers to the assumption that individuals make decisions that are most aligned with their personal preferences and goals and that they do so rationally and calculatedly (Amadae, 2021). However, there is growing evidence that many economic actors involved in water management, such as farmers, households, and water managers, do not always act rationally (David & Ploenger, 2014).

For the Balinese Hindu community, optimization and rationality regarding the human mind and physique by using sacred water for the benefit of ritual practice (Nastiti et al., 2022). In another way, Saraswati et al. (2023) mentioned that economic development causes the commodifying of sacred springs. The commodifying practice is a complex political and socioeconomic negotiation process. Power dynamics between decision-making actors such as local communities, government agencies, and private companies shape the outcomes of commodification (Latorre, Farrell, Martinez-Alier, 2015). More powerful actors are more likely to wield a more significant influence on expectations and decision-making processes, which can result in an unequal distribution of outcomes (Eferemo, 2016).

Furthermore, efforts to conserve sacred water sources are carried out daily and on certain days by community groups as a form of gratitude for the blessings bestowed by God on the entire universe. Other utilities are then carried out in the form of consumption, irrigation, and cleansing. From an economic perspective, the continuity of ritual ceremonies is an illustration of the rationality of the Balinese Hindu community in living their lives to achieve their version of well-being.

Methods

To achieve the research objective, this study used a qualitative approach with a case study design. For that, several methods were applied: collecting and analyzing relevant documents, in-depth interviews, and non-participant observations with residents of villages related to sacred water resource usage. The strength of the qualitative approach lies in its in-depth understanding of various people's points of view as well as the social and cultural contexts (Yng and Kaoteera 2021; Myers 2016), while also enabling researchers to delve into the dynamics of the sacred spring management activities of urban and suburban communities. The case study is used to explain the social and cultural changes that have occurred in the last decade with the influence of Bali's tourism development.

Research was conducted with several parties involved in the management and utilization of the sacred springs in the Denpasar City area and its surroundings (the border of Denpasar City with Badung and Gianyar Regency), including high priests, stakeholders, village heads, and the local village community. The existence of the sacred spring was revealed to be very important as a supplier of raw materials for sacred water (*tirta*) in Balinese Hindu ritual practices.

To collect and analyze qualitative data, a case study approach is used. According to Coombs (2022), a case study is a research method that aims to gain a comprehensive understanding of a current topic or phenomenon within a specific system. Case study research involves conducting in-depth investigations of individuals, groups, or events to acquire insight into real-life phenomena. It is commonly utilized in the social sciences and humanities to analyze complex issues and provide insights into unique situations. A case study may include several sources of data such as interviews, observations, and documents. Case study research aims to obtain a thorough understanding of the subject and develop novel theories or insights. In this study, the location-determination technique was chosen for this purpose. This study focuses on the use and management of sacred water resources by the people of Denpasar City and its surrounding areas. The sacred spring in a traditional village is the subject of this research, which is an institution with elements within it, including actors, sacred water managers, and the sustainability of sacred water.

Two data sources were used to investigate the phenomenon of sacred water use in Denpasar City and its surroundings: primary data collected directly through field studies by researchers, and secondary data collected through desk studies from reliable sources. Primary data were gathered by observing, photographing, and conducting semi-structured qualitative interviews with local communities about the use, management, and management of sacred water in traditional villages in Denpasar City and its environments. Furthermore, references in the form of literature containing previous studies, theories, research, government documents, customary law documents (*Balinese awig-awig*) from traditional villages, and archived photographs containing information and research on sacred springs in Bali were used as secondary data sources.

Result

Springs are natural groundwater discharge points that play an important role in groundwater circulation (Birk et al., 2004; Labat et al., 2002; Liu et al., 2018). Other discharges, such as groundwater uptake by wells, have a direct impact on the spring outflow in this hydrogeological unit. Consequently, if groundwater is extracted from a spring field, the outflow from the spring will be reduced or even halted. The demand for water is increasing owing to rapid population growth and industrial development. Excessive groundwater extraction is common in arid areas, where groundwater is the primary source of water (Luo et al., 2020; Wu & Xu, 2005). These factors influence indigenous

peoples' relationships with water sources (lakes, rivers, springs, and seas), which are explained in a variety of contexts, emphasizing reciprocity, interdependence, respectful behavior, and the existence of water vitality (Parsons & Fisher, 2020).

Table 1 shows the informants' characteristics. High priest from Kesiman Village (sacred water source which named *Pura Beji Musen*) Denpasar, and Gianyar (sacred water source: *Pura Beji Pancoran Solas*, Guwang Village), also one traditional leader (elder) who lives in Denpasar were the key informants in this study. The informants were chosen based on their involvement in interpreting the presence and use of sacred water as *tirta*, the primary use of sacred water in ceremonies/rituals, sacred water governance (regulation), and sacred water utilization as a commodity. In-depth interviews were used as an information exploration interview method.

Scheduled observations were used to gain a better understanding of the biophysical, social, and institutional aspects of the research area. In-depth interviews were also conducted with 8 other supporting informants obtained through the snowball method. A selection was made from the 12 informants based on the completeness of the information and suitability with the research objectives to be used as data sources in the qualitative analysis.

From in-depth interviews, the research found that water is important in the lives of Balinese people because it not only meets physical needs but also spiritual needs. This traditional knowledge leads to the belief that

Informants	Gender	Job	Age (years)	Location
Key Informant GS	Male	Elder	Above 60	Denpasar
Key Informant IBPY	Male	High priest	Above 60	Denpasar
Key Informant IRBWK	Male	High priest	Above 60	Gianyar
Key Informant IRBWKB	Male	High priest	Above 60	Denpasar
Informant AS	Female	Civil servant	50-60	Badung
Informant BP	Male	Lecture	30-40	Denpasar
Informant INA	Male	Water Manager	40-50	Gianyar
Informant IWK	Male	Elder	40-50	Denpasar
Informant IWS	Male	Head of village	40-50	Denpasar
Informant IWSu	Male	Elder	50-60	Denpasar
Informant JMDM	Male	Water Manager	50-60	Denpasar
Informant KS	Male	Vice chairman of village institution	50-60	Denpasar

Table 1. Informants Characteristics

Source: Field Data (2022)

water, both for consumption, agricultural land and plantations, and religious activities, is something sacred, so water must be sacred and maintain its existence through customary laws (*awig-awig*), which are passed down as a form of adaptive management for ritual implementation.

The preparation of *awig-awig* was a gradual process. Aside from traditional village manners, *awig-awig* preparation is also discussed with government officials and academics to ensure that it does not conflict with or deviate from official government regulations. After completion, this *awig-awig* undergoes a final ceremonial process at the temple. As a result, *awig-awig* possesses not only formal and social power (custom) but also spiritual power.

Land ownership is known to affect the utilization and management of sacred water sources. Because of the spiritual attachment between the people of different villages and the existence of the Water Temple, the sacred spring in one village is used for the benefit of more than one village. On the other hand, individual land ownership causes issues at one sacred water source location. According to Hauser-Schäublin (2011), periods of centralization and decentralization create land rights dynamics over time. Land access and control shifted between hierarchically and communally structured land tenure systems.

The Bali Governor Regulation No. 26 of 2020, concerning Integrated Environmental Security Systems Based on Customary Villages (hereinafter Governor Regulation No. 26/2020), aims to embody the integrated environmental security system through the customary village to purify and maintain the sustainability of Bali's natural resources (Yasa, 2021). The existence of customary villages is governed by Bali Provincial Regulation No. 4 of 2019, respecting Customary Villages (hence, the Customary Village Regulation). This rule recognizes that natural resources are part of the *padruwen desa adat*, which means they are regarded as material assets of the customary village for the benefit of the community (Yasa, 2021).

Several times during in-depth interviews with informants, concepts of 'ritual and local economy' also 'local wisdom and economy' were formed because of the informant's experience that the Balinese economy can survive and rotate with ritual as part of everyday life, requiring local production factors (local

content). A participatory (bottom-up) economy in which efforts to build individual communities and residents create value on the collective uniqueness of identity and sense of place (sense of place).

In-depth interviews with key informant IRBWK then provide the meaning that water is the source of life, that most of the Earth is formed from water, that the human body is formed from water (fluid in the human body), and that the human soul is formed from water, all of which not only needs to be cleaned but also has its purity maintained with sacred water (*tirta*). *Tirta* cleanses and purifies the human body and its souls. Sacred water represents the water element within humans seeking to reconnect with God. IRBWK has the following quotes:

"..Water is the source of all life....Hinduism was once known as the Tirta religion....Because the ancestors of Bali believed that water was the source of life....In the Vedic language...Eko narayanad sti kascit....Meaning: The one and only God is water.... Why?...This is because we cannot live without water. Vishnu is like water in that he absorbs, fills, infiltrates, and flows... water infiltrates and fills the human body to become a gift from God...Tirta is a sacred water used to influence the water within humans..."

Based on this conversation, it is clear that sacred water is the foundation of Balinese Hinduism, formerly known as the *Agama Tirta*. *Tirta* is significant because it represents Vishnu, the guardian of God. The concepts of local Balinese wisdom are still maintained in everyday life for the Balinese traditional community, despite shifts as a result of public policy and development, particularly the development of the tourism industry.

Meanwhile, in the sacred water source *Pura Beji Pancoran Solas*, one standout finding from the data analysis was the chosen alteration of the social network on the modification process while retaining religious traditions. The commodification of certain locations is intimately linked to spiritual values attributed to traditional sacred sites that are closely identified with a specific religious tenet, belief, or place of worship in rural communities. In an in-depth interview, the water manager of a specific place (informant INA) stated that.

“Norms and values have already been formed. With the concealed canyon, we strive to keep tourists out of the sacred area; religious rites continue as usual, while tourist activities take place outside the sacred springs area, which we have protected with customary regulations and some assigned managers...”

Currently, the urban Hindu community in Bali is concerned that Balinese society's adaptation to globalization is an unintended consequence of development. The improvement in people's well-being is followed by competition for the use of groundwater among rituals, domestic needs, and non-domestic needs, particularly to support the tourism industry. The phenomenon of changes in lifestyle and bottled water consumption because of the capitalist mindset is emphasized by informants IBPY, BP, and JMDM. Bottled water is a new choice for Balinese people because it is hygienic, practical, economical, and easily accessible. Bottled water has evolved into a modern form of life. According to the key informant's (IBPY) statement, which is quoted below:

“In my opinion, why is sacred water resource not being used optimally now, people prefer to consume bottled water,... they no longer trust the quality of sacred water resource, they just want to buy (bottled water) easily.. the sacred water resource (is) old-fashioned”

Lestari (2021) revealed that, based on data from Statistics Indonesia, people who consume bottled water in Indonesia reached 36 percent in 2018. It was significantly increased by 3 times compared to 10 years before. Furthermore, the study mentioned in 1973, Indonesia's bottled water industry began to flourish. Aspadin (Association of Bottled Drinking Water Companies) was created in 1991 and currently controls 36 drinking water providers. At the time, annual sales volume amounted to only 6 million liters. In 2005, bottled water use began to increase. Approximately 4% of Indonesia's population relies on bottled water as their primary source of drinking water. Currently, drinking bottled water is associated with a healthy lifestyle. Many media outlets have suggested that drinking bottled water is a modern way to live a healthy lifestyle. Bottled water is believed to be more sanitary than drinking water that has been treated or boiled at home. This increase needs to be watched out

because bottled water is an unsustainable source of drinking water.

Development of the core sector of tourism and globalization have resulted in an increasingly permissive attitude among indigenous communities toward violations of local wisdom values and disregard for natural balance, which has an impact on the sustainability of the existence and use of water originating from sacred water resources. Simultaneously, conflicts over water sources emerged as an unintended consequence of development, giving rise to environmental movements led by urban residents and traditional leaders in response to historical and contemporary inequities and discrimination in patterns of distribution and participation in the institutions of water governance (Jackson, 2018). Babidge (2015) also mentioned that Atacameño people in Chile take action to resist those who extract water from their territories, and they also engage in forms of water commodification that include the development of infrastructure for their communities through traditional communal labor practices combined with financial partnerships with corporations. However, the concepts of local wisdom, its implementation, and objects related to the existence and use of sacred water for ritual activities were preserved due to a strong awareness to preserve identity based on custom, religion, and culture as a tradition and religious practice of immeasurable value in the life of the Balinese Hindu community.

Adaptive management of sacred water can be defined as a process that promotes flexible decision-making that can be adjusted in the face of uncertainty (Thomann et al., 2020) in the supply of clean water and the negative impacts that arise because of rapid development with the practice of over-exploitation of water (especially groundwater) to domestic needs and support the Bali tourism industry. Decision making by customary representatives is required because adaptive management entails deliberative and iterative phases, which are manifested in indigenous peoples through local wisdom, which is held on a regular basis in everyday life, even in ritual practices.

Discussion

Little attention has been paid to the dynamics of the challenges that arise in the sustainable use and management of sacred water sources in

Denpasar City and its surroundings. There is an urgent need for socioeconomic studies on the consumption and adaptive management of sacred water sources based on traditional wisdom to ensure the survival of sacred waters. Thomaan et al. (2020) mentioned key elements of the deliberation phase from a western knowledge perspective include stakeholder engagement, goal setting, designing management alternatives, developing predictive models, and establishing monitoring protocols. Meanwhile, indigenous cultures employ local wisdom to preserve ecological balance and manage natural resources. Local wisdom is frequently associated with religious beliefs, customs, folklore, and local land use practices, and it plays an important role not only in the sustainable management of natural resources in the face of rapid and ongoing environmental change, but also in the preservation of traditional culture and as a source of livelihood (Chao and Hsu (2011); Ghorbani et al. (2021); and Juanwen et al. (2012)).

Conflicting concepts between normative laws and regulations with individualistic values and customary law in the form of customary laws by traditional villages that use the concept of tangible and intangible or *sekala-niskala* as their basis (Warren, 1993; 2007), as well as the manifestation of collective interests, impedes the progress of the adaptive management process. This study revealed that it is vital to recognize the commodification of water resources as a type of adaptive management for traditional Balinese communities, especially in Denpasar City and its surrounding areas.

The problem is also exacerbated by the Balinese Hindu indigenous people, who are currently experiencing the dynamics of change and competition for utilization, as well as cultural changes related to water (Lewis & Lewis, 2009). Excessive groundwater exploration in urban, peri-urban, and tourism areas to meet domestic water needs has resulted in competition for the use of water for ritual and irrigation purposes. According to the IDEP data, 65% of Bali's water is used for tourism-related purposes. In 2018, two years before the COVID pandemic shut down the tourism industry, the population of Bali reached 4.2 million people, with 15.9 million domestic and foreign tourists. Consequently, the need for water per house per day exceeded the availability of raw water in Bali by 13.6% (PNB & IDEP, 2018).

Based on research findings and data analysis, the adaptive management of sacred water has an impact on the sustainability of its existence and utilization. Exploration of the important elements of deliberative, iterative, and management aspects of the local wisdom base is then described as an adaptive water source management practice in Balinese Hindu society. The commodification of sacred water sources in the traditional community was initiated by local representatives who discovered that there was an abundance of clean water coming from natural fountains and the tranquility of the surroundings. Adaptive water management with ecotourism is thought to benefit traditional village communities because the profits generated by traditional village administrators go to the traditional village treasury and do not burden the community with fees if a religious ceremony occurs in the traditional village area. The traditional village head and delegates then drafted customary regulations that included obligations and fines for maintaining the sacred source in such a way that it did not jeopardize the holiness of the sacred place while also preserving the trees surrounding the spring area.

With the dynamic interaction between the adaptive management system of sacred water and the natural and social infrastructure based on the local wisdom philosophy for its implementation, the proportion of traditional people's participation in the effort to achieve the sustainability of sacred water utilization will grow. The early involvement of traditional people in the adaptive management of sacred water raises awareness of the more responsible sacred water use. Of course, education for the younger generation about the local wisdom that underpins sacred water management and other local wisdom concepts is inextricably linked to technological development. The young generation involved in sacred water adaptive management can find ways to incorporate local wisdom into technological developments, particularly digital technology.

The results of this study are consistent with the findings of Gleeson et al (2020), who claim that the sustainability of groundwater utilization is inextricably linked to the nature of groundwater. Because groundwater is a slow and invisible resource, long-term and adaptive plans with specific goals are required. It begins by defining a desired future and works

backward to identify policies and programs that will connect the future to the present. Conjunctive groundwater and surface water management is also important because many groundwater sustainability solutions involve surface water. According to Howard (2015), despite advances in urban groundwater science and western economic theories, holistic urban water management models have not adequately addressed the specificities of groundwater resource systems and have not identified the need for the engagement of all stakeholders in decision-making processes that inform groundwater governance.

Conclusion

In the context of Bali, the tourism industry is at the forefront of causing socioeconomic changes that impact the water use of Balinese indigenous people. Water sources in sacred natural sites (lakes, seas, rivers, and springs) that were previously only used for ritual needs, irrigation, and domestic consumption were eventually over-exploited and commodified because of regional autonomy. Regional autonomy delegates to regional and even local governments the authority to manage natural resources in accordance with their potential. Consequently, there is a lack of collaboration between the central, regional, and local governments and traditional community institutions in the adaptive management of sacred water. Customary representatives must be involved and make decisions on sacred water management policy because adaptive management requires deliberative and iterative phases that are manifested in indigenous peoples through local wisdom, which is held daily, including ceremonial practices.

Spiritual groundwater management in local wisdom is a valuable alternative to traditional western-based approaches. This approach can help avoid conflicts over groundwater use and ensure its sustainable utilization by incorporating values such as respect for nature, holistic thinking, and intergenerational knowledge transfer. It can be argued that there is potential for applying local wisdom approaches to groundwater management, emphasizing the importance of considering local wisdom and spirituality in groundwater management.

Exploring the concept of local wisdom is then described as an adaptive water source

management practice in Balinese Hindu societies. The participation of traditional people in its implementation will increase in an effort to achieve sustainability of sacred water utilization. The early involvement of indigenous people in the adaptive management of sacred water raises awareness of more responsible sacred water use. Of course, education for the younger generation about the local wisdom that underpins sacred water management and other local wisdom concepts is inextricably linked to technological developments.

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