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Indonesia's Unclear Groundwater Management in Achieving Sustainable Development Goals: Regulations, Environmental Impacts, and Strategic Solutions

In'am Zaidi[1], I Gusti Ayu Ketut Rachmi Handayani[2*]

[1] Master Program of Law, Faculty of Law, Universitas Sebelas Maret, Surakarta 57126, Indonesia
[2] Faculty of Law, Universitas Sebelas Maret, Surakarta 57126, Indonesia

Corresponding Author Email: ayu_igk@staff.uns.ac.id

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ABSTRACT

Indonesia is one of the countries committed to realising Sustainable Development Goals, but at the implementation level, Indonesia faces challenges in the form of unclear groundwater management regulations. This paper aims to examine the ambiguity of groundwater management from the aspects of regulation and impact on the environment to the formulation of strategic solutions. Through the analysis of various data sources, this paper succeeds in revealing three facts. Firstly, Indonesia still needs to have a special regulation on groundwater management. The current regulation still focuses on the approval of groundwater use. Still, it needs to regulate in detail the mechanisms of planning, implementation, monitoring, conservation, utilisation (except licensing), and control of groundwater damage. Secondly, the high percentage of groundwater use in Indonesia is evidence of the government's inability to fulfil the mandate of Law No.17 of 2019 Jo. Law No. 6 of 2023 recommends prioritising the utilisation of surface water over groundwater. Consequently, excessive use of groundwater has a negative impact on the environment, namely the emergence of a water crisis accompanied by a decrease in groundwater levels and a decrease in groundwater quality. Based on the lessons learnt on participatory groundwater management from Australia, this paper offers a strategic solution: the government needs to reconstruct the specific regulation of groundwater management in Indonesia to guarantee aspects of legal certainty. The reconstruction needs to be followed by ensuring public access to information, public participation in decision-making and public access to justice. These three elements are prerequisites for resolving groundwater governance issues in Indonesia to achieve water security and Sustainable Development Goals. To overcome the fragmentation of groundwater management, a national water information system in the form of a 'One Data Policy' is needed to provide real-time information on the quality and quantity of surface water and groundwater. The government must involve the community in national groundwater management planning to ensure public participation and community access to justice.

1. INTRODUCTION

Groundwater management is an essential study in the current era. The limited availability of groundwater and the use of groundwater that exceeds the threshold have accelerated a region to experience a water crisis. The water crisis is a condition of imbalance between the availability of water in an area and the demand for water from the community. In the global context, groundwater is the primary source of water that is most widely used by the community. UNESCO notes that nearly half the worldwide population uses groundwater daily as its primary water source [1]. UNESCO report is in line with the fact that the use of groundwater as the primary source of drinking water in sub-Saharan countries has reached over 70 per cent [2].

Indonesia is one of the countries in the world that uses groundwater as its primary water source, with a high percentage of 46 per cent [3]. This means that half of the Indonesian community and industry still rely on groundwater as their primary water source compared to water used through the piping network provided by the regional public drinking water company. Data shows that in 2021, 33 per cent of Indonesian people used water independently, with details of 28 per cent in urban communities and 37 per cent in rural communities, with the primary water source being groundwater [4]. Indonesia encounters a considerable challenge in attaining groundwater resilience due to its significant reliance on groundwater. Resilience is a system's capacity to adapt to an ever-changing environment without modifying its fundamental operational framework [5]. Groundwater resilience entails improving the groundwater recharge process, which is crucial for sustaining balance within the system [6].

Groundwater regulation in Indonesia originates in the colonial era, specifically through the Staatsblad of 1871 and the Algemene Water Reglement of 1936. Law No. 17 of 2019

juncto Law No. 6 of 2023 outlines the most recent legislative framework. Despite establishing legal instruments for managing water resources, Indonesia has yet to implement groundwater security fully. The inadequacy of water security is evident when considering the anthropological aspects of groundwater resources, which are influenced by both human activities [7] and the impacts of climate change [8]. These factors significantly affect the availability of groundwater resources [9-11].

Research by Bagheri-Gavkosh found that 76.92 per cent of land subsidence is influenced by human activities, with 59.75 per cent precisely due to groundwater extraction [7]. The factors associated with human activities are closely tied to groundwater management in Indonesia, which should place greater emphasis on the principles of good governance. This includes prioritising transparency, accountability, and community participation, which have not been adequately addressed [12]. Consequently, several regions in Indonesia, including Jakarta, have experienced land subsidence [13, 14].

Although several previous studies have discussed water resources policy, they have yet to focus on groundwater management in Indonesia in achieving Sustainable Development Goals (SDGs). This paper tries to elaborate on the unclear groundwater management in Indonesia, both in terms of regulations and impacts on the environment. In addition, this paper offers a strategic solution, namely lessons learned on groundwater management management in Australia. Recognising the adverse effect of excessive groundwater, Indonesia needs to transition to wise water use like Australia. Australia has a legal framework that recognises the right of communities to participate in groundwater governance as set out in the Water Allocation Plan or WAP. The existence of participatory recognition of rights in WAP allows communities and governments to be involved in groundwater resource management. By comparing water governance in other countries, it is hoped that we can emulate best practices to address current and future water management challenges to achieve water security and SDGs.

2. METHODOLOGY

This research is normative legal research, focusing on analysing norms and rules of law related to the Indonesian government's policies in groundwater management to achieve water security. It is descriptive and conducted through literature studies from scientific writings and institutional reports relevant to the research topic.

This research's data sources consist of primary legal materials, secondary law and non-legal materials. Primary legal materials are taken from policies and legislation on groundwater management in Indonesia, namely the 1945 Constitution of the Republic of Indonesia, Law No. 11 of 1974, Law No. 7 of 2004, Law No. 23 of 2014 in conjunction with Law No. 6 of 2023, Law No.37 of 2014, Law No. 17 of 2014. Year 2014, Law No. 17 of 2019 in conjunction with Law No. 6 of 2023, Government Regulation No. 22 of 1982, Government Regulation No. 43 of 2008, Government Regulation 121 of 2015, Government Regulation No. 22 of 2021, Presidential Regulation No. 97 of 2021, Presidential Regulation No. 37 of 2023, Joint Decree of the Minister of Energy and Mineral Resources, Minister of Public Works and Housing, and Minister of Investment/Head of the Investment Coordinating Board No. 225.K/GL.01 /MEM.G/2022, No. 07/PKS/M/2022, No. 188 of 2022, Minister of Energy and Mineral Resources Decree No. 291.K/GL.01/MEM.G/2023 and Constitutional Court Decision No. 85/PUU-XI/2013.

Secondary legal materials include legal and scientific writings, legal research reports, and opinions from legal experts. In contrast, non-legal materials come from scientific writings relevant to the topic of discussion, with a focus on international scientific publications indexed by Scopus in the last five (5) years. The aim is to focus the discussion on the latest relevant references.

Data analysis is done through deductive syllogism and interpretation. The major premise is the concept of SDGs, while the minor premise is the legislation on groundwater management in Indonesia. The analysis was conducted in three stages: the first stage was to examine the vagueness of groundwater management in Indonesia in terms of regulations. The second stage examines the impact of unclear groundwater management regulations on the environment. The third stage examines the lessons learned in groundwater management in Australia. Based on these three stages, a strategic solution for regulating groundwater management in Indonesia is formulated to achieve water security and SDGs.

3. RESULT AND DISCUSSION

3.1 Lack of clarity in groundwater management regulations in Indonesia

In Indonesia, the management of water resources, including groundwater, is governed by Article 33, Paragraph (3) of the 1945 Constitution of the Republic of Indonesia. This provision empowers the state to control water resources to maximise prosperity for the people [15]. The state is recognised as a Trustee responsible for managing water resources, given that water is a public good with limited availability. The regulation of these resources is closely related to Article 28 (H) Paragraph (1) of the 1945 Constitution of the Republic of Indonesia [16, 17]. This relationship underscores that the environment operates as a cohesive ecosystem, encompassing human beings and non-human elements, such as water, soil, air, and other natural resources [18].

The regulation of groundwater management in Indonesia traces its origins back to the Netherlands colonial period, beginning with Staatsblad 1871 and the subsequent Algemene Water Regulation of 1936. Initially, groundwater regulation emphasised geological mapping across Indonesia. Following the country's independence, Law No. 11 of 1974 was enacted to govern groundwater management, supported by Government Regulation No. 22 of 1982, which focused on water regulation. These regulations prioritised hydrogeological mapping, permitting, and the conservation of groundwater resources. As the complexities of water regulation evolved, Law No. 11 of 1974 was superseded by Law No. 7 of 2004 and Government Regulation No. 43 of 2008 concerning groundwater management. This updated framework introduced the concept of Groundwater Basins (*in Indonesian: Cekungan Air Tanah* or *CAT)*. A CAT is a region delineated by hydrogeological boundaries, encompassing all hydrogeological activities, including reclamation, drainage, and groundwater discharge.

Unfortunately, through Constitutional Court Decision No. 85/PUU-XI/2013, the enactment of Law No. 7 of 2004 was declared legally contrary to the 1945 Constitution of The

Republic of Indonesia and did not have binding legal force. Therefore, to fill the legal gap in regulating water resources in Indonesia, Law No. 11 of 1974 concerning Irrigation was re-enacted. While preparing the latest water resources law, the government stipulated PP 121 of 2015 as a follow-up to Article 11 of Law No. 11 of 1974. Because the enactment of Law No. 11 of 1974 differs from the times, the government then stipulated Law No. 17 of 2019, as amended by Law No. 6 of 2023, which is the primary legal instrument in regulating water resources.

The problem that arises is that until now, there has been no issuance of implementing regulations on groundwater management, thus creating a legal vacuum regarding planning, conservation, utilisation (except licensing) and groundwater damage control. The consequence of the Constitutional Court's decision No. 85/PUU-XI/2013 caused the invalidity of Government Regulation No. 43 of 2008 concerning groundwater. The current groundwater policy only pays attention to the approval of the use of groundwater. The Ministry of Energy and Mineral Resources (EMR) is an essential actor in implementing groundwater use approvals in Indonesia. This aligns with Presidential Decree No. 97 of 2021 and the Joint Decree of the Minister of Energy and Mineral Resources, the Minister of Public Works and Public Housing, and the Minister of Investment/Head of the Investment Coordinating Board No. 225. K/GL.01/MEM. G/2022, No. 07/PKS/M/2022, Number 188 of 2022.

The Ministry of Energy and Mineral Resources has established groundwater use approval requirements to promote the sustainability of groundwater resources, as outlined in Decree No. 291.K/GL.01/MEM.G/2023. All individuals, community groups, government agencies, legal entities, and social institutions must secure approval for groundwater use if their total consumption exceeds 100 cubic meters per month. This requirement also extends to agricultural activities outside the irrigation system, public water tourism, non-commercial initiatives, research projects, city parks, places of worship, public utilities, social facilities, drilled wells, and government agencies. Additionally, the Regional Government is tasked with regulating groundwater use approvals that do not fall under the jurisdiction of the Central Government.

Currently, Indonesia faces a legal vacuum regarding the regulation of planning, conservation, utilisation (except permits) and groundwater damage control. First, groundwater planning has yet to be strictly regulated. The government still needs to establish special rules regarding groundwater as a replacement for Government Regulation No. 43 of 2008, which is no longer in effect. The main challenge is the fragmentation of responsibility in managing and protecting water resources. This condition results in an overlap of authority if there is no firm regulation, resulting in a suboptimal implementation of the duties and responsibilities of each agency.

Second, Indonesia's responsibility for groundwater conservation still needs to be improved. The reason is the overlap of policies, namely the responsibility for groundwater conservation, managed by two different authorities. In Law No. 23 of 2014, groundwater planning and conservation is seen as a geological matter, so the Geological Agency under the Ministry of Energy and Mineral Resources is responsible for groundwater management in areas that cross provincial boundaries. The Provincial Energy and Mineral Resources Office manages groundwater in regions within the provincial boundaries. Law No. 17 of 2019 has eliminated the division of responsibility from Law No. 23 of 2014. Therefore, strict regulations regarding who is responsible for groundwater in Indonesia are currently necessary.

Third, in the context of groundwater quantity conservation, the regulation refers to the provisions of Law No. 37 of 2014; for example, groundwater conservation buildings in the form of absorption wells are needed to improve the soil's function on the land. It is just that in the context of regulating groundwater quality in Indonesia, it has yet to be regulated explicitly and in detail [14]. Groundwater quality regulation is currently limited to preventive efforts, such as using Indonesia National Standard 2398:2017 to plan septic tanks with advanced treatment, such as infiltration wells. Groundwater quality regulations have yet to be regulated in detail, and neither have surface water quality regulations in Government Regulation No. 22 of 2021. Although the Ministry of Environment and Forestry monitors groundwater quality, the ministry primarily focuses on surface quality. Therefore, it is necessary to be firm on who is fully responsible for groundwater quality monitoring. This is because the fragmentation of the person in charge of water resources management causes unclear authority. The allocation of responsibilities for water resource management in Indonesia is illustrated in Table 1 below:

Table 1. Agencies responsible for water resources management in Indonesia

No.	Water Source	Person in Charge
1.	Surface water	Ministry of Public Works and Public Housing
2.	Groundwater	Ministry of Energy and Mineral Resources
3.	Water quality and catchment management	Ministry of Environment and Forestry
4.	Spatial arrangement	Ministry of Agrarian and Spatial Planning
5.	Provision of water services for agriculture, domestic and industry	Ministry of Public Works and Public Housing
6.	Economic activities affecting water resources	Ministry of Energy and Mineral Resources, Ministry of Finance, Ministry of Environment and Forestry and Ministry of Marine Affairs and Fisheries
7.	Prevention and management of water-related disasters	National Disaster Management Agency
8.	Drinking water quality standards	Ministry of Health

3.2 Impact of unclear regulations on groundwater management on the environment

In the context of Indonesia, water resources management regulations are aimed at achieving national water security and a commitment to SDGs. National water security has been regulated in Article 1 Number 5 of Presidential Regulation Number 37 of 2023 concerning the National Policy on Water Resources, namely the condition that the needs for decent and sustainable water are met and maintained from water-related risks. Water security indicators are seen from the achievement

of the Sustainable Development Goals (SDGs) and Medium-Term Development Plan *(in Indonesian: Rencana Pembangunan Jangka Menengah Nasional* or *RPJMN),* namely the fulfilment of 100 per cent safe drinking water access as stipulated in Article 4 Paragraphs (1) and (2) of Presidential Regulation No. 37 of 2023. However, efforts to achieve 100 per cent safe water still need to be constrained by uneven water supply in every region in Indonesia. One of the causes is the excessive use of groundwater, which needs to be followed by clarity in groundwater management regulations, as previously explained.

The impact of unclear groundwater management regulations is the starting point for the emergence of groundwater use practices. The use of groundwater as the primary water source has reached 46 per cent, while those who use clean water through regionally-owned enterprises with drinking water are only 9 per cent [19]. The high percentage of groundwater use in Indonesia is proof of the government's failure to carry out the mandate of Law No. 17 of 2019 in conjunction with Law No. 6 of 2023, which prioritises the use of surface water over groundwater. On the contrary, facts show that almost half of Indonesia's population uses groundwater as the primary water source. This means that the mandate of Law No. 17 of 2019 Juncto Law No. 6 of 2023 has yet to run optimally, and there is evidence of the government's low role in water management through regionally owned drinking water enterprises. The practice of excessive use of groundwater has had a harmful impact on the environment, namely the water crisis in several regions in Indonesia [20]. The water crisis is where water availability in the region cannot meet the community's water needs. Several regions in Indonesia are threatened by the clean water crisis, as shown in the following table:

Table 2. Percentage of water availability and population on each island in Indonesia

No.	Islands in Indonesia	Percentage	
		Water Supply	Population
1.	Sumatra	24.9%	22.1%
2.	Java	5.9%	56.5%
3.	Kalimantan	29.3%	5.9%
4.	Sulawesi	6.4%	7.3%
5.	Bali and East Nusa Tenggara	1.1%	5.5%
6.	Maluku	2.4%	1.1%
7.	Papua	30.0%	1.6%

Table 2 above shows that several major islands in Indonesia face water scarcity. The imbalance between the water supply and the water demand of the population results in the inadequacy of the community's right to water. This condition is further exacerbated by the high rate of groundwater use in Indonesia, which reaches almost 50 per cent. The four major islands in Indonesia facing water crisis are Java, Sulawesi, Bali and East Nusa Tenggara. These four regions will face prolonged water scarcity if the Indonesian government immediately provides solutions to the current water scarcity. The large islands with sufficient water availability are Sumatra, Kalimantan, Maluku and Papua. Despite having sufficient water, these four islands need the government's attention due to the uneven water infrastructure in Indonesia. For example, Papua is one of the islands that lacks water infrastructure, especially water management through drinking water supply systems.

The continued impact of excessive groundwater use is significant land subsidence in several regions in Indonesia. For example, Jakarta is one of the cities in the world experiencing the fastest land subsidence, where some areas in Jakarta have sunk more than 4 meters, and North Jakarta has become the area with the highest land subsidence of 2.5 meters in the last ten years [21]. Bali also faces a similar problem; the rapid tourism in Bali results in the high use of groundwater, which impacts land subsidence [22]. For example, there was a land surface subsidence of 93.04 ha in the South Denpasar, West Denpasar and Kuta areas [23], and there was a subversion of the ground level with deformation of -8 mm to -19 mm in North Denpasar [24]. As shown in Figure 1, the rate of land subsidence in other areas is usually more than 1 cm per year.

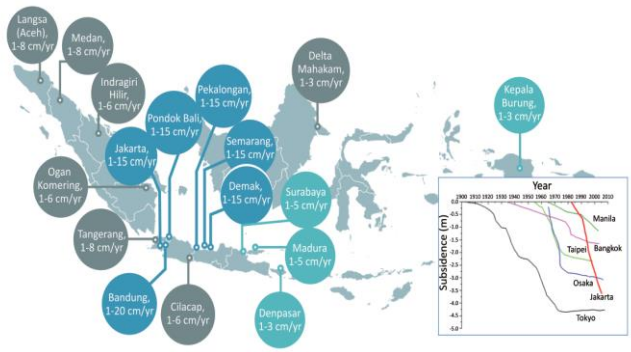

Figure 1. Rate of land subsidence in Indonesia

Based on Figure 1 above, Java is the island with the fastest subsidence rate of between 1 and 20 cm per year. Of all the regions in Indonesia, Jakarta is experiencing the highest rate of land subsidence, placing it among the world's major cities known to be sinking. It is, therefore, not surprising that Jakarta is highly at risk of flooding. Drastic land subsidence makes the city's land area lower than the sea level.

A further impact of excessive groundwater use is a reduction in gross domestic product growth as water resources development (including groundwater) is a key driver of gross domestic product growth (DPG). The report "Indonesia Vision 2045 Towards Water Security" notes that there will be a 2.5 per cent decline in DPG in 2045 if water availability in Indonesia is inadequate. If excessive groundwater use is not immediately addressed, it is projected to increase the impact of floods due to land subsidence and potentially reduce GDP by 1.42 per cent by 2045 [3]. The figure was obtained by Computable General Equilibrium analysis by providing an assessment of five water threats: water pollution due to inadequate water coverage, sanitation, and hygiene; coastal flooding affected by sea level rise and land level subsidence; soil subsidence due to excessive groundwater extraction; land degradation and climate change on floods; and the impact caused by the water crisis.

Excessive use of groundwater also has a destructive impact on the environment, namely a decrease in groundwater quality [1]. The uneven percentage of people (rural and urban) who receive clean water services from the Regional Public Drinking Water Company is one of the reasons rural communities use much groundwater as a source of drinking, which is carried out on a self-sufficient basis. Unfortunately, the government's weak supervision of the quality of groundwater used by households causes the quality of groundwater consumed prone to microbial contamination [25-

27]. More than 90 per cent of groundwater samples in Indonesia exceeded the threshold, with 70 per cent coming from toilet tank leaks and waste discharged into waterways [3]. Therefore, regular monitoring accompanied by sanitary inspections is necessary so that all water-related risks can be managed properly [28]. The government's presence in preventing all risks related to water is a strategic step towards national water security, as stated in Presidential Regulation Number 37 of 2023 concerning the National Policy on Water Resources.

3.3 Lessons learned on groundwater management in Australia: The first step towards water security and SDGs

The discussion of water resources is fundamentally intertwined with the concept of justice. Issues of justice arise when water resources are limited or access to them is restricted [29]. To prevent injustice, it is crucial to establish a well-structured approach to managing water resources, covering everything from allocation to distribution. In water resource management, key challenges include the scarcity of available water and unequal access to clean water services, particularly between urban and rural areas. Increasing populations drive a rise in water consumption, further exacerbating pressure on these limited resources. Moreover, ineffective governance of water resources intensifies the crisis in certain regions, resulting in inequitable access to clean water for communities. Vulnerable individuals or groups, as well as the environment, are often the ones most affected by shortcomings in water resource management.

Worldwide, groundwater is the primary source most used by communities to meet domestic and industrial needs [30]. In addition, groundwater is a hidden resource, so the impact of its use is difficult to identify and evaluate. Ideal groundwater management is a challenge because it is interdependent with other systems. Legal and institutional aspects of the various interdependent systems play an essential role in implementing groundwater management in the present and future. A good legal and policy aspect guarantees the recognition of the rights of communities to participate in groundwater management. Participation is the redistribution of power to everyone so they have the same opportunity to be part of the decision-making process or policy [31].

In the context of water resource management regulations, Indonesia needs to conduct a comparative study of water resource management regulations with Australia. Australia has a legal framework that recognises the right of communities to participate in managing water resources, including surface and groundwater. This recognition is provided for by the National Water Initiative (NWI) 2004 and the Water Act 2007. For example, Paragraph 36 of the NWI states that community input is required to resolve trade-offs between competing outcomes for a water system. Paragraph 40 of the NWI requires regular public reporting on the implementation of the water plan to ensure access to information. This aims to help governments and water users manage risks effectively. Paragraph 93 of the NWI also emphasises the importance of involving water users and other stakeholders in reaching the NWI objectives. This involvement is facilitated by maintaining transparency in decision-making and ensuring comprehensive information is accessible to all sectors at crucial decision points.

In the context of ensuring community participation in groundwater policy at the state level, the government regulates it through the Natural Resources Management Act 2004. For example, in Angas Bremer, South Australia, participation is represented in the form of including irrigation initiatives in the form of measurement, monitoring, annual reporting, and revegetation in the Water Allocation Plan or WAP [32], including funding for the provision of information through open meetings from government agencies. The success of participatory groundwater management in Angas Bremer, South Australia, is not only due to policies, laws, and open discussion forums. Other factors that influence access to information and community participation are the phenomenon of the groundwater crisis that has raised public awareness, leadership that can mobilise the community, participation, and funding from the government [32].

Access to information and community participation in decision-making in the context of Western Australian groundwater is carried out through the WAP. Access to information is realised by having access to information on groundwater issues in the region, while the formation of an advisory group realises participation. In addition, the Western Australian Government allocates funds to facilitate participation in the development of the WAP. Furthermore, in the Western Australian context, the WAP is not statutory, thus hampering effective enforcement because it does not create legally binding obligations [32]. Participatory groundwater management regulations can be done with three key elements, as shown in Figure 2 below:

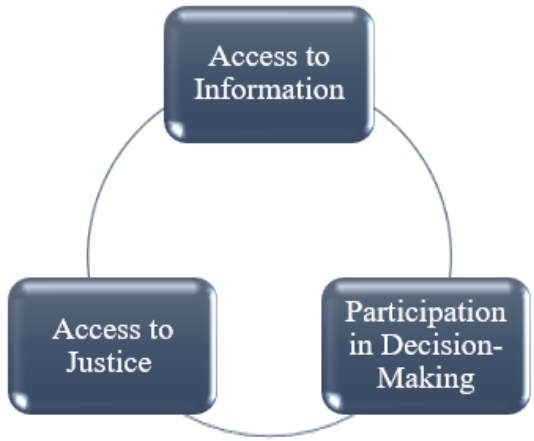

Figure 2. Three elements of participatory groundwater management regulation

Based on Figure 2, the first element to realise participatory groundwater management arrangements is the guarantee of public access to information. This guarantee manifests the principle of transparency in the General Principles of Good Governance. Indonesia needs a national water information system in the form of a "One Data Policy" that provides real-time information on the quality and quantity of surface water and groundwater. The fragmentation of those responsible for water resource management in Indonesia has led to lengthy bureaucratic procedures that result in the government not having easy access to water data from other government agencies. For example, the "Indonesia Vision 2045 Report towards Water Security" reveals difficulties accessing data on river area management (water supply and water needs) by the directorate of national spatial planning, the Ministry of Agrarian and Spatial Planning. Facing this condition, an understanding between agencies is needed regarding the data-

sharing mechanism followed by the determination of implementing rules for Law No. 17 of 2019 in conjunction with Law No. 6 of 2023 by the Government. In addition, the government must ensure the disclosure of public information regarding the "One Data Policy" so that the public can access the data as mandated by Article 157 letter (a) of Government Regulation No. 22 of 2021 concerning Environmental Protection and Management. The government must be responsive and take corrective steps when the use of groundwater causes a negative impact on the environment. This is because several regions in Indonesia are threatened with a water crisis due to the impact of excessive groundwater use, such as Java Bali and East Nusa Tenggara [3, 22].

The second element to realise participatory groundwater management arrangements is to ensure community participation in decision-making regarding groundwater resource planning. Participation can be realised through open meetings between the community and stakeholders to balance of interests. Community participation in decision-making must be based on awareness and knowledge regarding the importance of groundwater as an invisible resource because if it is not managed correctly, it will result in a groundwater crisis, including land subsidence. Considering this, the government is present as an administrative regulator and the main driver in inclusive and sustainable groundwater management. Community participation is essential to effective water resource management in Indonesia, as Article 63 of Law No. 17 of 2019 specified. This participation can manifest in various ways, including public consultations, deliberations, partnerships, voicing aspirations, and oversight. Additionally, the local wisdom of the Indonesian people is a critical element managing water resources. For example, Bali embodies the *Tri Hita Karana* philosophy, a guiding principle for achieving a balanced life that fosters harmonious relationships between humans, the creator, and the environment. To implement the directives of Article 2 of Law No. 17 of 2019, it is crucial to integrate local wisdom, such as the *Tri Hita Karana* philosophy, into water resource management, thereby honouring the noble values upheld by society.

The third element is the existence of regulations that ensure public access to justice, especially related to groundwater governance. Often, the lower layers of society are victims of the massive use of groundwater by the private sector. In Indonesia, the dominance of groundwater use as the primary water source is still very high, for domestic and industrial purposes. Indonesia has implemented a policy of approving the groundwater use through a mechanism for granting permits by the government. However, many households and industries are reluctant to handle the licences. Weak government supervision over groundwater use is the main reason why massive groundwater use is still exist this day. As a result, groundwater availability is gradually decreasing, and there is a water crisis in the region. Bali is one of Indonesia's islands experiencing a water crisis. The cause is the high utilisation of groundwater in the area, followed by the practice of land conversion to benefit the tourism industry. Badung Regency, located in Bali, faces a significant challenge in terms of water scarcity. As a leading tourism centre, this regency attracts many domestic and foreign tourists. As a result, the need for water in the area is very high. The President Director of the Regional Drinking Water Company, Tirta Mangutama, highlighted the situation and stated that the need for drinking water supply in Badung is urgent. Conditions like this need to be the government's attention to stop development that is not inclusive and sustainable. Community access to justice in groundwater use must continue to be encouraged to realise the 2030 SDGs agenda.

3.4 Potential challenges and limitations of participatory approaches to groundwater management in Indonesia

The implementation of participatory approaches in Indonesia faces challenges and limitations. Firstly, Indonesia has various regions with different water resource conditions, both surface and groundwater. The difference is based on three things: too much water in the rainy season, which results in flooding; too dirty water, which causes a decrease in water quality of both surface and groundwater; and too little water in the dry season, which causes extreme drought. Of the various regions in Indonesia, the areas that have the potential to experience all three are Java Island, Bali Island, Sulawesi, Bali and East Nusa Tenggara. The reason is that these three regions face imbalances in water supply and water demand, as explained in the previous discussion. These issues need to be considered as they affect the implementation of the participatory approach.

There is a different treatment between areas that have been categorised as water-resilient and areas that are not water-resilient. Treatment of water-resilient areas can be done by optimising the role of local communities as mandated by Article 3 letter (e) of Law No. 17 of 2019 in conjunction with Law No. 6 of 2023, namely empowering communities, including indigenous peoples, in water resources management. In Indonesia's groundwater management context, community involvement can be focused on conserving water and water sources. The treatment of areas that could be more water resilient can be done by first classifying the problems faced in groundwater management in each region in Indonesia. Because the problems in groundwater management in Indonesia are very complex, legal certainty related to who is responsible for groundwater management is still an unresolved concern until now. This has resulted in groundwater use needing to be controlled more closely and in real-time. Therefore, it is unsurprising that groundwater is Indonesia's most widely used water source. Furthermore, implementing participatory approaches in Indonesia needs to be supported by developing water management infrastructure, such as investment in filtration technology, seawater desalination, water-saving irrigation technology, etc. Technology investment in water management will divide the regions facing drought or water shortages. In addition, strengthening regional and international cooperation is needed. Collaboration can help Indonesia discover new insights and implement best practices in managing its water resources, both groundwater and surface water.

Regulatory coherence is needed at the national, provincial, or city levels to realise Indonesia's participatory approach to water management. This includes the coherence of water management targets in national and regional medium-term development planning documents. The goal is to provide legal certainty and achievement targets. Respect for the rights of indigenous peoples must be truly guaranteed in regulations and implementation. For example, Bali is one of Indonesia's regions with local wisdom in the form of the Tri Hita Karana philosophy, which the local community uses as a guideline for daily life. So, in the context of a participatory approach, the values of the Tri Hita Karana philosophy should be included in regional water management regulations. These values

include Parahyangan (maintaining human relations with the creator), Pawongan (maintaining good relations with fellow humans) and Palemahan (maintaining good relations with the environment or nature). The Tri Hita Karana philosophy is a strategic solution in realising ecologically just water resource management regulations. Ecological justice focuses on equity among all living and non-living entities.

4. CONCLUSIONS

Indonesia's groundwater management regulations still need to be improved; However, groundwater use permits have been regulated, and aspects of planning, conservation, utilisation (except licensing) and groundwater damage control have yet to be expressly regulated in government regulations. The high percentage of groundwater use in Indonesia is proof of the government's inability to carry out the mandate of Law No. 17 of 2019 Juncto Law No. 6 of 2023, which recommends prioritising surface water over groundwater. Groundwater regulation in Indonesia has not realised water security; excessive use of groundwater has a harmful impact on the environment, namely the emergence of a water crisis accompanied by a decrease in groundwater levels and a decrease in groundwater quality (prone to microbial contamination). Based on the lessons learned from Australia's participatory groundwater management, strengthening in terms of regulation needs to be encouraged to accelerate the realisation of water security. The Central Government needs to construct the substance of groundwater management policies that provide guarantees for public access to information, community participation in decision-making and public access to justice. These three elements are the initial prerequisites for resolving groundwater governance issues in Indonesia to achieve water security as mandated by Law No. 17 of 2019, Juncto Law No. 6 of 2023, and Presidential Regulation No. 37 of 2023 concerning the National Policy on Water Resources.

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