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Groundwater Tax as a Regulatory Instrument: Supervision Strategies for Controlling Negative Environmental Externalities in DKI Jakarta

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ABSTRACT

Groundwater tax (PAT) functions as a dual-purpose regional fiscal instrument that serves not only as a revenue source but also as a regulerend policy tool to control excessive groundwater extraction. The phenomenon of land subsidence in DKI Jakarta, particularly in northern areas, demonstrates the critical need for more effective supervision of groundwater utilization. This study aims to analyze the implementation of groundwater taxation in Indonesia, examine groundwater usage patterns in DKI Jakarta, and investigate supervision strategies that regional governments can employ to prevent negative externalities. The research employs a qualitative approach utilizing literature review methodology. Data were obtained from legislative regulations, government agency reports, Central Statistics Agency publications, and previous research findings. Analysis was conducted using descriptive-analytical methods, emphasizing the interconnections between regional taxation, environmental management policies, and international best practices. Results indicate that PAT implementation in DKI Jakarta remains suboptimal due to persistent challenges including taxpayer compliance issues, weak inter-agency coordination, and limited supervision resources. Comparative analysis with the Netherlands and Germany reveals that technology-based supervision systems, self-monitoring mechanisms, and revenue allocation for water conservation can enhance regulatory effectiveness. This research concludes that regulatory strengthening, improved transparency, and digital technology utilization are essential for reinforcing PAT's role as an equitable and sustainable regulerend instrument.

Keywords: *DKI Jakarta, Fiscal Policy, Groundwater Tax, Land Subsidence, Regulere*

INTRODUCTION

Water constitutes an essential natural resource fundamental to human survival and ecosystem sustainability. Access to clean water represents not merely a basic need but a fundamental human right recognized by the United Nations through General Assembly Resolution 2010 on Human Right to Water and Sanitation. This resolution affirms that every individual possesses the right to safe, affordable, and sustainable access to clean water (United Nations, 2010). In Indonesia, water resource management is governed by Law No. 7 of 2004 concerning Water Resources, which emphasizes the importance of protection, conservation, and sustainable water utilization (UU No. 7 Tahun 2004 Tentang Sumber Daya Air, 2004).

The phenomenon of land subsidence in DKI Jakarta serves as compelling evidence of pressure on water resources. Research demonstrates that the most significant land subsidence occurs in northern Jakarta areas, including Pademangan, Penjaringan, Tanjung Priok, and Cengkareng, triggered by excessive groundwater exploitation for domestic, industrial, and commercial purposes (Witarsa et al., 2021). This condition has been exacerbated by seawater intrusion and environmental pollution, consequently generating extensive socio-economic risks, including infrastructure damage, deteriorating quality of life, and increasing potential for environmental disasters (Falkenmark, 2013).

Groundwater, defined as water contained within soil layers or rocks beneath the earth's surface, encompasses water containing dissolved salts and minerals acquired during passage through soil layers, as well as water originating from rainfall that penetrates the earth's surface and fills soil cavities or pores (Bambang et al., 2022). Groundwater serves multiple purposes including human consumption, agriculture, industry, and supporting numerous groundwater-dependent ecosystems (Bordbar et al., 2023; Crayol et al., 2024; Kuang et al., 2024). Excessive groundwater extraction in coastal areas results in progressive land surface decline, facilitating seawater intrusion into terrestrial areas (Shinawi et al., 2022; Truong et al., 2025). Groundwater taxation implementation serves multiple purposes, particularly reducing negative externalities potentially generated by excessive groundwater utilization.

Indonesia currently experiences a critical land subsidence crisis in DKI Jakarta, particularly in northern regions including Pademangan, Ancol, Penjaringan, Cengkareng, Tanjung Priok, Cilincing, Pulogadung, Muara Baru Pluit, Graha Sunter, and Marunda, where continuous subsidence persists. This phenomenon results from various factors, primarily excessive groundwater extraction (Witarsa et al., 2021). Furthermore, DKI Jakarta's position as Indonesia's economic center creates significant migration attraction for Indonesian citizens. Data presented in Figure 1 demonstrates continuous population growth in DKI

Jakarta over the past five years, implying increased clean water consumption, partially fulfilled through groundwater extraction.

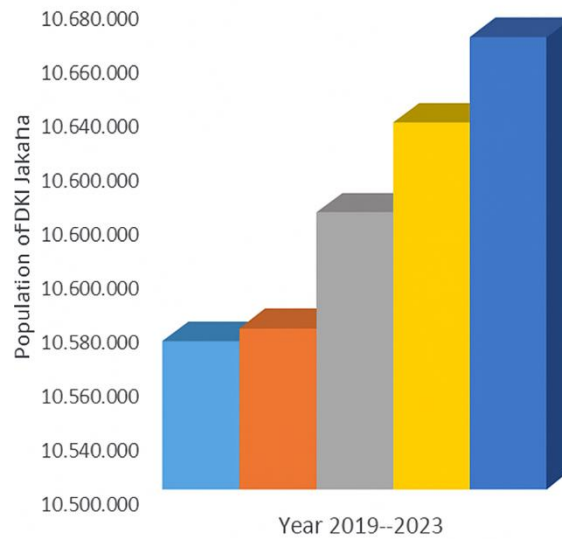


Figure 1 Population Data for DKI Jakarta 2019-2023
Source: Statistics Indonesia 2024. Reprocessed by authors

To address this issue, the government has implemented taxation on groundwater utilization, authorizing regional governments to collect Groundwater Tax (PAT). Historically, this tax type has existed since 2000 under Law No. 34 of 2000. Through continuous tax reform, PAT has undergone continuous development, with the most recent changes incorporated in Law No. 1 of 2022 concerning Financial Relations between Central and Regional Governments (UU HKPD). This regulation represents the realization of taxation's *regulerend* function, serving as an incentive to influence polluter choices that potentially generate significant negative impacts. Consequently, taxation functions not solely as revenue enhancement but also as regulatory mechanism, particularly for activities capable of generating negative externalities in both short and long terms.

Table 1 Comparison of Groundwater Usage and PAM Water Distribution in DKI Jakarta 2019–2023

Year	Groundwater Usage (m ²)	PAM Water Distribution (m ³)
2019	6.693.949	631.957.814
2020	6.014.240	623.538.678
2021	5.893.788	633.339.522
2022	5.342.680	635.819.589
2023	5.018.895	656.400.453

Source: Statistics Indonesia 2024. Reprocessed by authors

Table 1 reveals a significant disparity between groundwater usage and PAM water distribution, indicating that the differential water usage among DKI Jakarta residents remains undocumented regarding data and fulfilment status.

Table 2 Percentage Change Comparison of Groundwater Usage and PAM Water in DKI Jakarta 2019-2023

Year	Groundwater Usage Change (%)	PAM Water Usage Change (%)
2019	-10.16%	-1.33%
2020	-2%	+1.57%
2021	-9.35%	+0.39%
2022	-6.06%	+3.24%
2023	-10.16%	-1.33%

Source: Based on Table 1 data, reprocessed by authors

These data demonstrate that percentage decreases in groundwater usage are disproportionate to increases in PAM water usage, consequently raising questions regarding alternative clean water sources sought by residents. Based on these conditions, this research aims to examine Groundwater Tax implementation in Indonesia, identify groundwater usage conditions in DKI Jakarta, and analyze supervision strategies that DKI Jakarta Provincial Government can implement. Research findings are expected to enrich academic literature regarding regional taxes as *regulerend* instruments, while simultaneously increasing public awareness of PAT importance and providing policy recommendations for government regulatory and supervision strengthening of groundwater utilization in urban areas vulnerable to environmental crises.

LITERATURE REVIEW

Externality Theory

Musgrave and Musgrave (1993) defined externalities as “situations where consumption benefits are shared and cannot be limited to particular consumers, or where economic activity results in social costs which are not paid for the producer or the consumer who causes them.” They argued that negative externalities can occur during consumption activities. Excessive groundwater utilization or exploitation causes environmental damage and disrupts groundwater conservation, consequently generating substantial remediation costs disproportionate to benefits obtained (Musgrave, 1959; Musgrave & Musgrave, 1993).

According to Pigou (1932), externalities can be internalized through fiscal instruments such as Pigouvian taxes imposed on environmentally damaging activities. OECD (2020) emphasize that well-designed environmental taxes can serve as effective mechanisms for correcting societal behavior and reducing pressure on natural resources. Consequently, Indonesia's Groundwater Tax (PAT)

can be positioned as an internalization instrument for negative externalities from groundwater exploitation. In addressing negative externalities, government intervention is necessary for effective problem resolution, with taxation serving as one primary instrument (Velati & Pudjolaksono, 2023). Fundamentally, taxation imposes burdens on various parties; however, taxation also serves regulatory functions to achieve predetermined objectives (Markevych & Parasii-Verhunencko, 2024; Serhii, 2021).

Tax Policy

Fiscal policy can be understood through two perspectives. According to Mansury (2003), fiscal policy in its broad sense encompasses government efforts to influence societal production patterns, employment opportunities, and inflation levels through taxation instruments and government expenditure. In its narrow sense, fiscal policy relates directly to determining tax subjects, tax bases, tax liability calculations, and payment mechanisms (Rosdiana & Irianto, 2012). Mansury (2003) defined tax policy as government decisions aimed at supporting state revenue while creating more conducive economic conditions. Additionally, tax policy serves as a mechanism for increasing revenue through taxation sectors to fulfill state funding requirements. In collection processes, taxation is positioned as government action whose proceeds serve state and societal interests (Alimbudiono & Jie, 2024).

Taxation functions extend beyond revenue enhancement (*budgetair*) to include *regulerend* functions that are regulatory in nature. The *regulerend* function provides government opportunity to influence societal behavior, for instance, by offering incentives through tax reductions for activities promoting economic growth or, conversely, imposing high tax rates on activities generating negative environmental externalities. Consequently, taxation is not merely perceived as revenue source but also as public policy instrument capable of creating balance between state fiscal interests and societal socio-economic interests (OECD, 2020).

Earmarked Tax

Tax collection policies are fundamentally implemented to achieve specific government-determined objectives. One form of tax collected for specific purposes is termed earmarked tax, defined as “tax collected and used for a specific purpose” (Kusyeni et al., 2021; Stadnick et al., 2024). In earmarked tax collection, taxes are generally combined with subsidies, as stated by Millock: “such systems combining a tax and subsidy are commonly called 'earmarked tax' systems” (Rosdiana & Irianto, 2012). Additionally, Ismail explains that earmarking represents counter-performance whose designation must be determined by law and implementing regulations, ensuring legal certainty regarding counter-performance obligations in service provision and percentages that regional governments can allocate for relevant tax services. The government emphasizes that legal certainty principles are

fundamental in good governance, emphasizing compliance with regulations, justice, and certainty in every policy.

Public Policy

Scholars present varying perspectives in defining public policy. Eyestone (1971) stated that public policy represents the relationship between government units and their environment. However, May (1975) thought that Robert Eyestone's statement overly broad and difficult to comprehend. Consequently, she concluded her own understanding of public policy as relating to two aspects: public policy implementation requires specific actions to achieve objectives, and measures exist to assess objective achievement progress (May, 1975; Pilar et al., 2022). Furthermore, some studies quoted Thomas R. Dye's definition of public policy as "whatever governments choose to do and not to do," which can be interpreted as government actions encompassing what must and must not be done (Howlett & Cashore, 2014; Reynolds et al., 2020).

Public policy can be concluded as a series of decisions or actions determined by government as efforts in performing their duties of regulating, directing, or providing services. Consequently, public policy also encompasses implementation, supervision, evaluation, and adaptive actions to ensure that expected objectives or essence are achieved.

Regional Tax

Regional tax represents a fiscal instrument that constitutes part of regional government authority within the fiscal decentralization framework. Sunarti (2018) defined regional tax as both original regional tax and state tax transferred to regions, with collection conducted by regional governments themselves to finance regional expenditures and fulfil obligations to regulate and manage their affairs. This definition emphasizes regional tax function as the primary financial source for regional autonomy implementation.

Sunarti (2018) explained that regional tax can be understood through several forms. First, tax collected directly by regional government based on regional regulations. Second, collection based on national regulations with rate determination delegated to regional government. Third, tax determined and collected entirely by regional government. Fourth, collection conducted by central government with proceeds shared with regional governments through revenue-sharing mechanisms. These definitional variations demonstrate different authority dimensions in regional tax management, depending on regulatory sources and applied management models.

Within Indonesia's positive law context, regional tax is comprehensively regulated in Law No. 28 of 2009 concerning Regional Tax and Regional Retribution. This law grants authority to provincial and district/city governments to collect specific tax types while observing justice, legal certainty, and administrative

efficiency principles. Groundwater Tax (PAT) represents one regional tax object managed by provincial government, thus holding strategic position both as revenue source and *regulerend* instrument for controlling water resource utilization (Mulyanti et al., 2023, 2024).

Groundwater Tax

Groundwater represents an important instrument in water resources that provides water supply for ecosystems, particularly populations (humans) and economic activities. Waltz (2021) defined groundwater as a water found beneath the earth's surface, sand, or rocks. Generally, groundwater utilization can exceed daily capacity without proper supervision. When utilization exceeds capacity, it is no longer termed groundwater utilization but rather subsurface material mining (Fang et al., 2022). Consequently, maintaining groundwater availability to support living beings' basic needs requires supervision of water volume usage, which can be implemented through Groundwater Tax application.

Groundwater tax represents taxation on groundwater extracted and utilized, specifically water located in soil layers or rocks beneath the earth's surface (Mulyanti et al., 2024). Fundamentally, groundwater tax shares similar essence with environmental tax implementation (Mulyanti et al., 2023). Consequently, groundwater tax represents one government instrument for controlling excessive groundwater usage, leading to the conclusion that environmental tax implementation aims to fulfill taxation's *regulerend* function

Law Enforcement

Tax collection must be based on legal certainty for both tax authorities and taxpayers. This certainty encompasses who is subject to taxation, applicable tax objects, payable rates, and required payment procedures. If tax governance lacks clarity, opportunities for disputes between tax officials and taxpayers will emerge. Taxpayers must pay taxes clearly without room for negotiation or compromise (Suandy, 2016). To ensure legal certainty in taxation, tax regulations must be continuously improved and adapted to evolving social and economic dynamics. Legal certainty in taxation must be supported by clear and detailed guidelines in tax collection processes, including advance rulings or other forms of legal interpretation that can provide clarity for taxpayers (Gorodilov, 2022).

RESEARCH METHODOLOGY

This study employs a literature review research methodology, defined as the process of collecting, comparing, evaluating, and synthesizing previous research (Robinson & Lowe, 2015; Snyder, 2019). This research constitutes a review of literature relevant to groundwater usage conditions in DKI Jakarta and its relationship with DKI Jakarta government policies in supervising Groundwater Tax

implementation as an instrument for controlling negative externalities (Agustina & Inayati, 2020).

This study utilizes secondary data sources that have been processed and presented by the OECD and previous researchers, presented in the form of figures and tables within this research. Through this methodology, research can be conducted by expanding and comparing insights across literature addressing groundwater usage conditions in DKI Jakarta. Other research highlights how DKI Jakarta government supervises Groundwater Tax implementation. Through detailed findings from various sources, this study aims to analyze, evaluate, and present alternative strategies that can serve as solutions to groundwater problems in DKI Jakarta.

RESULT AND DISCUSSION

Overview and Regulerend Function of Groundwater Tax

Groundwater Tax (PAT) constitutes one type of regional tax regulated under Law No. 28 of 2009 concerning Regional Tax and Regional Retribution. This tax is collected by provincial governments with the primary objective of increasing regional revenue while controlling groundwater exploitation. PAT implementation in Indonesia demonstrates taxation function dualism, namely the budgetair function for increasing regional revenue and the regulerend function for limiting excessive groundwater utilization (Mulyanti et al., 2023, 2024). However, field implementation has not been fully optimal. Various studies indicate that taxpayer compliance levels remain low, groundwater usage reporting transparency is limited, and regional government supervision remains weak due to limitations in human resources and supporting technology (Ananta et al., 2024).

Groundwater Tax (PAT) represents one regional tax collected at the district/city level. According to Article 1 Number (55) of Law No. 1 of 2022 concerning Financial Relations Between Central and Regional Governments (UU HKPD), Groundwater Tax (PAT) constitutes tax imposed on groundwater extraction and/or utilization. Groundwater is defined as water contained within soil layers or rocks beneath the earth's surface (Article 1 Number (56) UU HKPD). According to its definition, groundwater tax objects encompass groundwater extraction and/or utilization, while tax subjects comprise individuals or entities conducting groundwater extraction and/or utilization activities.

Based on Article 65 Number (2) UU HKPD, several exemptions from Groundwater Tax objects include extraction and/or utilization of groundwater used for:

1. Household needs
2. Basic household needs
3. Community agricultural irrigation
4. Community fisheries

5. Community livestock
6. Religious purposes
7. Other activities regulated by Regional Regulations

Groundwater Tax (PAT) represents one regional tax instrument and constitutes implementation of taxation's regulatory function (regulerend function). Groundwater Tax (PAT) policy is implemented to prevent various negative externalities, such as water pollution occurring due to deep well extraction or drilling, land subsidence due to limited groundwater, reduced water availability and sources that may cause drought, and others. Groundwater Tax (PAT) is expected to provide positive impacts in preventing various negative externalities. Fundamentally, water constitutes a vital basic need concerning the livelihood of many people. Therefore, earth, water, and natural resources contained therein are controlled by the state and utilized for the greatest prosperity of the people.

Groundwater Usage Conditions in DKI Jakarta

DKI Jakarta represents one region where 36% of the population still utilizes groundwater to fulfill daily needs (Taftazani et al., 2022). This situation necessitates proper and systematic water management systems, as well as supervision and monitoring of groundwater sources for consumption. In reality, groundwater usage in DKI Jakarta experiences decreased availability due to excessive exploitation and pollution. Based on Central Statistics Agency (BPS) data in 2018, groundwater users reached 8,155,282 m³, slightly decreasing in 2019 to 6,693,949 m³ (DKI Jakarta Provincial Environment Agency, 2021). This groundwater availability decline is largely influenced by rapid population growth and land use conversion that reduces green open spaces. Only 14.9% of DKI Jakarta area constitutes green space, resulting in much rainwater that should be absorbed into soil becoming surface runoff and not adding to groundwater reserves. Massive urbanization impacts are also evident in increasingly depleted groundwater basin conditions, while water demand continues increasing.

Beyond quantity issues, groundwater quality in DKI Jakarta continues declining. Many areas experience severe pollution, particularly due to poorly managed domestic and industrial waste. Deputy for Maritime Affairs and Natural Resources Bappenas Vivi Yulaswati stated that 45% of DKI Jakarta areas have poor, damaged, and even bacteria-contaminated water quality according to 2018 data (Amani, 2023). Wells located too close to septic tanks, particularly in densely populated areas, constitute one primary cause of *Escherichia coli* (*E. coli*) bacterial contamination. This bacteria can cause serious health problems for residents who still rely on groundwater for daily needs. Other quality parameters such as total coliform, detergent, and heavy metal content also demonstrate relatively high pollution levels in several DKI Jakarta areas, particularly densely populated urban

areas such as West Jakarta and Central Jakarta (Dinas Lingkungan Hidup Provinsi DKI Jakarta, 2021).

Coastal areas such as North Jakarta and parts of East Jakarta also experience seawater intrusion problems that significantly increase groundwater salinity. High salinity indicates seawater intrusion contaminating groundwater layers, particularly in coastal area wells. Seawater intrusion poses serious threats to groundwater quality, as it not only damages water sources but also potentially damages underground infrastructure and causes health problems for residents using such water for daily needs.

Overall, groundwater usage conditions in DKI Jakarta face increasingly complex challenges. Beyond continuously increasing demand, groundwater quality continues declining due to domestic pollution and intrusion, as well as seawater intrusion problems in coastal areas. Therefore, DKI Jakarta government needs to implement strategic measures to protect these resources.

PAT Supervision Strategies Implemented by DKI Jakarta Government

Fundamentally, government cannot work independently in implementing specific policies or programs due to resource and network limitations. Therefore, collaboration-based governance systems involving various parties are necessary for more effective, efficient policy implementation not hindered by various constraints, such as high costs or regulatory complexity (Suryadi, 2021). This collaboration-based policy is also manifested in concrete regulations supporting groundwater supervision and utilization. One example is DKI Jakarta Governor Decree No. 279 of 2018, which regulates integrated supervision team formation to ensure compliance with infiltration well provision, wastewater treatment installation provision, and groundwater utilization in buildings and housing. Additionally, similar teams are formed at administrative city levels through coordination with Regional Tax and Retribution Agency branches, enabling more effective groundwater tax supervision and collection while supporting sustainable water resource management.

DKI Jakarta Provincial Government also involves several relevant agencies in groundwater tax supervision. Regional Revenue Agency (Bapenda) holds primary responsibility for groundwater tax collection, ensuring all taxpayers using groundwater pay according to applicable regulations. Water Resources Agency (SDA) plays roles in water resource management and supervises groundwater usage to prevent excessive exploitation while ensuring groundwater utilization complies with established regulations. Investment and One-Stop Integrated Service Agency (PTSP) handles groundwater usage permits for communities and business entities. This permit process is important because without official permits, groundwater usage can be considered illegal and subject to sanctions. Civil Service Police Unit (Satpol PP) also plays supervision roles, particularly in law enforcement aspects regarding illegal groundwater utilization violations. When illegal groundwater

usage cases without permits are discovered, Satpol PP has authority to take action according to applicable regulations.

Beyond government agencies, DKI Jakarta Government also collaborates with private sectors to ensure clean water availability as alternatives for communities to avoid complete dependence on groundwater. Regional Water Company (PAM Jaya) cooperates with two clean water service operators, PALYJA and AETRA. Both operators play important roles in distributing clean water to areas not yet fully covered by piped water systems, providing communities with alternatives other than groundwater extraction as their primary source.

To enhance supervision effectiveness, DKI Jakarta Government has begun adopting digital systems in groundwater tax monitoring. One innovative measure implemented is developing the Geology and Groundwater Information System (SIGA) managed by Water Resources Agency (SDA). This application is designed to record groundwater usage directly in the field through mobile devices, minimizing recording errors previously conducted manually. Nevertheless, integration improvements between SIGA and tax systems managed by Regional Revenue Agency (Bapenda) are still required so collected data can be automatically used in groundwater tax calculation processes.

Additionally, DKI Jakarta Government continuously conducts socialization and education efforts for communities regarding groundwater tax obligations and negative impacts of excessive groundwater exploitation on the environment. Socialization activities are conducted through various methods, including billboard installation, reminder letter distribution, and sticker placement at locations known to not fulfill their tax obligations. These measures aim to increase community awareness and encourage their compliance in paying groundwater taxes. Regarding law enforcement, government implements sanctions for violators who fail to pay groundwater taxes on time. Sanctions involve obligations to pay taxes twice the amount that should have been paid. However, this policy's effectiveness still faces constraints as many taxpayers continue avoiding payments. Therefore, supervision system and rule enforcement strengthening are necessary for significant improvements in community compliance regarding groundwater tax payments.

Challenges in Groundwater Tax Supervision in DKI Jakarta

Groundwater tax supervision in DKI Jakarta faces several complex constraints despite various implemented strategies. One primary challenge is low compliance levels and community awareness in fulfilling groundwater tax obligations. Many individuals and business operators use groundwater without obtaining permits and paying taxes they should bear. Minimal understanding regarding regulations and inadequate socialization distribution constitute primary causes of this problem. Some communities remain unaware that groundwater utilization incurs taxation and legal consequences for those failing to fulfill these obligations.

Limited human resource numbers in groundwater tax supervision constitutes major constraints in ensuring taxpayer compliance. With extensive coverage areas and high groundwater usage levels in Jakarta, available personnel numbers are disproportionate to supervision needs. Consequently, many violations remain undetected or are discovered only after impacts become more serious. Recording systems that remain largely manual further deteriorate situations, causing time gaps between groundwater usage recording and Regional Tax Assessment Letter (SKPD) issuance. These delays create opportunities for taxpayers to avoid their obligations and reduce supervision effectiveness (Salsabila et al., 2024).

Additionally, weak monitoring functions implemented by regional governments further deteriorate supervision conditions. Many illegal borehole usages remain unregistered, particularly in business areas such as Sudirman, Thamrin, and other commercial areas. These boreholes are often used without official permits and unreported in taxation systems, making it difficult for governments to identify and control their usage. Even for those with official permits, many violate regulations by using groundwater exceeding established limits. Weak monitoring mechanisms cause inaccuracies in groundwater usage data collection, ultimately hindering control and optimization of taxation collection in this sector (Nathania, 2023).

Overlapping authorities among various agencies involved in groundwater tax supervision also create obstacles. Regional Revenue Agency (Bapenda), Water Resources Agency (SDA), and Investment and One-Stop Integrated Service Agency (PTSP) have different roles in groundwater tax management and supervision. However, in practice, coordination among these institutions has not functioned optimally. Bapenda holds responsibility for tax collection, while Water Resources Agency oversees groundwater usage supervision, and PTSP handles permits. Task division misunderstandings cause weak supervision, where many illegal groundwater users remain undetected or do not receive appropriate sanctions.

Furthermore, inadequate binding regulations in inter-agency cooperation constitute another challenge in groundwater tax supervision. Currently, collaboration mechanisms among government agencies in groundwater tax supervision still rely on Memoranda of Understanding (MoU) or Cooperation Agreements (PKS), which are legally insufficient for effective rule enforcement. Several regions outside DKI Jakarta also have different regulations regarding groundwater tax management, making inter-provincial coordination remain a separate challenge. Dependence on gubernatorial policies also constitutes one constraint in groundwater tax supervision. Regulations governing groundwater taxes, including supervision policies and sanction implementation, depend on gubernatorial decisions that can change at any time depending on current leadership.

Based on research conducted by Dewanto et al. (2024), dependence exists on gubernatorial regulations and other agencies such as Water Resources Agency (SDA). This differs from other taxes that can be fully controlled by tax authorities, while groundwater taxes require coordination with relevant technical agencies, particularly regarding permits and groundwater meter usage supervision. This uncertainty can affect long-term policy consistency, ultimately impacting supervision effectiveness and taxpayer compliance.

Challenges in groundwater tax supervision in DKI Jakarta, such as low taxpayer compliance, weak inter-agency coordination, and regulatory uncertainty, do not occur only in Indonesia. Dutch experience in implementing groundwater tax (Groundwater Tax - GWT) provides valuable insights in understanding various challenges also faced by DKI Jakarta. The journal “The Life and Death of the Dutch Groundwater Tax” demonstrates that the Netherlands faced constraints ultimately leading to groundwater tax elimination in 2011. One primary challenge in the Netherlands was tax ineffectiveness in reducing groundwater consumption. GWT was designed as environmental tax aimed at reducing groundwater exploitation. However, in practice, this tax functioned more as fiscal tax rather than environmental control instrument. Absence of strict monitoring systems made tax impacts on groundwater conservation difficult to measure.

Conversely, groundwater tax in the Netherlands generated resistance from industry groups, particularly drinking water companies (DWCs). Approximately 90% of total groundwater tax revenue in the Netherlands was paid by around 10 largest drinking water companies. This created tax burden inequality causing political and economic pressure, enabling these companies to successfully lobby government for tax elimination.

This situation provides important lessons for DKI Jakarta, considering that in Indonesia, groundwater tax also tends to burden business and industry sectors more than households. If tax structures are not designed more fairly and transparently, resistance from industry sectors in DKI Jakarta could also increase, potentially weakening overall groundwater tax implementation.

The Netherlands also faced policy conflicts between national groundwater tax (GWT) and regional retribution (PGF - Provincial Groundwater Fee). PGF represents charges long implemented at provincial levels with proceeds directly used for groundwater conservation. GWT existence was considered disruptive to PGF effectiveness because tax proceeds entered state treasury and were not directly used for environmental improvement. Consequently, GWT lost legitimacy as environmental tax and was increasingly viewed merely as additional tax burdening industry.

In DKI Jakarta, similar challenges also emerge in the form of inadequate earmarking (specific allocation) from groundwater tax proceeds for groundwater conservation. Currently, groundwater tax revenue enters regional treasury without obligations for direct use in groundwater recovery or management programs. If this

policy is not improved, then as occurred in the Netherlands, groundwater tax in Jakarta could lose credibility and risk facing taxpayer rejection.

Additionally, Dutch experience demonstrates that without effective monitoring systems, groundwater tax struggles to achieve environmental objectives. In the Netherlands, this tax was imposed without mechanisms for monitoring groundwater consumption changes before and after tax implementation. Consequently, determining whether tax was truly effective in reducing groundwater extraction became difficult. In DKI Jakarta, despite existing monitoring systems such as Geology and Groundwater Information System (SIGA), integration with regional taxation systems remains suboptimal. If this system is not promptly improved, then groundwater tax effectiveness in Jakarta will also be difficult to measure.

Solutions for Groundwater Tax Supervision Challenges in DKI Jakarta

From institutional perspectives, Groundwater Tax supervision in DKI Jakarta can be optimized through strengthening more structured inter-institutional collaboration models with strong legal foundations. Currently, coordination among Bapenda, Water Resources Agency (SDA), PTSP, and Satpol PP still operates within respective main duties without truly integrative mechanisms. To address this challenge, cooperation agreements (PKS) that clearly regulate duties, responsibilities, and coordination mechanisms among relevant agencies are necessary. Role clarity will reduce authority overlaps and increase supervision effectiveness toward groundwater taxpayers.

Additionally, supervision institutions need support from technology-based monitoring systems, such as data integration from SDA regarding groundwater usage with tax systems at Bapenda. Currently, Geology and Groundwater Information System (SIGA) applications have been used by SDA to record groundwater consumption but remain unconnected directly with regional taxation systems. Through this integration, supervision can be conducted real-time and facilitate violation identification. Furthermore, human resource (HR) strengthening in groundwater tax supervision teams is necessary, considering current personnel numbers remain disproportionate to supervised area coverage. Training for tax officials and field supervisors is crucial for them to have capacity in analyzing groundwater usage data and implementing regulations effectively.

Beyond strengthening institutions and technology supervision, DKI Jakarta also needs to learn from Dutch experience in implementing groundwater tax. One primary factor causing Groundwater Tax (GWT) failure in the Netherlands was tax ineffectiveness in reducing groundwater exploitation due to weak monitoring systems. The tax was implemented without mechanisms for monitoring groundwater consumption before and after tax implementation, making it difficult to measure impacts on groundwater conservation. DKI Jakarta must avoid this mistake by strengthening monitoring systems through technology usage such as IoT

sensors and Geographic Information System (GIS)-based monitoring enabling more accurate and rapid supervision of groundwater usage. Through this approach, taxpayer compliance can be improved and tax effectiveness as regulerend instrument can be maintained.

Furthermore, Groundwater Tax failure in the Netherlands was also caused by inequality in tax burden distribution, where approximately 90% of total groundwater tax revenue originated from 10 largest drinking water companies. This created resistance from industries feeling unfairly burdened, enabling them to lobby government for tax elimination. DKI Jakarta can avoid this through implementing fairer and more proportional tax structures, where tax rates are based not only on groundwater usage volume but also consider environmental impacts generated by respective sectors. For instance, businesses or industries generating higher pollution should pay higher taxes, while users implementing water conservation technology could receive tax incentives.

This approach has been implemented in Germany, where tax amounts are determined based on generated pollution levels. Higher pollutant levels in wastewater result in higher taxes paid by business operators. Through this method, tax not only becomes regional revenue source but also provides incentives for companies to reduce groundwater exploitation and implement environmentally friendly technology.

DKI Jakarta also needs to avoid Dutch mistakes regarding non-transparent tax fund usage. Groundwater Tax in the Netherlands lost credibility because revenue entered state treasury without clear allocation for groundwater conservation programs. In DKI Jakarta, similar challenges also emerge in the form of inadequate earmarking (specific allocation) from groundwater tax proceeds for groundwater conservation. Currently, groundwater tax revenue enters regional treasury without obligations for direct use in groundwater recovery or management programs. If this policy is not improved, then as occurred in the Netherlands, groundwater tax in Jakarta could lose legitimacy and risk facing taxpayer rejection. Therefore, regulations are necessary specifying that portions of groundwater tax revenue must be specifically allocated for conservation programs, water management infrastructure development, or incentives for sectors attempting to reduce groundwater exploitation.

Beyond learning from the Netherlands, DKI Jakarta can also adopt data-based supervision models implemented in Germany. In Germany, every water usage and waste disposal must have permits granted based on Best Available Technology (BAT) standards. Supervision is conducted through discharge permit systems that regulate not only usage amounts but also discharged wastewater quality. In Indonesia, this system can be implemented by tightening groundwater usage permits and integrating them with digital monitoring systems enabling real-time supervision of water extraction volumes and environmental impacts.

Additionally, supervision in Germany is conducted through self-monitoring systems, where companies must regularly report their water consumption and waste pollution levels themselves. These reports are then verified by environmental authorities with powers to conduct audits and sudden inspections. Indonesia can adopt this approach by requiring every large-scale groundwater user to install digital measuring devices integrated with regional government systems. Government also needs to increase supervisor capacity and implement stricter sanctions for violators, such as fines calculated based on environmental damage levels.

Beyond technical aspects, inter-agency coordination also constitutes key success factors in groundwater tax supervision. In Germany, central and regional governments cooperate in implementing regulations and conducting monitoring, preventing policy overlaps. In Indonesia, coordination among regional tax agencies, environmental agencies, and groundwater management bodies needs strengthening for more integrated supervision. Every issued permit must be jointly supervised, and groundwater usage data must be transparently shared among agencies to prevent tax leakage and uncontrolled groundwater usage.

Through improvements in regulation, coordination, and technology utilization aspects, groundwater tax supervision in DKI Jakarta is expected to become more optimal. These measures will not only increase regional tax revenue but also assist in controlling excessive groundwater exploitation, minimizing negative environmental impacts. By learning from Dutch experience and implementing more strategic approaches like in Germany, DKI Jakarta can build more effective, fair, and sustainable groundwater tax systems.

The theoretical foundation of PAT as a Pigouvian tax, as referenced by Pigou (1932) and supported by contemporary OECD (2020) recommendations, assumes that taxation can effectively internalize environmental externalities through price mechanisms. However, empirical evidence from DKI Jakarta reveals significant limitations to this theoretical framework when applied in developing country contexts. Unlike the controlled market conditions assumed in Pigouvian tax theory, Jakarta's groundwater market is characterized by widespread informal usage, limited monitoring capacity, and substantial information asymmetries between regulators and users. This disconnect between theory and practice suggests that while Pigou's internalization concept remains valid, its practical application requires substantial institutional adaptations that go beyond simple tax imposition.

Furthermore, the OECD's assertion that well-designed environmental taxes can serve as effective behavioral correction mechanisms presupposes the existence of robust governance structures and enforcement capabilities. The Jakarta case demonstrates that without adequate institutional capacity, environmental taxes may paradoxically create perverse incentives, where formal sector users bear disproportionate tax burdens while informal users continue unregulated extraction. This challenges the universal applicability of OECD environmental tax guidelines

and suggests that developing countries require context-specific approaches that prioritize institutional strengthening alongside fiscal instrument implementation.

The concept of regulerend function, while theoretically sound, also faces practical limitations in Jakarta's implementation. Musgrave and Musgrave's (1993) framework assumes that regulatory taxes can modify behavior through cost-benefit calculations, yet evidence suggests that many groundwater users in Jakarta are driven by necessity rather than economic optimization. For households and small businesses lacking access to piped water alternatives, groundwater represents a survival necessity rather than an economic choice, rendering price-based regulation less effective than the theory predicts. This indicates that successful environmental taxation requires complementary policies ensuring alternative resource access before regulatory mechanisms can function as intended.

CONCLUSION

Groundwater Tax (PAT) represents a regional tax instrument with regulerend function in controlling groundwater exploitation and preventing negative impacts such as pollution, land subsidence, and reduced water availability. Although this tax aims to control groundwater usage, exemptions remain for specific uses such as household needs and community agricultural sectors according to UU HKPD provisions. In DKI Jakarta, groundwater usage remains high with approximately 32% of the population relying on it, despite decreasing availability due to excessive exploitation and land conversion. Additionally, groundwater quality deteriorates due to domestic and industrial waste pollution, as well as seawater intrusion threats in coastal areas. These conditions indicate that groundwater problems in Jakarta involve not only quantity but also quality aspects, necessitating stricter management and supervision strategies to maintain groundwater resource sustainability in the region.

Groundwater tax supervision in DKI Jakarta has been implemented through inter-agency collaboration approaches, technology utilization, and private sector involvement to reduce community dependence on groundwater. DKI Jakarta Provincial Government coordinates various institutions, including Regional Revenue Agency (Bapenda), Water Resources Agency (SDA), Investment and One-Stop Integrated Service Agency (PTSP), and Civil Service Police Unit (Satpol PP), in ensuring compliance with groundwater utilization regulations. Technology usage such as Geology and Groundwater Information System (SIGA) has begun implementation to improve groundwater tax recording and monitoring accuracy. However, in practice, supervision still faces various challenges, including low community compliance, limited human resources in supervision, and weak inter-agency coordination causing many violations to remain undetected. Additionally, much illegal groundwater usage persists due to inadequate socialization distribution and suboptimal law enforcement mechanisms. Overlapping authorities and

dependence on gubernatorial policies that can change at any time further complicate supervision and consistency in groundwater tax policy implementation.

Groundwater tax supervision optimization can be achieved through institutional strengthening, technology utilization, human resource improvement, and implementation of more effective incentives and sanctions. Currently, coordination among agencies such as Bapenda, SDA Agency, PTSP, and Satpol PP remains fragmented, necessitating clear cooperation agreements (PKS). Supervision can also be enhanced by integrating groundwater usage data from SDA Agency to tax systems at Bapenda, enabling real-time monitoring. From human resource perspectives, tax official and supervisor capacity improvement is necessary for them to analyze groundwater usage data and implement regulations effectively. To improve compliance, sanctions must be tightened, such as business license freezing for serious violators, and tax incentives for companies implementing water conservation technology.

Benchmarking from Germany demonstrates the importance of technology-based supervision systems, taxpayer self-monitoring, and environment-impact-based taxation. Indonesia can adopt this model by mandating digital measuring device installation and implementing taxation considering pollution levels and environmental impacts. Additionally, inter-agency coordination must be strengthened for more transparent groundwater usage data and tax leakage prevention. Through stricter regulations, better coordination, and technology utilization, groundwater tax supervision can become more optimal, increasing regional tax revenue while controlling excessive groundwater exploitation.

RECOMMENDATIONS

Currently, Indonesia, particularly DKI Jakarta government, faces challenges in maximizing groundwater tax implementation through supervision aspects. Inter-agency collaboration, technology utilization, and private sector involvement remain insufficient in optimizing groundwater tax supervision because many deficiencies require improvement and other factors affecting suboptimal supervision performance.

Therefore, DKI Jakarta government is strongly encouraged to participate more actively in groundwater tax supervision and implementation optimization through:

1. Ensuring monitoring and evaluation of impacts before and after tax implementation.
2. Determining clear proxies regarding tax implementation objectives, whether for revenue purposes or environmental conservation.
3. Designing more equitable and fair taxation to avoid political pressure that could undermine policy implementation.

4. Emphasizing transparency aspects by specifically allocating funds for programs supporting groundwater resource sustainability.
5. Implementing more flexible tax rates based on local environmental conditions and groundwater availability levels.
6. Strengthening governmental institutional systems.
7. Utilizing more advanced technology, possibly adopting supervision models from other countries such as Germany that mandate digital measuring device installation.
8. Strengthening coordination with parties collaborating with government.
9. Improving human resources for effective, equitable, and optimal supervision implementation.
10. Implementing incentives and sanctions (law enforcement) for parties conducting groundwater misuse/illegal extraction and/or arbitrarily without considering environmental damage impacts.

Through implementing these measures, groundwater tax supervision optimization is expected to improve and effectively prevent undesired negative externalities.

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