MITIGATING AQUIFER CRISIS IN INDONESIA'S NEW CAPITAL, NUSANTARA: PROBLEMS AND LESSONS LEARNED FROM SINGAPORE

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ABSTRACT

Water availability is crucial to every nation's capital. The appointment of Indonesia's new capital through Indonesian Law No. 3 of 2022 poses concerns regarding the aquifer crisis as Nusantara is located on top of medium- to low-productivity aquifers. The shift of the capital would entail groundwater resource utilization, which poses huge aquifer crisis risks. In contrast, Singapore, a city-state with limited aquifers, sufficiently mitigated the aquifer crisis due to its water management policy that could accommodate its citizens' water demands. In this paper, the authors conducted a comparative analysis of Singapore's water management policies to provide recommendations on the shift of Indonesia's capital to fulfill water demands and mitigate the aquifer crisis. Using a normative approach, this paper portrays the lessons that can be taken from Singapore in ensuring water availability amidst its limited water resources and high demand of water.

KEYWORDS

Nusantara, Water Availability, Water Management, Groundwater, Aquifer Crisis.

I. Introduction

Law No. 3 of 2022 on the New Capital marks Indonesia's decision to move its capital from Jakarta to Nusantara, Kalimantan.[1] From an urban science perspective, it seems logical to move Indonesia's capital as Jakarta is currently packed. The location also seems strategic as Kalimantan has a relatively low seismic activity, making it less prone to earthquakes.[2] However, keeping in mind the existing problems in Nusantara's location which affect its aquifer resources, i.e., deforestation and peat problems,[3] the following question arises: Will the shift of Indonesia's capital harm Nusantara's aquifer resources?

Aquifer resources and groundwater are vital in the development of cities and countries as they determine whether or not industrial and agricultural activities would be able to develop,[4] and as numerous regions rely on groundwater as the main source to fulfill water demands.[5] Recognizing such importance along with the water demands, aquifer resources are prone to overexploitation, which may result in problems starting from the decline of groundwater levels, land subsidence, and even the deterioration of aquifer resources. Undoubtedly, the aforementioned possible problems are threatening to communities and economic growth, especially in capital cities. As such, aquifer resources sustainability in capital cities should become a striking concern towards governments especially noting the importance of ensuring a harmonious balance between development and environmental preservation.

Despite the Mahakam River in East Kalimantan being resourceful with its ability to discharge 3,000 liters of water per second for 2.88 million people,[6]

[1] Indonesian Law No. 3 Year 2022 on New Capital.

[2] Tim Pusat Studi Gempa Nasional: *Peta Sumber dan Bahaya Gempa Indonesia Tahun 2017*. Indonesia, Badan Penelitian dan Pengembangan Kementerian Pekerjaan Umum dan Perumahan Rakyat, 2017. ISBN: 978-602-5489-01-3, p. 78.

[3] Theresia, Sihombing, R. M. – Simanungkalit, F: The Impact of Indonesia Capital Relocation to Kalimantan *Peatland Restoration. Sociae Polites, 21*(2), 2020, p. 234. https://doi.org/10.33541/sp.v21i3.2262.

[4] Uc-Castillo, J. L., et al.: A systematic review and meta-analysis of groundwater level forecasting with machine learning techniques: Current status and future directions. *Environmental Modelling & Software, 168*, 2023. https://doi.org/10.1016/j.envsoft.2023.10578.

[5] Malmir, M., et al.: Integrated groundwater management using a comprehensive conceptual framework. *Journal of Hydrology, 605*, 2022. https://doi.org/10.1016/j.jhydrol.2021.127363.

[6] Van, C. P., Brye, B. – Deleersnijder, E., Hoitink, A. J. F., Sassi, M., Spinewine, B., Hidayat, H., Soarez-Frazão, S. Simulations of the flow in the Mahakam river–lake–delta system, Indonesia. *Environmental Fluid Mechanics, 16*, 2016, p. 607. https://doi.org/10.1007/s10652-016-9445-4.

Nusantara's location does not have plenty of water[7] nor aquifer resources.[8] Contrastingly, Singapore, a city-state 175 times smaller than the size of East Kalimantan, also faces challenges in ensuring water availability due to its densely populated area and limited aquifers.[9] If Singapore is unable to prevent groundwater exploitation, the aquifer crisis is a situation waiting to happen. Therefore, the government has taken efforts to ameliorate the water management system, allowing Singapore to receive the Stockholm Water Industry Award in 2007. Efforts to enhance water security and ensure water self-sufficiency include the promotion of sustainable and water efficient practices, the usage of advanced technologies to ensure water availability as well as monitor aquifer resources, and effective urban planning to prevent aquifer-related issues from occurring.[10]

By observing measures adopted by Singapore in ensuring water availability and reducing aquifer resources exploitation, this paper aims to provide insightful solutions from Singapore's water management policies to the possible aquifer crisis flowing from the shift of Indonesia's capital. The authors aim to answer two main research questions. *First*, how will the shift of the capital city from Jakarta to Nusantara pose threats related to the aquifer crisis? *Second*, what lessons can be taken by the Indonesian government from Singapore to reduce aquifer crisis risks? Ultimately, these questions will pave a strategic pathway for Indonesia to mitigate an aquifer crisis through proactive and innovative water management approaches in its new capital city.

To address the posed inquiries listed above, this research employs a normative legal research approach, which includes dissecting normative standpoints of policies to provide recommendations, as well as a comparative

[7] *A tale of two cities: why Indonesia is planning a new capital on Borneo – and abandoning Jakarta.* The Conversation, 2022. https://theconversation.com/a-tale-of-two-cities-why-indonesia-is-planning-a-new-capital-on-borneo-and-abandoning-jakarta-podcast-181134 (2023.08.21); *Nusantara is set to be the new capital of Indonesia, but what will happen to Jakarta?*. ABC, 2022. https://www.abc.net.au/news/2022-01-30/what-will-happen-to-jakarta-when-indonesia-builds-a-new-capital/100784566 (2023.08.21).

[8] Herlambang, A: Estimation of Groundwater Potential of Penajam Region to Support the Need for Clean Waterin IKN Penajam East Kalimantan. *Jurnal Sains dan Teknologi Mitigasi Bencana, 16(2)*, 2022, p. 9.

[9] Gordon, J.: On the Road to Independence: The Case of Water Management in Singapore. *Ecological Urbanism, 11.308*, 2014, p. 1.

[10] Octastefani, T. – Kusuma, B. M. A.: Water Governance of Singapore in Achieving Sustainable Water Security. *Jurnal Pembangunan dan Alam Lestari, 7(1)*, 2016, pp. 1-10; Water Policy in Singapore. Lee Kuan Yew School of Public Policy, National University of Singapore, 2017. https://lkyspp.nus.edu.sg/gia/article/water-policy-in-singapore (2023.08.21).

approach between Singaporean and Indonesian laws. The authors refer to primary sources including Indonesian and Singaporean laws, secondary sources such as law, geography, and geology journals, articles, and textbooks, as well as tertiary sources by resorting to online libraries.

II. Analysis

Nusantara is located on top of medium- to low-productivity aquifers.[11] Not only are Nusantara's aquifers limited, but the scarce groundwater might not cater the needs of a capital city. Expected activities carried out in a capital entail huge water demands, and the excessive withdrawal of groundwater may affect aquifer levels. Thus, Nusantara is prone to risks of an aquifer crisis as evidenced by Jakarta's depletion of aquifer resources[12] stemming from the overpumping of groundwater.[13] Such risks raise the potential of land subsidence, sinkholes, and cracks in buildings,[14] and threaten the biodiversity of groundwater-dependent ecosystems.[15]

The urgency to address issues of an aquifer crisis is also due to the existence of the UN Sustainable Development Goals ("**SDGs**"), whereas a number of these SDGs are closely linked to groundwater exploitation. Among others, the following are the relevant SDGs in this issue: SDG 6 on clean water and sanitation; SDG 12 on responsible consumption and production; SDG 13 on climate action; and SDG 15 on life on land, which includes reversing land degradation.[16] Such is further highlighted under the 2030 Agenda for Sustainable Development, which promotes the sustainable use of natural resources as well as

[11] Herlambang, 2022, *op. cit*, pp. 9-10.

[12] Agustin, A. – Zulkhoiri, A. – Putra, R. D. – Irawan, D. E.: A Review of Groundwater Issues in Jakarta [Conference presentation]. *43rd IAH (International Association of Hydrogeologists Congress, Montpellier, France*, 2016.

[13] Onodera, S., et al.: Effects of intensive urbanization on the intrusion of shallow groundwater into deep groundwater: Examples from Bangkok and Jakarta. *Science of the Total Environment, 404(2-3)*, 2008, pp. 401-410. https://doi.org/10.1016/j.scitotenv.2008.08.003.

[14] Khanlari, G., et al.: The effect of groundwater overexploitation on land subsidence and sinkhole occurrences, West of Iran. *Quarterly Journal of Engineering Geology and Hydrogeology, 45(4)*, 2012, pp. 447-456. https://doi.org/10.1144/qjegh2010-069

[15] Devitt, T. J. – Wright, A. M. – Cannatella, D. C. – Hillis, D. M.: Species delimitation in endangered groundwater salamanders: Implications for aquifer management and biodiversity conservation. *Proceedings of the National Academy of Sciences, 116(7)*, 2019 https://doi.org/10.1073/pnas.181501411.

[16] United Nations Department of Economic and Social Affairs: *The 17 Goals*. 2023. https://sdgs.un.org/goals (2023.08.21).

the protection and restoration of water resources including aquifers.[17] As in numerous instances, Indonesia and Singapore have expressed their commitment to support the SDGs,[18] and the search for ways to further develop Indonesia's water management system will help the nation in accomplishing its SDGs-related targets, subsequently allowing more Indonesian citizens to enjoy the benefit of sustainable water resources use.

Recognizing the need to search for alternatives to groundwater in fulfilling Indonesia's water demands whilst taking into account the relevant SDGs above, the authors would like to analyze Singapore's ability to fulfill its water demands. Despite Singapore's densely populated area, the considerable water demand, along with the limited aquifer resources that the country has, Singapore has skillfully established a considerably successful water management system whilst ensuring the sustainability of water resources.

1. Singapore's Practice in Fulfilling Water Demands

In Singapore, the Public Utilities Board ("**PUB**") under the Ministry of Sustainability and the Environment of the Government of Singapore is mainly responsible to oversee the hydrologic cycle of the country. Presently, the Singaporean government relies on 4 sources to ensure water availability named the "Four National Taps of Singapore", which is meticulously overseen by the PUB.[19] This approach allows the blend of imported water, local catchment water, highly

[17] United Nations: *Transforming our World: The 2030 Agenda for Sustainable Development*. 2015. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf (2023.08.21).

[18] Singapore Ministry of Foreign Affairs: *Sustainable Development*. 2023. https://www.mfa.gov.sg/SINGAPORES-FOREIGN-POLICY/International-Issues/Sustainable-Singapore Ministry of Foreign Affairs: Development#:~:text=Singapore%20supports%20the%202030%20Agenda,and%20achieve%20the%20SDGs%20globally (2023.10.04); The Jakarta Post: *Indonesia aims to increase SDG achievement through cross-country partnerships*. 2023. https://www.thejakartapost.com/business/2023/07/11/indonesia-aims-to-increase-sdg-achievement-through-cross-country-partnerships.html (2023.08.21); Kagda, S.: *Indonesia launches investor map on sustainable development goals*. The Business Times, 2022. https://www.businesstimes.com.sg/international/asean-business/indonesia-launches-investor-map-sustainable-development-goals (2023.08.21).

[19] Chua, L. – Eikass, H. S.: The Four National Taps of Singapore: A Holistic Approach to Water Resources Management from Drainage to Drinking Water. *Journal of Water Management Modeling, 22*, 2014, pp. 1-3. https://doi.org/10.14796/JWMM.C375.

purified reclaimed water, as well as desalinated water to meet the country's water demands.

1.1. Water imported from Johor, Malaysia

Since Singapore's independence, the country has primarily relied on water supplied by Johor, Malaysia, which is in accordance with a bilateral agreement extending to 2061.[20] Back in 2015, it was recorded that the imported water from Johor, Malaysia met about 40% of Singapore's water demands.[21] To date, Singapore still relies on water imported from Malaysia, but the country is obligated to provide Malaysia with daily supply of treated water amounting to up to 2% of the water that is imported to Singapore.[22] Although the agreement is effective until 2061, the Singaporean government aims to reduce the amount of import water supplied from Malaysia.[23] Regardless, Singapore's goal is to avoid being dependent on external water sources such as from Malaysia and enhance its technologies to make the country water self-sufficient.[24]

1.2. Rainwater harvesting through local catchments and reservoirs

In regards to rainwater harvesting, Singapore has utilized a substantial amount of its land – which is around two-thirds of Singapore's land – and created a network of canals that are able to capture rainwater. The rainwater is then stored in reservoirs throughout the country;[25] this effort creates water supply whilst also controlling floods.[26] The Singaporean government aims to increase the area of land that will be able to capture rainwater up to 90% by the year 2060 whilst ensuring that the water quality is maintained.[27] In maximizing rainwater harvesting, the Singapore PUB has resorted to numerous initiatives, such as the installation of

[20] Lafforgue, M. – Lenouvel, V.: Closing the urban water loop: lessons from Singapore and Windhoek. *Environmental Science Water Research & Technology, 1*(5), 2015, pp. 624. https://doi.org/10.1039/c5ew00056d.
[21] *Ibid.*
[22] Ministry of Foreign Affairs, Singapore: *Water Agreements*.. https://www.mfa.gov.sg/SINGAPORES-FOREIGN-POLICY/Key-Issues/Water-Agreements#:~:text=Yes.,the%20water%20supplied%20to%20Singapore (2023.08.21).
[23] Lafforgue, 2015, *op. cit.* pp. 622-631.
[24] Chua, 214, *op. cit.*, p. 3.
[25] *Ibid.*
[26] Hindiyeh, M. Y. – Matouq, M. – Eslaiman, S.: *Rainwater Harvesting Policy Issues in the MENA Region: Lessons Learned, Challenges, and Sustainable Recommendations* in *Handbook of Water Harvesting and Conservation*. United Kingdom, John Wiley & Sons, Inc, 2020, p. 18.
[27] *Ibid.*

raingardens, stormwater planters, which can be seen around Singapore's shopping areas, pervious pavements, which can be seen in most Singaporean public housing and parking lots, floating wetlands, constructed wetlands, as well as green roofs.[28]

1.3. Reclaimed water

Singapore's prominent water recycling technology which is produced by the PUB is known as NEWater; the technology essentially converts water from urban sewage treatment plants to high-grade clean reclaimed water.[29] In attaining the final results of NEWater, the technology utilizes a 3-step purification process consisting of microfiltration, reverse osmosis, and ultraviolet disinfection.[30] Commonly, clean water from NEWater is used for industrial purposes by various industries and for the purpose of air conditioning cooling in commercial buildings.[31] Such technology undoubtedly plays a major role in conserving water, understanding that industries and commercial buildings entail a huge demand of water.

The PUB has ensured that the quality of water produced under NEWater has been approved by the World Health Organization and the United States Environmental Protection Agency as safe to be consumed as drinking water.[32] Moreover, NEWater has been predominantly used to replace portable water in the industrial processing sector.[33] Accordingly, most recent studies reflect that NEWater is able to provide for 30% of Singapore's water demands and that the Singaporean government is expecting that NEWater will be able to meet 50% of Singapore's water demand by 2060.[34] It is to be noted, however, that the primary

[28] Chua, 214, *op. cit.*, pp. 4-6.
[29] Bai, Y., et. al.: Long-term performance and economic evaluation of full-scale MF and RO process – A case study of the changi NEWater Project Phase 2 in Singapore. *Water Cycle, 1*, 2020. https://doi.org/10.1016/j.watcyc.2020.09.001.
[30] *Ibid.*
[31] *NEWater in Singapore Fact Sheet*. Hong Kong Research Office Legislative Council Secretariat, 2016). https://www.legco.gov.hk/research-publications/english/1516fsc22-newater-in-singapore-20160226-e.pdf
[32] Singapore Public Utilities Board (PUB): *PUB Innovation Magazine Issue 12*. 2022. https://www.pub.gov.sg/Documents/PUBInnovationMagazineIssue12_11042022.pdf (2023.08.19).
[33] Chua, 214, *op. cit.*, p. 3.
[34] *Ibid.*

concern surrounding NEWater is the fact that this process entails high energy consumption.[35]

1.4. Seawater desalination

In the 1970s, the Singapore Water Plan highlighted advanced technologies, allowing the PUB to look into both seawater desalination technologies and the previously elaborated water recycling technologies; both technologies are currently relied on in ensuring Singapore's water availability. Regardless, Singapore currently has 5 desalination plants, namely SingSpring Desalination Plant, Tuas South Desalination Plant, Tuas Desalination Plant, Marina East Desalination Plant, and Jurong Island Desalination Plant.[36] By 2060, the Singaporean government expects that desalinated water will be able to provide Singapore with 30% of its water demand.[37]

Regardless of seawater desalination technologies' ability to aid in fulfilling water demands, similar to NEWater, such technologies have been considered to be costly. Accordingly, numerous countries have considered seawater desalination technologies as the last resort to fulfill water demands.[38] Furthermore, the PUB considered desalinated water as the water source consuming the most energy out of all Four National Taps of Singapore.[39] Therefore, the PUB has worked with numerous industry partners to develop new water desalination technologies which require less energy consumption to reduce production costs.[40] Such effort is exemplified by the PUB's grant to a technology firm named DuPont to research on how certain technologies can be implemented into seawater desalination processes in allowing the process to be more energy efficient.[41]

[35] Lafforgue, *op. cit.,* p. 628.

[36] Singapore Public Utilities Board (PUB): *Desalinated Water*. https://www.pub.gov.sg/watersupply/fournationaltaps/desalinatedwater (2023.08.21).

[37] Singapore Public Utilities Board (PUB): *Tuas Nexus: Singapore's Next Generation Integrated Waste and Water Management Facility*., 2021. https://www.pub.gov.sg/Documents/TDPBrochure_Final.pdf (2023.08.21).

[38] Chua, 214, *op. cit*., p. 3.

[39] Hong Kong Research Publications of the Legislative Council Secretariat: *Seawater Desalination in Singapore*., 2016. https://www.legco.gov.hk/research-publications/english/1516fsc21-seawater-desalination-in-singapore-20160226-e.pdf (2023.08.21).

[40] *Ibid.*

[41] Smart Energy International: *Singapore Invests In Energy-Efficient Water Desalination*. https://www.smart-energy.com/energy-efficiency/singapores-invests-in-energy-efficient-water-desalination/ (2023.08.21).

2. Singapore's Practice in Minimizing Risks of Endangering Aquifer Resources

Acknowledging Singapore's high water demand and its limited aquifers, the authors also looked into Singapore's water management policies. In responding to these challenges, Singapore has adopted a proactive approach by revising its legal framework to promote the importance of water conservation. As mentioned in the previous section, the PUB was given the pivotal authority to control Singapore's water management.

Singapore has set an ambitious goal for the near future: by 2030, the Singaporean government aims to reduce its water demands to 130 litres per person per day.[42] Singapore's commitment is in particular noteworthy provided that as of 2021, each individual consumed approximately 158 litres of water daily.[43] The city-state also focused on the following measures,[44] collectively contributing in minimizing the risk of endangering Singapore's aquifer resources:

2.1. Water Pricing

The Singaporean government has introduced incentive-based water billings, which requires investing in water meters,[45] taxes,[46] and periodic water price revisions. By combining these efforts, Singapore has not only encouraged responsible water consumption but also provides a sustainable framework to support water infrastructure development and conservation efforts through water pricing. Singapore's water pricing in citizens' monthly water bill consists of the following components:[47]

[42] Singapore Public Utilities Board (PUB): *Save Water*. https://www.pub.gov.sg/savewater (2023.08.21).
[43] The Straits Times: *Budget Debate: Daily consumption of water rose again in 2021 to reach 158 litres per capita*. 2022. https://www.straitstimes.com/singapore/politics/budget-debate-daily-consumption-of-water-rose-again-in-2021-to-reach-158-litres-per-capita#:~:text=SINGAPORE%20%2D%20Household%20water%20consumption%20is,lowest%20since%202015's%20151%20litres (2023.08.21).
[44] PricewaterhouseCoopers: *Singapore Water Management Framework*. https://www.gfdrr.org/sites/default/files/D3_CaseStudy14_PwC_WB_Water_Sector_in_Singapore_20160709.original.1531383095.pdf (2023.08.21).
[45] Lafforgue, *op. cit*., p. 628.
[46] Singapore Goods and Services Tax Act 1993 Rev. Ed. 2020.
[47] Sanlath, C. & Masila, N. M.: Water demand management: What lessons can be learned from Singapore's water conservation policy?. *Water Utility Journal, 26*(1), 2020, pp. 1-8.

a. Water tariff: Imposed in association with the costs incurred in the different stages of water production, namely the collection of rainwater, the treatment of raw water, as well as the distribution of water to citizens through water pipelines.[48] Water tariffs are charged according to citizen's water usage volume.[49]
b. Water conservation tax: Imposed in association with the conservation of water by reflecting the water scarcity value.[50]
c. Waterborne fee: Imposed in association with costs utilized to treat and maintain water.[51] Similar to water tariff, a waterborne fee is charged according to citizens' water usage volume.

From the above components, the water conservation tax was introduced in the 1990s along with Singapore's major revision of water price. Years after, the Singaporean government increased the water price in 2017 by 30%, which was the first revision of water price after 17 years. The water pricing revision successfully lowered household water consumption in the following year by 5 litres per capita from 148 litres per capita to 143 litres per capita.[52]

2.2. Water Conservation

The Singaporean government has adopted numerous water conservation policies aimed at cutting down excessive water waste and the flow of water.[53] This commitment is reflected by the implementation of various measures as stated below that are designed to tackle water inefficiency and encourage responsible water consumption:

2.2.1. Water Efficiency Labelling Scheme

The Water Efficiency Labelling Scheme is a grading system which indicates a product's water efficiency level.[54] Products that are covered by the Water Efficiency Labelling Scheme include taps, dual-flush low capacity flushing cisterns,

[48] Singapore Public Utilities Board (PUB): *Water Price.* https://www.pub.gov.sg/watersupply/waterprice (2023.08.21).
[49] *Ibid.*
[50] Sanlath, *op. cit.*, pp. 1-8.
[51] *Ibid.*
[52] PricewaterhouseCoopers, *op. cit.*
[53] *Ibid.*
[54] Singapore Public Utilities Board (PUB): *About Water Efficiency Labelling Scheme (WELS).* https://www.pub.gov.sg/wels/about (2023.08.21).

washing machines, dishwashers, urinal flush valves,[55] and many more other products which involve the utilization of water. According to this scheme, suppliers and retailers must first comply with existing requirements set by the PUB – in particular to gain water efficiency labels – before advertising, displaying, and selling their products in Singapore.[56]

Essentially, the Water Efficiency Labelling Scheme was established in 2006 to promote water conservation by the reduction of water consumption as Singaporean citizens are aware of whether or not products are water efficient. This measure also encourages vendors to produce products that are more water efficient, as this would affect whether or not Singaporean citizens would prefer purchasing such products.[57] In consequence, Singaporean citizens can make an informed choice when purchasing products that are subject to the Water Efficiency Labelling Scheme.

2.2.2. Water Efficiency Management Plan

Under the same goal to measure water efficiency, Singapore also adopted the Water Efficiency Management Plan which has been applicable since 1 January 2015. Essentially, large water users with at least 60,000 cubic metres' water consumption are required to notify the PUB. Large water users are not only required to notify the PUB, but they are also subjected to requirements to install private water meters to track their water usage as well as submit their Water Efficiency Management Plans annually to the PUB.[58] These measures are carried out as an attempt to provide Singaporean citizens that fall under the category of large water users information regarding water usage within their premises as well

[55] Singapore Public Utilities Board (PUB): *WELS Requirement*. https://www.pub.gov.sg/Documents/WELS_Requirement.pdf (2023.08.21).

[56] Singapore Accreditation Council: *WELS Guidebook*. 2018. https://www.sac-accreditation.gov.sg/files/documents/management-system-and-products-certification/WELS-Guidebook-(4-May-18).pdf (2023.08.21), p. 1.

[57] WELS Guidebook, *op. cit*., p. 1.

[58] . Singapore Public Utilities Board (PUB): *Simple Guide and Frequently Asked Questions of Water Efficiency Management Plan*. https://www.pub.gov.sg/Documents/Simple%20Guide%20and%20Frequently%20Asked%20Questions%20of%20Water%20Efficiency%20Management%20Plan%20(PDF).pdf (2023.08.11).

as identify specific ways in which water consumption can be reduced and water efficiency can be increased.[59]

Although the Water Efficiency Management Plan and water efficiency management practices are regulated under the 2014 Public Utilities (Water Supply) Regulations,[60] the Water Efficiency Management Plan may be deemed to give large water users and companies an additional task to submit such plans. Accordingly, the PUB provides ways to support companies for compliance with the said water efficiency management efforts. The PUB provided and enhanced incentives for water recycling and/or the use of alternative water sources under the Water Efficiency Fund.[61]

2.2.3. Smart Water Meters to Increase Citizens' Awareness of Water Usage Behavior

The PUB invests in the water meter installations in households to raise citizens' awareness of water usage.[62] In 2021, the Singapore Power ("**SP**") Services plans on installing 300.000 smart water meters where the first phase of the smart water meter programme is aimed to be completed by the year 2023; the initiative is part of Singapore's national plan to digitalize the water system and allow Singaporean citizens to monitor their water usage.[63] With the smart water measure, users can be more aware of their water usage behaviour as they can review their hourly and daily water usage. Accordingly, Singaporean citizens can be more efficient in using water, which both saves water and money.

2.3. Public Education

Understanding the importance of water conservation, the government conducted numerous campaigns to increase public awareness.[64] Such measures were successful as reflected by Singapore's NEWater winning the UN-Water Best

[59] Singapore Public Utilities Board (PUB): *Management Practices.* https://www.pub.gov.sg/savewater/atwork/managementpractices (2023.08.21).
[60] Singapore Public Utilities (Water Supply (Amendment No. 2) Regulations 2014, Part IVA.
[61] *Simple Guide and Frequently Asked Questions of Water Efficiency Management Plan, op. cit.*
[62] Singapore Public Utilities Act (Chapter 261, Section 72) G.N. No. S 584/2002 Rev. Ed. 2004.
[63] The Straits Times: *First 300,000 smart water meters in S'pore to be installed by SP Services from 2022*. https://www.straitstimes.com/singapore/first-300000-smart-water-meters-in-spore-to-be-installed-by-sp-services-from-2022 (2023.08.21).
[64] Tortajada C. – Joshi, Y.K.: Water Demand Management in Singapore: Involving the Public. *Water Resources Management, 27(8)*, 2013, pp. 2729–2746. https://doi.org/10.1007/s11269-013-0312-5

Practices Award in 2014 for raising citizens' awareness.[65] Among others, the government educated the younger generations of Singapore by providing education at schools, provided water saving kits to households, conducted community campaigns, and granted awards to water efficiency performers.[66]

Singapore's PUB has even gone to the extent of introducing water conservation topics in school curriculums and formal education. Such measures include the study of water usage behaviors to encourage citizens to save water. Although public education may not be seen as groundbreaking, Singapore upholds the belief that by promoting water stewardship or the responsible management of water, Singaporean citizens will adopt a lifestyle that promotes water conservation.[67]

3. Status Quo in Indonesia

Upon analyzing the measures implemented in Singapore, it can be seen that several approaches taken by Singapore have been implemented in Indonesia. In particular, incentive-based water billings and investment in water meters have been implemented by the Indonesian government. Under existing Indonesian regulations, the Indonesian state-owned water utility (*Perusahaan Daerah Air Minum* or "**PDAM**") is under the obligation to replace water meters periodically at least once every 4 years.[68] In the case where Indonesian citizens' water meters are damaged before the 4-year period has elapsed, it is also still within the PDAM's obligation to replace such water meters. The practice, however, reflects that there are certain cases in which water meters are not immediately replaced after 4 years. PDAM Surya Sembada in Surabaya and PDAM Perumda in Makassar, for instance, replaced water meters that had been installed for more than 5 years.[69]

[65] *'Water for Life' UN-Water Best Practices Award*. United Nations, 2014. https://www.un.org/waterforlifedecade/winners2014.shtml (2023.08.21).
[66] PricewaterhouseCoopers, *op. cit.*
[67] Sanlath, C. & Masila, N. M.: Water demand management: What lessons can be learned from Singapore's water conservation policy?. *Water Utility Journal, 26*(1), 2020, p. 4.
[68] See for example Regulation of Pontianak No. 4 Year 2009 on PDAM Tirta Khatulistiwa, Regulation of Bitung No. 9 Year 2012 on PDAM Duasudara Bitung, and Regulation of Mojokerto No. 11 Year 2013 on PDAM Maja Tirta Mojokerto.
[69] Official Website of Surabaya City Government: *PDAM Surya Sembada Ganti Meter Air Pelanggan Gratis*. https://www.surabaya.go.id/id/berita/71255/pdam-surya-sembada-ganti-meter-air-pelanggan-gratis (2023.08.21); Program Penggantian Meter Serentak. Official Website of PDAM Kota Makassar. http://pdamkotamakassar.co.id/berita/program-penggantian-meter-serentak1 (2023.08.21).

Aside from the government's efforts to instill water usage behaviour amongst Indonesian citizens through the installation of water meters to also ensure that water is not wasted due to pipe leaks, other measures have also been taken by the government. Most notably, the Indonesian government has also imposed taxes on both groundwater and clean water provided by the PDAM to underscore the value of water resources. However, despite the aforementioned measures, Indonesia can still improve such efforts as resort to water resources provided by PDAM is still not at its maximum potential. Among others, Indonesia still faces problems regarding water availability, particularly in rural areas[70] as well as poor water quality.[71]

The use of advanced technologies can also be seen in Indonesia, i.e. desalination and water recycling technologies. However, the usage is not as massive as in Singapore; they are more commonly used by factories in Indonesia.[72] Advanced technologies can certainly become an alternative to the usage of groundwater, minimizing aquifer crisis risks. However, such technologies can be energy-consuming[73] and expensive to build. For instance, the NEWater technology, a prominent water recycling technology in Singapore, is expensive to build as it utilizes membrane technology.[74] In numerous instances, Indonesian stakeholders, such as the Indonesian Ministry of Social Affairs,[75] Freeport Indonesia,[76] and the Provincial Government of Riau Islands,[77] have planned to

[70] Saparuddin: Rintisan Menuju Kemandirian Air Minum Masyarakat Desa di Sulawesi Tengah. *Jurnal SMARTek, 3(3)*, 2005, pp. 199–208.

[71] Viorence, E. et al: Analisis Tingkat Pencemaran Air PAM di Desa Meurandeh. *GRAVITASI Jurnal Pendidikan Fisika dan Sains, 5*(1), 2022, p. 29.

[72] See, for example, *Indonesia Power Utilizes Desalination Technology for Micro Hydro Power Plant Sources in North Jakarta*. Indonesia Water Portal, 2020. https://www.indonesiawaterportal.com/news/indonesia-power-utilizes-desalination-technology-for-micro-hydro-power-plant-sources-in-north-jakarta.html (2023.08.21).

[73] Lafforgue, 2015, *op. cit.,* pp. 622-631.

[74] *Singapore's Solution to Water Scarcity: NEWater*. Save The Water, 2019. https://savethewater.org/singapores-solution-to-water-scarcity-newater/#:~:text=What%20are%20some%20problems%20with,US%24125%20million%20to%20build (2023.04.20).

[75] *Kemensos Siapkan Rencana Desalinasi Air Laut di Kawasan 3T*. Media Indonesia, 2022. https://mediaindonesia.com/humaniora/471588/kemensos-siapkan-rencana-desalinasi-air-laut-di-kawasan-3t (2023.08.21).

[76] *Black & Veatch Hadirkan Fasilitas Desalinasi Air Laut di Indonesia*. Antara News, 2023. https://www.antaranews.com/berita/3337278/black-veatch-hadirkan-fasilitas-desalinasi-air-laut-di-indonesia (2023.08.22).

invest in seawater desalination technologies. Desalination and water recycling technologies may certainly become an alternative source to groundwater as water recycling promotes water sustainability, but the Indonesian government needs to further develop a strategic plan in utilizing such technologies remembering how energy-consuming and costly these technologies are.

Perhaps some of Singapore's efforts that cannot really be seen in Indonesia are water conservation measures introduced by the government as well as public education on water usage behaviors. As previously discussed, Singapore has both the Water Efficiency Labelling Scheme and Water Efficiency Management Plan, which aim to increase Singaporean citizens', business vendors', and large water users' awareness regarding water efficiency. Currently, there are no similar schemes implemented in Indonesia. On the other hand, when it comes to public education, Indonesia has actually attempted to incorporate materials regarding water use efficiency within its formal education curriculum, as reflected by the Ministry of Education, Culture, Research, and Technology's efforts.[78] However, in contrast with Singapore, where the PUB is also responsible for conducting water use efficiency education in schools, Indonesia has no specific governmental body in charge of educating the public about the specific matter. Moreover, there are limited public campaigns and education conducted in Indonesia by other governmental bodies. Indonesia thus has a long way to go in the field of public education to increase its citizens' awareness regarding water use.[79]

III. Conclusion

The shift of the capital city from Jakarta to Nusantara will inevitably mean that numerous activities – including those that are agricultural or industrial– will be conducted in the new capital city. Accordingly, whether or not the Indonesian

[77] *Pemerintah Berencana Bangun Penyulingan Air Laut di Pulau Bintan*. Kompas, 2023. https://www.kompas.id/baca/nusantara/2023/01/19/pemerintah-berencana-bangun-penyulingan-air-laut-di-pulau-bintan (2023.08.21).

[78] See for example the Indonesian Ministry of Education, Culture, Research, and Technology's *Modul Belajar Literasi Numerisasi Tingkat SD*. Bersama Hadapi Korona - Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia. https://bersamahadapikorona.kemdikbud.go.id/tingkat-sd-modul-belajar-literasi-numerisasi/ (2023.08.20).

[79] See the importance of awareness-raising measures: Hohmann, B.: *The Principles and Fundamental Requirements of the Transparency on the Public Administrative Proceedings*. In: P., Suresh (Eds.): *Proceedings of THE IIER. INTERNATIONAL CONFERENCE Dubai, UAE*. Dubai, International Institute of Engineers and Researchers (IIER), 2019, p. 2.

government will be able to ensure the fulfillment of water demands must be considered. This is crucial not only to guarantee the availability of water resources for Indonesian citizens, but also as a means to further demonstrate Indonesia's commitment in fulfilling the SDGs, especially SDGs 6, 12, 13, and 15. By investing in ways to further promote the SDGs, Indonesia can minimize the risk of an aquifer crisis and contribute to the sustainability of water resources for subsequent generations of Indonesian citizens.

Despite the availability of aquifers below Nusantara, groundwater extraction bears promising prospects with issues to resolve. As Nusantara is located on top of medium- to low-level aquifers,[80] due diligence on the construction of the new capital needs to be conducted by the Indonesian government to avoid aquifer resources depletion in line with SDGs 6, 12, 13, and 15. Furthermore, the Indonesian government has a paramount role in preventing groundwater exploitation by not only searching for alternatives to groundwater but also promoting the responsible use of water.

The multifaceted measures adopted by Singapore minimize aquifer crisis risks by reducing water demands, increasing Singaporean citizens' awareness of the efficient use of water, as well as searching for alternatives to groundwater. Nonetheless, Singapore is still exposed to numerous challenges spanning from its dependence on water imported from Malaysia, as well as the substantial energy consumption footprint that the utilization of advanced water technologies possesses.[81] Indonesia, on the other hand, is positioned in a manner without imported-water-related concerns. Accordingly, Indonesia must seize this opportunity and ensure that existing water management policies are tailored in a manner that allows the fulfillment of water demands whilst ensuring that aquifer resources are not harmed, which is in line with the 2030 Agenda for Sustainable Development.

If Singapore's water management policy were to be adopted, Indonesia would have to take into account the challenges that may arise through such adoption along with the differences in circumstances that exist between Singapore and Indonesia. Notwithstanding the existence of several of the above measures in Indonesia, there are still numerous ways to improve the existing Indonesian water management system to mitigate an aquifer crisis and ensure the sustainable use of

[80] Herlambang, 2022, *op. cit.*, pp. 9-10.
[81] Gordon, 2014, *op. cit.*, p. 1.

water resources. Keeping in mind the high energy consumption and costs of advanced technologies, the authors recommend that the Indonesian government focus on the efforts listed below.

1. Increasing water efficiency efforts through the government's policy

Learning from the implementation of the Water Efficiency Labelling Scheme and the Water Efficiency Management Plan in Singapore, the Indonesian government may also adopt similar schemes. By adopting schemes similar to the Water Efficiency Labelling Scheme, Indonesian citizens will be able to make better choices when purchasing products involving the utilization of water. On the other hand, by adopting mechanisms that are similar to the Water Efficiency Management Plan, large water users can enhance their plans regarding water efficiency. If Indonesia were to implement such measures, whether the program should be mandatory or voluntary in nature must also be considered.

2. Enhancing rainwater harvesting

As Indonesia has relatively high rain precipitation patterns,[82] there is a significant opportunity for the Indonesian government to utilize this abundant resource in transformative ways. The elevated rain precipitation patterns may be used to effectively fulfill water demands while simultaneously reducing recourse to groundwater, subsequently mitigating the possibility of an aquifer crisis. Despite the numerous rainwater harvesting efforts in Indonesia, these measures can be further improved by the Indonesian government the way the Singaporean PUB has been able to utilize two-thirds of its land to capture rainwater.

3. Increasing the public's awareness and conducting public campaigns

From Singapore, we can learn how the collective effort to promote responsible management of water has been able to aid the country's water management system. Since Indonesia has limited public campaigns and education conducted by the government, the Indonesian government may consider appointing a government institution to conduct public education regarding water usage behaviour; this measure has been proven to be effective as reflected by

[82] Rofil, Maryono: Potensi dan Multifungsi *Rainwater Harvesting* (Pemanenan Air Hujan) di Sekolah bagi Infrastruktur Perkotaan. *Biology Education Conference Proceeding, 14*(1), 2017, p. 247.

Singapore's approach in appointing the PUB to educate on such matters even in schools.

4. Improving the quality and availability of water across the nation

Noting the pressing issue of inadequate access to clean water in rural areas, Indonesia may need to invest in substantial efforts to enhance water accessibility across the nation. In addition to improving water accessibility, water quality must also be improved to ensure not only that Indonesian citizens' water demands are fulfilled, but also that the water they consume is of good quality and free from contaminants.