Proceeding
IsWASH
2023

Realizing Access to Safe, Inclusive, Sustainable and Climate Resilient Drinking Water, Sanitation and Hygiene for All

20-21 March 2023

Photo by Gustav Bogar @gusssgarrr

Proceeding IsWASH 2023

Organized by:

Supported by:

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Foreword By Asia Pacific Centre for Ecohydrology (APCE) – UNESCO C2C, National Research and Innovation Agency (NRIA)

Water, sanitation and hygiene are fundamental needs for the people. Its availability must be guaranteed permitting them to carry out their activities in various sectors of life. This is one of the national development priorities in Indonesia. Various obstacles faced in achieving this target include: decentralization policies, suboptimal resource management, lack of coordination, and overlapping authorities between sectors and levels.

The COVID-19 pandemic hitting the world including Indonesia has greatly affected central government’s ability to ensure water, sanitation and hygiene security nationally. Intensive coordination and consolidation of stakeholders, government and community should be strengthened in order to fulfil basic needs in the WASH sector according to SDGs corridors. The role of different institutions is very important in providing recommendations and solutions to WASH problems in Indonesia.

Indonesian WASH Symposium 2023 is expected to be a medium of exchange and discussion to understand the relationship between water, sanitation and hygiene main factors to support the achievement of SDGs targets in these three sectors in the New Normal era. Collaboration across ministries, institutions, universities, AMPL networks etc. is needed in initiating and facilitating different related activities to contribute to solving national problems through:

a. Comprehensive Studies and recommendations regarding the alignment of national policies in the WASH sector to achieve the SDGs targets in the New Normal era
b. Research and Innovation related to system, technology and social etc. to support the development and management of national WASH.
c. Strengthening HR and institutional capacities in the management and utilization of relevant science and technology-based WASH in the future.

I would like to express my gratitude to the organizers, co-hosts, and supporters of IsWASH 2023 for all commitment and contribution in addressing the critical issues in WASH in Indonesia through this important symposium.

In closing, I hope that this symposium will produce comprehensive recommendations related to WASH for stakeholders based on all participants engagement in sharing knowledge, insights, best practices as well as fruitful discussion in the symposium sessions. Hopefully, access to safe, inclusive, sustainable, and climate-resilient drinking water, sanitation, and hygiene for all may probably be realized together in the future.

Bogor, 20 March 2023

Prof. Dr. Ignasius D.A. Sutapa, MSc.
Executive Director of APCE – UNESCO C2C
National Research and Innovation Agency (NRIA)

Foreword By Jejaring AMPL

Greetings and warm regards to all participants, collaborators, and champions of the Indonesian Water, Sanitation, and Hygiene Symposium (IsWASH) 2023. It is indeed a historic moment, and I am honored to address you on behalf of Jejaring Air Minum dan Penyehatan Lingkungan (Jejaring AMPL), the Water and Sanitation Network Indonesia.

Jejaring AMPL has, for years, served as a vital platform for fostering synergy among stakeholders in the drinking water, sanitation, and hygiene sector. Our work program revolves around information resource centers, capacity building, partnership development, and advocacy and awareness raising. We take pride in our independent stance as an organization, free from affiliations with the government or political bodies, guided by the collective decisions of our esteemed members.

As the host and key organizer of IsWASH, Jejaring AMPL, representing civil society, recognizes the monumental significance of this symposium. This event is a milestone in the development of WASH in Indonesia and reflects the dedication and collaborative spirit of a multitude of stakeholders.
We wish to express our sincere gratitude to our co-organizers:

- Asia Pacific Center for Ecohydrology
- Badan Riset dan Inovasi Nasional (BRIN)
- Center for Regulation Policy and Governance (CRPG)
- Institut Teknologi Bandung (ITB)
- Universitas Gadjah Mada (UGM)
- Universitas Indonesia (UI)
- Universitas Ibn Khaldun Bogor, Program Studi Ilmu Lingkungan
- Universitas Udayana (UNUD)

We also extend our heartfelt appreciation to our co-hosts, who have been instrumental in supporting and shaping this symposium:

- Badan Perencanaan Pembangunan Nasional (Bappenas)
- Institute for Sustainable Futures, University of Technology Sydney
- Sanitation and Water for All (SWA)
- The World Bank

Jejaring AMPL envisions IsWASH as a continuous journey—a platform for dialogue, learning, and partnership-building that will be carried forward into the future. It is through events like IsWASH that we can collectively contribute to addressing the challenges in the WASH sector and finding innovative solutions.

I encourage all participants to actively engage, share your expertise, and embrace this opportunity for knowledge exchange and collaboration. Together, we can realize access to safe, inclusive, sustainable, and climate-resilient drinking water, sanitation, and hygiene for all. This is not just a conference; it is a shared commitment to a better, healthier future for Indonesia and the global community.

Ir. R. Laisa Wahanudin M. Med. Sc (PH)
Chair of Jejaring AMPL
Water and Sanitation Network Indonesia

IsWASH Preface Committee

The inception of the Indonesian Symposium of Water, Sanitation, and Hygiene (IsWASH) represents a significant milestone in the academic and multidisciplinary exploration of WASH (Water, Sanitation, and Hygiene) within Indonesia. This pioneering online symposium was conceptualized during a collaborative research effort under the Sanitation and Water for All (SWA) Mutual Accountability Mechanism Catalytic Program, conducted by the Center for Regulation Policy and Governance (CRPG) and Jejaring AMPL.

From its inception, IsWASH was envisioned as a platform that is *independent*, *free*, and *inclusive*. This vision encompasses not just the wide-ranging participation from diverse stakeholders but also extends to the nature of the publications and discussions fostered at the symposium. It is with great hope and anticipation that this ethos of inclusivity and openness will persist, guiding the future iterations of IsWASH and continuing to enrich the discourse in this vital sector. The symposium's foundation is built upon the principles of mutual learning, knowledge exchange, and the pursuit of solutions through a multidisciplinary lens.

The 2023 IsWASH received an impressive tally of 64 presentations, representing the dedicated work of scholars and professionals from 40 institutions. These submissions span a remarkable geographic range, including contributions from various parts of Indonesia and countries across the globe such as Australia, the United Kingdom, the United States, Taiwan, and Germany. The diversity of these contributions reflects the multidisciplinary nature of the WASH sector. Academics, researchers, non-governmental organizations, ministries, the Indonesian National Research and Innovation Agency (BRIN), and the private sector have all brought their unique viewpoints and expertise. In terms of participation, the symposium has attracted 600 registrants. This enthusiastic participation is a clear indication of the vital role WASH plays in our societies and the urgent need for collaborative efforts to enhance water, sanitation, and hygiene.

We extend our deepest gratitude to each presenter, convener, and participant. Their invaluable contributions, stemming from a variety of cultural and institutional backgrounds, have been instrumental in shaping the success of this symposium. Hopefully, their dedication and hard work in sharing knowledge and fostering discussions will contribute to the advancement of WASH practices and policies.

On behalf of the Organizing Committee,
Mohamad Mova AlAfghani

Scientific Committee

- **Mohamad Mova Al'Afghani** obtained a PhD in water regulation from the University of Dundee, UNESCO Center for Water Law, Policy and Science. Mova has more than 15 years of experience in the water sector, including as a research consultant at UN agencies such as the World Bank, WHO, FAO, UNDP and UNIDO, donor agencies and various development partners. Mova's primary expertise is law, regulation and governance of water, environment and natural resources. Current research interests are informality and water tenure, as well as the impact of emerging pollutants on drinking water. Mova currently serves as Director at the Center for Regulation, Policy and Governance (CRPG) and lecturer at Ibn Khaldun University, Bogor.

- **Prof. Dr. Ignasius Dwi Atmana Sutapa, MSc.** Completed his bachelor's and master's Degrees at the University of Nancy I in 1992, and a Ph.D. in Chemical Engineering in 1996 at The Institute National Polytechnique de Lorraine (INPL), France. He is currently a Professor of Chemical and Environmental Technology at the National Research and Innovation Agency. Apart as an environmental expert, he serves as Executive Director of the Asia Pacific Centre for Ecohydrology (APCE) – UNESCO C2C, Deputy Chair of the Committee of Environmental Health Experts at the Indonesian Ministry of Health, as well as Chairman of the Indonesian Digital Leaders Association (IDLA/APDI).

- **Prof. Sri Irianti, SKM, M.Phill, Ph.D** obtained her Master of Philosophy (M.Phil.) in 2001 and Doctor of Philosophy (Ph.D.) in 2012 in Environmental Engineering from Griffith University, Australia. She is currently researcher at National Research and Innovation Agency. During her research career, she has produced 48 scientific papers, both in the form of books, book sections, journals and international and national proceedings. A total of 41 papers of which are as the main contributors and 24 papers are written in English.

- **Cindy Rianti Priadi** is a lecturer at the University of Indonesia since 2011 and the Head of the Environmental Engineering Study Program since early 2022. Her research since her doctoral studies in 2007 includes drinking water and urban sanitation, groundwater and surface water quality and resource recovery from waste with support from and collaboration with various local parties, national and international. Cindy is a member of the Indonesian Academy of Young Scientists (ALMI) and the editor of Journal of Water, Sanitation and Hygiene for Development.

- **Daniel** is a lecturer and researcher at the Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University. He has research experience in the field of drinking water, sanitation and hygiene (WASH) both in Indonesia and abroad and works closely with international institutions. His special interest in research is about community behavior in the field of WASH, risk analysis and drinking water quality, drinking water security plans, and sustainability of WASH services in rural and remote areas of Indonesia.

- **Anindrya Nastiti** is an engineer-by-training who pursues interdisciplinary research in water governance and the intersection of environment and human behaviour. She is an associate professor in the Environmental Management and Technology Research Group, Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung (ITB) and also the Secretary of Center for Environmental Studies (ITB). She has been involved in several interdisciplinary research projects with social scientists on the topic of water security challenges, water governance and stewardship, human rights to water and sanitation, inclusive water, sanitation, and hygiene (WASH), and others.

- **Ni Made Utami Dwipayanti** Dr Ni Made Utami Dwipayanti holds a Bachelor of Environmental Engineering from the Institute of Technology Bandung, Indonesia, a Masters of Built Environment (Sustainable Development) from UNSW, Sydney, Australia and a PhD from the School of Environment, Griffith University, Brisbane, Australia. Her research focuses on water, sanitation and hygiene (WASH) in developing areas with qualitative and quantitative approach. She is experienced in facilitating participatory methods, designing and implementing WASH behavior change communication strategy in communities. Currently she teaches at School of Public Health, Udayana University, Bali, Indonesia and conducts research with the Centre of Public Health Innovation (CPHI), Udayana University.

About the organizers

Sanitation and Water for All (SWA) is a global partnership under the United Nations. SWA's membership consists of international organizations, countries (including Indonesia), donor organizations, NGOs, universities, research institutes, regulatory bodies, drinking water companies, the private sector and various other development partners. Bappenas is the focal point for SWA in Indonesia.

Jejaring AMPL is a forum to synergize the potential for information, knowledge and communication between stakeholders in the drinking water, sanitation, and hygiene sector. The work program focuses on the Information Resource Center, Capacity Building, Partnership Development, as well as Advocacy and Awareness Raising, the WSES Network is independent as an organization that is not affiliated with the government and political organizations and is subject to the decisions of member meetings. This symposium is co-organized by Badan Perencanaan Pembangunan Nasional (Bappenas), Asia Pacific Center for Ecohydrology, Badan Riset dan Inovasi Nasional (BRIN), Center for Regulation Policy and Governance (CRPG), Institut Teknologi Bandung (ITB), Universitas Gadjah Mada (UGM), Universitas Indonesia (UI), Universitas Ibn Khaldun Bogor, Program Studi Ilmu Lingkungan Universitas Udayana (UNUD). The co-supporters of the symposium are Institute for Sustainable Futures, University of Technology Sydney Sanitation and Water for All (SWA) The World Bank.

Synthesis Report – IsWASH 2023

IsWASH 2023 was clustered into 4 topics:

- **Cluster 1: “Regulation, Policies and Institution”**
  Coordinator: Mohamad Mova Al’Afghani (UIKA), Anindrya Nastiti (ITB)
- **Cluster 2: “Water Utility Management”**
  Coordinator: Ignasius Dwi Atmana Sutapa (BRIN).
- **Cluster 3: “WASH Sciences and Technology”**
  Coordinator: Cindy Priadi (UI).
- **Cluster 4: “Social, Behavior and Economic Aspect of WASH”**
  Coordinator: Daniel (UGM), Ni Made Utami Dwipayanti (UNUD) and Prof Sri Irianti (BRIN)

Cluster 1 of the IsWASH conference, focusing on “Regulation, Policies, and Institution,” offered a multifaceted exploration of the legal and institutional frameworks governing water, sanitation, and hygiene (WASH). The cluster delved into human rights perspectives on water access, underscoring the importance of effective water management for sustainable development and upholding human rights. Discussions also centered on the complexities of water privatization in Jakarta, using innovative analytical approaches to examine the interplay between law, space, and time in the city’s water jurisdiction.

Several presentations in the cluster highlighted the role of institutionalization in behavior change communication for safe sanitation, emphasizing the need for multi-sectoral collaboration. The analyses extended to political barriers in water governance decentralization, particularly in West Java, focusing on the region’s strategic importance and its varied engagements with water and sanitation projects. Additionally, the cluster touched on the challenges of aquifer management in Indonesia’s new capital, Nusantara, drawing lessons from Singapore’s effective water policies.

The cluster also addressed the impact of the climate crisis on WASH, particularly in coastal areas like Semarang, and explored the significant role universities play in influencing water policy and hygiene practices. Pro-poor policies in community-based drinking water and sanitation programs were examined, particularly in drought-prone areas, highlighting the need for policies that effectively target the poor and increase access to clean water and proper sanitation.

Discussions extended to the challenges of providing adequate water and sanitation services in urban slum areas, using analytic methods to prioritize interventions and understanding the complexities of service provision in these contexts. The cluster also explored the complexities surrounding post-concession water services in Jakarta, analyzing the challenges in achieving just and effective regulatory frameworks for water service provision.

The final themes revolved around mutual accountability and multi-stakeholder partnerships in the Indonesian water and sanitation sector, aligning with Sustainable Development Goal 6. Presentations focused on adapting sanitation services to sea level rise, developing resilient sanitation technologies and strategies, and examining legal aspects of river management for community water needs, especially in contexts like Banten Province. The role of private sector participation in water resource management post-reform in Indonesia was also discussed, highlighting the evolving political-economic structures influencing the sector.

These presentations collectively underscored the intricate interplay of legal, political, and institutional factors in shaping effective water governance and the critical need for multi-sector collaboration and innovative solutions in the WASH sector.

Cluster 2 of the IsWASH conference, titled “Water Utility Management,” brought forward a diverse array of research focused on enhancing and sustaining water utility services. One study assessed the quality of raw water for drinking in a specific region using Pollution Index (PI) and Storage and Retrieval (STORET) methods, finding that the water met the required standards but emphasized the importance of continuous monitoring to prevent contamination. Another research examined the challenges of maintaining chlorine levels in water distribution networks, highlighting the risk of bacterial contamination due to pipe leaks and the necessity for effective disinfection strategies. This cluster also delved into the community-based rural water supply and sanitation program (PAMSIMAS) in Indonesia, revealing insights on factors that influence the sustainability of water projects, such as management practices and financial contributions.

Additionally, research utilizing the Fuzzy Delphi Method (FDM) was presented to assess the resilience of Drinking Water Supply Systems (DWSS) against flooding, an increasingly important area of focus due to the prevalence of flood disasters. This method provided a flexible approach for experts to address uncertainties in disaster management. The final presentation in the cluster explored the

development of water and sanitation systems in regions with marginal raw water quality. It emphasized the need for ongoing technological innovation and policy adaptations to meet the growing demand for water in the face of environmental changes and new challenges. This cluster’s collective insights highlighted the complex interplay between technology, policy, and community engagement in managing water utilities effectively and sustainably.

Cluster 3 of the IsWASH conference, titled “WASH Sciences and Technology,” offered insights into the scientific and technological advancements in water, sanitation, and hygiene. One presentation discussed the ecological risks associated with the use of antibiotics in aquaculture, particularly in shrimp farming areas in Taiwan. It highlighted the persistence of antibiotic mixtures in water, emphasizing the need for cautious application of such medications to prevent ecological harm.

Another study explored the potential of marine porous biosilica as a renewable biomaterial for microbial removal in drinking water processing. This research underscored the need for sustainable and cost-effective materials in water treatment, particularly given the increasing reliance on non-renewable resources in conventional water purification processes.

The effectiveness of mineral wool as a filter for pollutant removal in river water was also examined. This study, conducted on the Cikapayang River in Indonesia, provided the first real-world evidence of mineral wool’s ability to improve surface water quality, showcasing its potential as an innovative solution for water pollution control.

The cluster also presented research on a segmented and scalable online monitoring approach to reduce greywater pollution in Indonesia. This study aimed to support the sustainability of decentralized greywater treatment systems through online monitoring, aligning with government efforts to enhance sanitation and river cleanliness.

Research from Malang City, Indonesia, focused on transforming sewage sludge into bio-solid fuel as part of a community-based total sanitation program. This innovative approach not only addresses sanitation challenges but also contributes to resource recovery and carbon emission reduction, showcasing the potential of sewage sludge as an alternative, low-emission fuel source.

Finally, a study on climate-resilient sanitation in East Lombok, Indonesia, highlighted the vulnerability of coastal communities to climate change impacts. This research proposed the development of flood-resistant toilets to ensure

the sustainability of sanitation facilities amidst rising sea levels and increased flooding, thus contributing to climate resilience in vulnerable regions.

These studies collectively highlight the crucial role of scientific research and technological innovations in addressing current and future challenges in the WASH sector. They emphasize the importance of sustainable practices, innovative solutions, and adaptive strategies to ensure effective water and sanitation management in the face of environmental and societal changes.

Cluster 4 of the IsWASH conference, titled "Social, Behavior, and Economic Aspect of WASH," provided a comprehensive look into the social dynamics and behavioral aspects influencing WASH practices and policies. The cluster opened with a study examining the relationship between household knowledge, attitudes, and behaviors in relation to household waste management, particularly in the context of COVID-19. It highlighted the importance of handwashing with soap as an effective preventive measure against infectious diseases and explored the persistence of these behaviors post-pandemic. The research utilized frameworks like RANAS (Risk, Attitude, Norms, Abilities, and Self-regulations) and IBM-WASH (Integrated Behavioral Model for Water, Sanitation, and Hygiene), offering insights into the factors influencing hygiene behaviors.

Another presentation focused on the provision of clean drinking water, improved sanitation, and basic handwashing facilities and their impact on diarrhea among children under five in Indonesia. This research highlighted the critical role of these infrastructures in preventing waterborne diseases and improving overall public health, particularly in young children who are most vulnerable to these conditions.

The challenges of developing inclusive WASH facilities in urban slum areas were also addressed. This presentation provided a community perspective on the difficulties of achieving access to sanitation and safe drinking water in these regions, emphasizing the need for inclusive development strategies that cater to the needs of marginalized communities.

The consumption of packaged drinking water (PDW) in Indonesia and its implications for water security was another focal point of this cluster. The study analyzed the trends in PDW consumption over the last two decades and the socio-economic determinants influencing this trend, shedding light on the growing reliance on PDW as a perceived safe water source and its potential health implications.

Additionally, the cluster included a presentation that delved into building community resilience with water-saving program preferences, highlighting the importance of green building concepts and water conservation. The study aimed at understanding community preferences in saving water and how these efforts contribute to creating more resilient communities in the face of environmental challenges.

These presentations in Cluster 4 brought forth a nuanced understanding of the social, behavioral, and economic factors that play a crucial role in the effective implementation and sustainability of WASH practices. They emphasized the need for holistic approaches that consider the diverse needs and behaviors of communities, especially in urban and marginalized settings, to achieve lasting improvements in water, sanitation, and hygiene.

Keynotes

Tri Dewi Virgiyanti's (Bappenas) keynote presentation at the IsWASH conference centered on the urgent integration of climate issues into Water, Sanitation, and Hygiene (WASH) planning in Indonesia. Virgiyanti began by highlighting the substantial risk posed by climate hazards to sanitation service chains. Through case studies from Bekasi, Makassar, Palu, and East Lombok, she illustrated how climate threats could potentially reverse progress toward achieving open defecation-free status and access to sanitation. These examples underscored the immediacy of the climate challenge within the realm of sanitation.

Virgiyanti then detailed the Climate Resilient WASH Framework, a comprehensive approach developed to address the intersection of climate change and WASH. This framework is essential for cities and regions in Indonesia grappling with the adverse impacts of climate change on sanitation infrastructure and public health. She described how this framework encompasses both adaptive strategies and preventive measures, ensuring that WASH systems remain effective and sustainable despite the escalating climate threats.

The presentation also delved into various opportunities that can be utilized to enhance WASH resilience against climate threats. Virgiyanti emphasized the importance of mainstreaming WASH climate resilience into broader policy and planning frameworks. She highlighted specific actions and strategies required for this integration, signaling a move toward more holistic and inclusive approaches to WASH planning that consider environmental sustainability and climate resilience.

Addressing the challenges inherent in integrating climate considerations into WASH planning, Virgiyanti underscored the significance of developing robust action plans. She stressed the creation of adaptable and sustainable sanitation systems capable of withstanding climate-related hazards. This part of her presentation focused on the need for innovative, flexible solutions that can respond to the dynamic nature of climate change and its impacts on WASH infrastructure.

Concluding her keynote, Virgiyanti provided insights into the policy implications of the discussed framework and strategies. She set the direction for future efforts in developing climate-resilient WASH infrastructure and policies in Indonesia. Her presentation was instrumental in charting a course for the WASH sector to adapt and overcome the challenges posed by the changing climate, highlighting the critical role of policy and decision-makers in this endeavor. Through her comprehensive analysis and strategic framework, Virgiyanti's keynote offered a roadmap for ensuring that WASH systems in Indonesia are resilient and sustainable in the face of evolving climate challenges.

Guy Howard's keynote presentation at the IsWASH conference, titled "Climate Resilience in Water and Sanitation – Thinking Beyond the SDGs," offered a critical examination of the Sustainable Development Goals (SDGs) in the context of Water, Sanitation, and Hygiene (WASH). He started by discussing the SDGs related to WASH, with a focus on ensuring universal access to safely managed services. Howard highlighted the gaps in safely managed water and sanitation, not just globally but also within Indonesia, pointing out the disparities between the ambitious goals and the current realities.

In his presentation, Howard delved into the vulnerability of water and sanitation services to climate threats, distinguishing between resilience and sustainability. He argued that while the SDGs are pivotal in aiming for safely managed services, they fall short in guaranteeing resilience against the myriad of climate threats. This distinction underscored the need for an expanded focus beyond the current SDG framework to effectively address the challenges posed by climate change.

Howard emphasized the necessity of understanding the changing nature of risks and the potential for adaptability in the face of climate change. He spoke about the importance of preparing for both 'unknown knowns' and 'unknown unknowns' - potential threats whose frequency and severity are yet to be fully understood or those that haven't been previously experienced but are plausible in a changing climate. This part of his presentation stressed the need for using diverse data sources and envisioning multiple future scenarios to build effective resilience strategies.

The keynote outlined specific actions required for resilient water supply and sanitation systems. For water supply, these included understanding future climate threats, developing adaptive management plans, and formulating investment plans based on climate scenarios. In terms of sanitation, Howard highlighted the complexity of adaptive management, emphasizing the need to consider the entire Faecal Sludge Management (FSM) chain and to develop strategies that are responsive to evolving climate conditions and community needs.

The final aspect of Howard's presentation addressed the broader measures required for resilience, focusing on the necessity of regulatory action to confront critical climate threats and impacts. He discussed the significant role of climate and green finance in WASH, pointing out the need for substantial investment and the establishment of clear criteria for WASH projects to meet the requirements of climate and green finance. This part of his presentation provided a comprehensive overview of the economic and policy dimensions crucial for building climate resilience in the WASH sector.

Guy Howard's keynote at the IsWASH conference provided an in-depth perspective on the challenges and strategies necessary for developing climate-resilient WASH systems, highlighting the importance of expanding the scope of current SDGs, understanding and adapting to evolving risks, and integrating economic and regulatory measures to ensure sustainable and resilient WASH services in the face of climate change.

Professor Juliet Willetts' keynote presentation at the IsWASH conference emphasized the critical need for transdisciplinary research in the WASH sector. She highlighted the pressing state of the world's drinking water and sanitation and underscored that effective WASH solutions must operate within ecological limits while addressing social inequities. Willetts stressed that creating a safe and just space for humanity requires a paradigm shift in how WASH is provided, with a focus on sustainability and equity.

Willetts advocated for a significant change in the research paradigm for WASH, drawing on Albert Einstein's notion that new types of problems cannot be solved with the same kind of thinking that created them. This call for a shift set the tone for her presentation, which emphasized the necessity of moving beyond traditional methods in WASH research. She argued for more holistic and inclusive approaches, underscoring the importance of innovative solutions in addressing the complex challenges faced in the WASH sector.

The keynote then explored the outcomes and quality of transdisciplinary

research. Willetts discussed how such an approach leads to improvements within the field of inquiry, generation of relevant knowledge, and mutual learning among researchers and participants. She detailed quality criteria for robust transdisciplinary research, including original contribution to knowledge, demonstrated reflexivity, research integrity, and engagement with diverse perspectives. This part of her presentation highlighted the importance of a comprehensive and multi-faceted approach to WASH research.

Willetts also focused on specific areas within transdisciplinary WASH research. She discussed gender equality in the WASH workforce in Cambodia and Indonesia and the impact of climate change on resilient sanitation. Additionally, she highlighted the life-cycle costs of rural water supply systems and inequalities in access in Vietnam, as well as the risks and benefits associated with self-supplied water sources in Indonesia and the Asia-Pacific region. These examples underscored the diversity and depth of issues that transdisciplinary research in WASH can address.

Concluding her presentation, Willetts touched upon global research trends in water and sanitation. She emphasized the importance of research focusing on service delivery and not just infrastructure, underlining the need for building resilience, economic viability, and public health improvements. She concluded with a forward-looking perspective on WASH research in Indonesia, highlighting the role of transdisciplinary research in driving change and improving WASH access.

Rundown

Indonesian Water, Sanitation and Hygiene Symposium 2023

Symposium Program

20-21 March 2023

Notes:

1. Interpretation (English to Indonesia and vice-versa) will only be available during Keynotes and its Q&A
2. IND indicates that the session will contain presentation(s) in Bahasa Indonesia (no interpretation will be provided)
3. B.O.R = Break our room in zoom

Total presentation: 64 presenters

1. Cluster 1: Regulation, policies and institution → **12** presenters
2. Cluster 2: Water utility management → **5** presenters
3. Cluster 3: WASH sciences and technology → **16** presenters
4. Cluster 4: Social, behavior and economic aspects of WASH → **31** presenters

Day 1: Monday, 20 March 2023

Time	Session		
09.00 – 09.25 (25 min)	**Opening** Agenda: Opening, general elaboration of agenda & sessions: MC from Jejaring AMPL Opening Remarks, welcoming speech, introduction to IsWASH: Mohamad Mova Al'Afghani, SH, LL.M.Eur, PhD. (UIKA, CRPG) Welcome Addresses: Prof. Ignas Sutapa (BRIN) and Dr. Oswar Mungkasa (Jejaring AMPL) → @5 min Bridge to the keynote 1: MC from Jejaring AMPL		
09.25 – 10.00 (35 min)	**Keynote 1** Speaker: Tri Dewi Virgiyanti, ST. MEM (Indonesian Ministry of National Development Planning / Bappenas) Theme: Integration of climate issues into WASH planning in Indonesia Moderator: Mohamad Mova Al'Afghani, SH, LL.M.Eur, PhD. (UIKA, CRPG) Assistant: Hana Yesica Agenda: Introduce the speaker Presentation Q&A Conclusion (moderator) Bridge to the BOR: MC from Jejaring AMPL		
10.00 – 11.30 (90 min)	**B.O.R 1A** **Cluster 4** Convener: Dyah Wulandari Putri (ITB) Assistant: Hana Yesica Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Progress in Drinking Water Wells among Households in Indonesia: Impact of Population Density (Mardiana Dwi Puspitasari – BRIN) • Understanding household self-supply use and management in urban Indonesia (Franziska Genter – University of Technology Sydney) • Business and Behavioral Aspects of Drinking Water: A Systematic Literature Review and Research Agenda (Dwinto Martri Aji Buana – NTUST) • Social Vulnerability Assessment To Clean Water Management, Study Case: Clean Water Crisis In Baleendah And Dayeuhkolot districts, Bandung Regency (Fitrah Ramadhan - Edukasi Bumi Indonesia) • Effect of Introduction of Water Filters on Hydration of Primary School Students (Guido van Hofwegen - Nazava)	**B.O.R 1B** **Cluster 3** Convener: Iftita Rahmatika (UI) Assistant: Ajeng Rahastri Agenda: *Please see the presenter's guidance - session flow below* Presenter: • The presence of mixed SMX and TMP in the water and sediments of a shrimp aquaculture area in Yunlin, Taiwan (Fefi Eka Wardiani – Ching Yuan Christian University, Taiwan) • Marine Porous Biosilica as Prospective Renewable Biomaterial for Microbial Removal Grade Filter in Drinking Water Processing Elva Setiawan – Univ. Pertahanan RI) • The Investigation Of Pollutant Removal By Mineral Wool To The Water River Quality Status Of Cikapayang River, Indonesia (Wisnu Prayogo – Univ. Negeri Medan) • Segmented And Scalable Online Monitoring Approach to Reduce The Risk Of Greywater Pollution In Indonesia (Muhammad Alfalah Fauzi – Endress+Hauser Indonesia) □ Recording Presentation	**B.O.R 1C** **Cluster 1** Convener: Anindrya Nastiti (ITB) Assistant: Xenixia Pratita Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Prediksi Pengembangan Sistem Pengelolaan Air Limbah Domestik (SPALD) Di Pulau Sumatera Tahun 2030 Dengan Pendekatan Spasial (Nasrul Putra – Institut Teknologi Sumatera) (IND) • Pro-poor Policy in Community-Based Drinking Water and Sanitation Program in Gunungkidul Regency (Marita Ahdiyana – UNY) • Policy Strategy Context of Human Right Discourse as a Tool to Accelerate Water and Sanitation Access in Indonesia (Noerdiyanti Novika – Yayasan Plan International Indonesia) • Strengthening Local Government Policies on the Protection of Groundwater Sources to Obtain Sustainable Water Supply for Regional Drinking Water Companies (Suwari Akhmaddhian – Univ. Kuningan)

11.30 – 12.30 (60 min)	Break		
12.30 – 14.00 (90 min)	**B.O.R 2A** **Cluster 4** Convener: Ni Made Utami Dwipayanti (Univ. Udayana) Assistant: Xenixia Pratita Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Building Community Resilient with Water Saving Program Preferences (I Wayan Koko Suryawan – Univ. Pertamina) • Financial Modeling For Achieving Safely Managed On-Site Sanitation With Financial Flow Simulatorn (esSOSViewTM) (Case Study: Tabanan Regency, Bali) (Dameria Maranatha Gloriani – ITB) • Water supply improvement and payment for environmental services for lower-income coastal communities in Tegal Regency (Ade Robbani Setiawan – BPKP) • Hygiene perception and behaviour after the easing of COVID-19's social restrictions in urban Jakarta (Fathurrachman Fachri Nurpasya – ITB) Recording Presentation	**B.O.R 2B** **Cluster 2** Convener: Rositayanti Hadisoebroto (Univ. Trisakti, Jejaring AMPL) Assistant: Hana Yesica Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Assessment of Raw Water Quality Status for Drinking Water in the PTFI Concentrating Division Area (Arif Susanto – PT Freeport Indonesia) (IND) • Analisis Pengaruh Residual Klorin Terhadap Kualitas Mikrobiologi Pada Jaringan Distribusi Air Bersih (Wathri Fitrada - ST Teknologi Industri Padang) (IND) • Fuzzy Delphi Method (Fdm) In Identifying Properties And Indicators Of Drinking Water Supply System Resilience To Flood: An Introduction And Overview (R Hari Yuliandra – Univ. Andalas • Reflection on the community-based rural water supply and sanitation program (PAMSIMAS) in Indonesia (Daniel – UGM) • Potential Development of Drinking Water and Sanitation Systems and Technologies in Regions with Marginal Raw Water: Opportunities and Challenges (Ignasius Dwi Atmana Sutapa – BRIN)	**B.O.R 2C** **Cluster 3** Convener: Cindy R Priadi (UI) Assistant: Ajeng Rahastri Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Characterization of Sewage Sludge as Briquettes Combined with Sawdust (Suci Wulandari – Univ. Andalas) • Life Cycle Assessment Approach to Evaluation The Performance of Wastewater Treatment Plant for Reuse Water in Surakarta (Iva Yenis S. – UNS) • Kinetic study of domestic wastewater treatment by filtration using coconut (Cocos nucifera) fibers (Nur Novilina Arifianingsih – ITB) • Environmental Health Risk Assessment In Settlement Area In Batang Arau River Watersheds, Padang West Sumatera Indonesia (Ansiha Nur – Univ. Andalas)

14.00 – 15.30 (90 min)	**B.O.R 3A** **Cluster 4** Convener: Vera Yulyani (Univ. Malahayati) Assistant: Xenixia Pratita Agenda: *Please see the presenter's guidance - session flow below* Presenter: • WASH Access or Behavior? Which one contributes to children under 5 years old's nutritional status? A situational analysis for Children are Well Nourished Technical Program in 15 Districts in Indonesia (Mita Sirait – Wahana Visi Indonesia) (IND) • Kolaborasi Pengembangan dan Pelaksanaan Strategi Komunikasi Perubahan Perilaku untuk Percepatan Capaian Sanitasi Aman di Kota Bandar Lampung dan Metro, Provinsi Lampung (Putri Sortaria – SNV) (IND) • Personal and Environmental Factors in Menstrual Health Hygiene Practices Among Girls in Central and South Sulawesi (Muliani Ratnaningsih – Tulodo Indonesia) (IND) • WASH Access and RTI Symptoms Across Life Stage among Indonesian Ever-Married Women (Riza Fatma Arifa – BRIN) (IND)	**B.O.R 3B** **Cluster 3** Convener: Adhin Wulaningtyas (UGM) Assistant: Hana Yesica Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Status Mutu Air Tanah di Kawasan Kumuh Kota Bima dengan Menggunakan Metode Indeks Pencemar sebagai Upaya Pemantauan Kualitas Air Baku untuk Kebutuhan Higiene dan Sanitasi (Rachma Sekar Utami – Institut Teknologi Sumatera) (IND) • Pembangunan Toilet Tahan Banjir Di Desa Pijot, Lombok Timur Untuk Mendukung Sanitasi Berketahanan Iklim (Carissa Eukairin Purnomo – UI) (IND) • Evaluasi Penerapan Sanitasi Di Tempat Wisata Danau Sipin Kota Jambi Assessment Of Sanitation Implementation In Lake Sipin Tourism Jambi City (Zuli Rodhiyah – Univ. Jambi) (IND) • Greenhouse Gas Emission (GHG) from onsite domestic wastewater treatment in Surabaya City (Mar'atusholihah – ITS)	**B.O.R 3C** **Cluster 1** Convener: Prathiwi W Putri (University of Kassel) Assistant: Ajeng Rahastri Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Politics of Decentralisation of Water Governance Reform in West Java, Indonesia (Dewa Ayu Putu Eva Wishanti – University of Leeds) • The chronotope of city: Exploring the jurisdictional game of water privatization in Jakarta, Indonesia (Harison Citrawan – BRIN) • Is the "Privatization" Over? Towards a Just Regulatory Framework in Post-Concession Jakarta (Mohamad Mova AlAfghani –Univ Ibn Khaldun Bogor; Prathiwi Widyatmi Putri – Univ Kassel) • Mitigating aquifer crisis in indonesia's new capital, nusantara: problems and lessons learned from Singapore (Ardianto Budi Rahmawan – UGM)
15.30 – 16.00 (30 min)	**Synthesis and feedback** Bridge to the synthesis session: MC from Jejaring AMPL Recap of the first day: Dr. Anindrya Nastiti. ST. MT. (ITB) Closing and reminder for tomorrow: MC from Jejaring AMPL		

Day 2: Tuesday, 21 March 2023

Time	Session		
09.00 – 09.15 (15 min)	**Opening** Agenda: Opening, general elaboration of agenda & sessions: MC from Jejaring AMPL Recap from 1st day: Dr. Daniel, M.Sc. (UGM) Bridge to keynote 1: MC from Jejaring AMPL		
09.15 – 10.00 (45 min)	**Keynote 2** Speaker: Prof. Juliet Willetts, University of Technology Sydney Theme: Importance of robust transdisciplinary research in WASH: Lessons learned from ISF-UTS in Indonesia and elsewhere Moderator: Dr. Daniel, M.Sc. (UGM) Assistant: Xenixia Pratita Agenda: Introduce the speaker Presentation Q&A Conclusion (moderator) Bridge to the BOR: MC from Jejaring AMPL		
10.00 – 11.30 (90 min)	**B.O.R 4A** **Cluster 4** Convener: Reza Hendrawan (Jejaring AMPL) Assistant: Hana Yesica Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Peranan Desain Produk dan Sign System pada Fasilitas Umum di Ruang Publik (Studi Kasus: Kran Air Siap Minum) (Dewi Isma Aryani – UKM) (IND) • Eksplorasi Pola Konsumsi Air Domestik Rumah Tangga pada Masyarakat Kawasan Kumuh di Kota Bima, Indonesia (Nadia Syakhira – Institut Teknologi Sumatera) (IND) • Analysis of packaged drinking water use in Indonesia (Arman Nur Ikhsan – UGM) (IND) • Wadah Partisipatif untuk Penyediaan Layanan Air, Sanitasi, dan Kebersihan di Fasilitas Pelayanan Kesehatan yang Adil dan Setara (Annisa Pramesti Putri – SNV) (IND) • Improving Readability of Communication Materials in Creating Demand for Safely Managed Sanitation in Indonesia (Putri Sortaria – SNV) (IND)	**B.O.R 4B** **Cluster 4** Convener: Tities Puspita (BRIN) Assistant: Xenixia Pratita Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Drinking Water, Sanitation, Handwashing Facilities, Environmental Hygiene and Diarrhoea among Under-Five (U 5) in Indonesia (Adrian Chrisnahutama, Ni Made Sukartini – Univ. Airlangga) • Assessing Child Feces Disposal Management Practices in Indonesia with Integrated Behavior Model WASH (Mita Sirait – Wahana Visi Indonesia) • Safe Child Feces and Diaper Disposal Behavior Change Determinants in Rural Sekadau, West Kalimantan, and Urban Surabaya, East Java (Corie Indria Prasasti – Univ. Airlangga & Wahana Visi Indonesia) • Menstrual health management campaign targeting community members and adolescents in South Sulawesi (Heribertus Rinto Wibowo – Tulodo Indonesia)	**B.O.R 4C** **Cluster 3** Convener: Nopa Dwi Maulidany (UI) Assistant: Ajeng Rahastri Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Management Information System (MIS): Accelerating Access to Safely Managed Sanitation in Pinrang, South Sulawesi (Hajrah – Unicef Indonesia) • Vulnerability of on-site Sanitation Service Chain and Adaptation Response toward Climate Hazards in Four Areas in Indonesia (Inas Imtiyaz – UI) • Indonesian Water, Sanitation, and Hygiene Symposium (Nanda Savira Ersa – Univ. Malikussaleh) • Upgrading the wastewater sanitation system for urban area, johar baru district, central jakarta (Ignatius Anandhityo Dwiputra – Univ. Trisakti)

11.30 – 12.30 (60 min)	Break		
12.30 – 14.00 (90 min)	**B.O.R 5A** **Cluster 4** Convener: Oswar Mungkasa (Jejaring AMPL) Assistant: Ajeng Rahastri Agenda: *Please see the presenter's guidance - session flow below* Presenter: • The impact of COVID-19 on women's access to water, sanitation, and hygiene in an Indonesian fishing village (Wigke Capri – UGM) (IND) • Water, sanitation and hygiene (WASH) and Infection Prevention and Control in COVID-19 referral hospitals in Indonesia: Evidence from Indonesia (Zahra – BRIN) (IND) • Tata Kelola Sanitasi Lingkungan Pasar Rakyat Menuju Pasar Sehat Era New Normal di Kota Yogyakarta (Morrin Choirunnisa Thohira – UGM) (IND) • The Challenges of Inclusive WASH Development to Achieve Access to Sanitation and Safe Drinking Water in the Urban Slum Area of Padang City: As a Community Perspective (Azyyati Ridha Alfian – Univ. Andalas) (IND)	**B.O.R 5B** **Cluster 4** Convener: Wika Maulany Fatimah (Radboud University) Assistant: Hana Yesica Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Systematic Review of the Community Sanitation Program to Achieve SDG's Targets in Bogor City, Indonesia (Budi Susetyo – Univ. Ibn Khaldun Bogor) • Sustainability Status Analysis of Women's Participation in The Iuwash Plus Program In Malang Regency (Aptu Andy Kurniawan. Dinas PU Kab. Malang • The Public Willingness to Participate in the Management of Domestic Wastewater in Banda Aceh (Aulia Rohendi - UIN Ar-Raniry Banda Aceh) • Socio-Ecological Barriers to Women Empowerment in Sanitation in Eastern Indonesia (Ni Made Utami Dwipayanti – Univ Udayana)	**B.O.R 5C** **Cluster 1** Convener: Mohamad Mova Al Afghani (UIKA, CRPG) Assistant: Xenixia Pratita Agenda: *Please see the presenter's guidance - session flow below* Presenter: • Constructing Boundary Work: Unpack the Multi-Discipline Collaboration Research in WASH Project (Arga Pribadi Imawan – UGM) • Mutual Accountability and Multistakeholder Partnerships in Water and Sanitation Sector in Indonesia (Nishrin Qowamuna – CRPG, Mohamad Mova Al'Afghani, Univ Ibn Khaldun) • Tanggung Jawab Pengelolaan Sungai Untuk Pemenuhan Kebutuhan Air Minum Masyarakat; Tinjauan Hukum Pemanfaatan Sungai oleh Perusahaan Daerah Air Minum di Provinsi Banten, (R Ismala Dewi dan Aad Rusyad Nurdin – FHUI Depok) (IND) • Right to Water in the Perspective of Human Rights Law: The concept of Ius Constituendum and its relation to the Sustainable Development Goals in Indonesia (Haekal Al Asyari – UGM)
14.00 – 14.45 (45 min)	**Keynote 3** Speaker: Prof. Guy Howard, University of Bristol Theme: Climate resilience in water and sanitation – thinking beyond the SDGs Moderator: Dr. Cindy Rianti Priadi, ST., MSc. (UI) Assistant: Ajeng Rahastri Agenda: Bridge to the keynote 1: MC from Jejaring AMPL Introduction of the speaker by moderator Presentation Q&A Conclusion (moderator)		
14.45 – 15.15 (30 min)	**Closing** Bridge to the synthesis session: MC from Jejaring AMPL Recap of the symposium (synthesis, take away, next plan, and closing): Dr. Cindy Rianti Priadi, ST., MSc. (UI) Closing of the symposium: MC from Jejaring AMPL		

Assessment of Raw Water Quality Status for Drinking Water in the PTFI Concentrating Division Area

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ABSTRACT

The quality of the drinking water is determined by the raw water obtained from surface run-off, which must fulfill the requirements set by the Indonesian Government. Therefore, this study aims to analyze the quality of the raw water used as a source of drinking water. It was carried out using the Pollution Index (IP) as well as Storage and Retrieval (STORET) methods. The results of both methods, namely the IP and STORET have a score of 0.612 and 0, respectively. The samples tested fulfilled the water quality standard because all physical, chemical, and microbiological parameters have values below the threshold. The raw water based on the STORET method is classified in category A, and to maintain this quality, the water must not be polluted or contaminated. Laboratory testing and routine daily inspections also need to be conducted on the content of the water quality parameters. Meanwhile, when the test results exceed the standard due to the presence of contamination in the raw water, corrective action is required.

KEY WORDS: pollution index, raw water, STORET, water classification, water quality status.

INTRODUCTION

Water is an important nutrient for the life of every living thing, including humans. Based on previous investigations, it was reported that approximately 50-60% of

the human body is in form of liquid. Meanwhile, the differences in the amount of water are due to age, health, weight, and gender. The water requirements are obtained by the body through food, drinking water consumed, and processed raw water.

The need for raw water is not only for household activities but also in the agricultural, tourism, industrial, and mining sectors. In the mining sector, at PTFI, raw water that fulfills drinking water quality requirements is also needed for workers in their activities. This is because raw material that does not fulfill the quality standard requirements will have a bad impact on health. When contaminated raw water is used directly, it can also cause diseases such as diarrhea, cholera, dysentery, typhoid, etc. Meanwhile, in Indonesia, the water quality standard is handled based on the Regulation of the Indonesian Minister of Health No. 32 of 2017.

Quality status indicates whether a water source is in good condition with the presence of contamination at a certain time. Subsequently, the condition of this raw water is compared with the quality standard based on the stipulated requirements. In this process, Pollution Index (IP) as well asStorage and Retrieval (STORET) methods are used to determine the quality status. The IP method uses a formula to identify the contamination level, while the STORET compares raw water quality with the standards. The flow chart related to the implementation of the status assessment of the two methods is described in Figure 1.

The need for drinking water in the PTFI Concentrating Division area comes from run-off as raw water, which is tapped with water-tapping structures, namely dams. The raw water used is channeled to the water treatment plant according to its designation after collection. The treatment plant consists of a step-by-step filtering process and a disinfection process. The filtering process involves, namely microfiltration and nanofiltration, while the disinfection uses chlorination and ozonation methods.

A sampling of raw water and quality testing is routinely carried out by the PTFI Concentrating Division. This is conducted internally and externally by the PTFI Environmental Laboratory. The implementation of this test follows the specified requirements. Similarly, the raw quality test is needed to determine whether the water sample is suitable for use as a source of drinking water for workers. Subsequently, the results of the complete test consisting of physical, chemical, and microbiological parameters were analyzed for raw water quality.

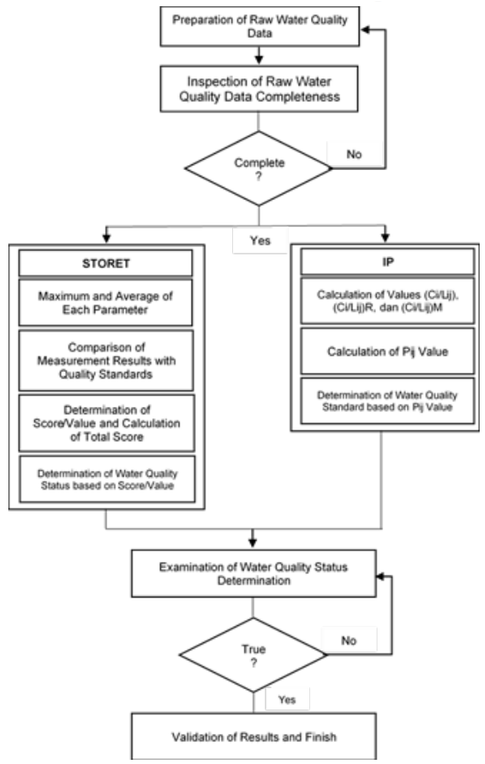
This study aims to analyze the raw water quality for drinking water sources using IP and STORET methods. The result is expected to be a consideration for the selection of raw water treatment units and a reference for monitoring and evaluating the quality used as drinking water for workers in the PTFI Concentrating Division.

METHOD

This study was conducted in the PTFI Concentrating Division area from August to October 2022. The primary data were obtained from direct observations carried out in water-tapping structures or dams. Meanwhile, the secondary data were collected from the results of testing physical, chemical, and microbiological parameters from January 2018 to September 2022. The parameters used in this study refer to the Regulation of the Minister of Health No. 32 of 2017. Furthermore, the physical parameters consist of TDS (total dissolved solid), temperature, turbidity, and color. Chemical parameters consist of pH, NO3-N, NO2-N, SO4, F, Cn, Cd, Cr, Pb, Mn, and Se, while the microbiological parameters consist of Total Coliform and *Escherichia coli*.

The quality status was determined using the IP method obtained from the analysis of raw water samples with the formula, as follows:

$$IPj = \frac{\sqrt{\left(\frac{C_i}{L_{ij}}\right)^2_M + \left(\frac{C_i}{L_{ij}}\right)^2_R}}{2}$$



Where:

IPj = pollution index for the designation j.Ci = level of water quality parameter i.

Lij = level of water quality parameter i in the water quality standard j M = maximum value

R = average value

(1) Determination of the pollution level is the next step after the IPj results are obtained based on 4 IP classifications, namely:

Score IPj > 10 .....heavily polluted

Score 5,0 < IPj ≤ 10 ..... moderately polluted Score 1,0 < IPj ≤ 5,0 lightly polluted

Score 0 ≤ IPj ≤ 1,0..... fulfill the quality standard

Figure 1. Flowchart of Raw Water Quality Status Assessment with IP and STORET Methods.

The STORET method for status determination used the time series water quality data. The status can be used as an evaluation material to determine harmful contamination in raw water. The stages of this method begin with the collection of the data from quality testing periodically, followed by comparing the test results with the quality standard values based on each parameter. The measurement result less than the water quality standard value is given a score of 0, while the value that exceeds or does not meet the threshold is given a score according to the value system determination table. Moreover, the total negative number of all parameters was calculated based on the number of scores obtained as follows:

Class D Poor, with a score >-31 and heavily polluted status

Class C Moderate, with a score of -11 to -30 and moderately polluted statusClass B Good, with a score of -1 to -10 and a lightly polluted status

Class A Very Good, with a score of 0, and the status fulfills the quality standards.

RESULT AND DISCUSSION

Water Tapping Building (Dam) & Water Treatment Plant (WTP)

The water-tapping building or dam functions as a collector of surface run-off, which becomes raw water as depicted in Figure 2. The dam is located in the area of the ore processing production complex at Mile Post 74. Furthermore, it is between the confluence of two mountain cliffs at an altitude of about 3,046 meters above sea level (masl). Annual rainfall in this area is significantly abundant, therefore, it can be used as raw water. Oncecollected, it is channeled to a water treatment plant using the gravity method through a 4-inch diameter HDPE pipe.

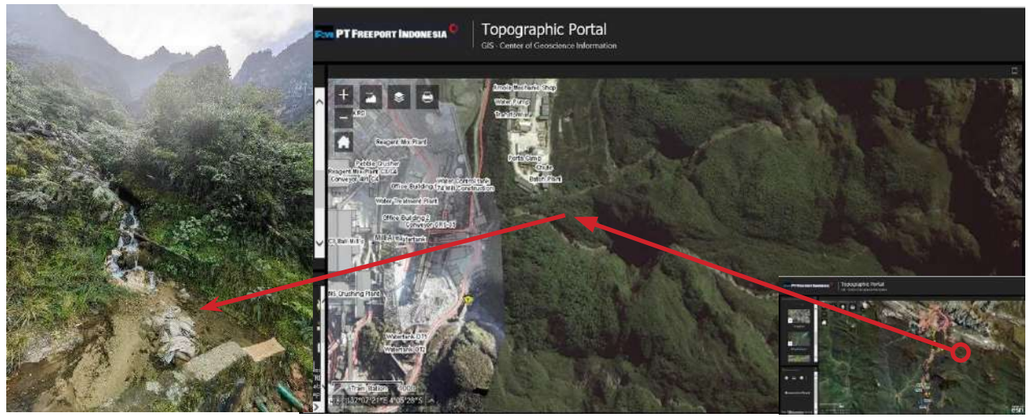


Figure 2. The Dam Location as a Raw Water Tapping Structure in the Upper Amole Dam

The use of raw water as a source of drinking water for workers in the PTFI Concentrating Division is confirmed to pass the water treatment plant,although all physical, chemical, and microbiological parameters have fulfilled the quality standards. This is to ensure that the water is always processed to obtain better quality. This treatment plant consists of several stages of processing, namely microfiltration, nanofiltration, and disinfection. The filtration is carried out to remove suspended and colloidal particles, as well as color, taste, odor, iron, and manganese. The flow direction in the filtration process uses up-flow and a gravity filtration system.

In addition to sand as a filter medium used in this water treatment plant, there is also activated carbon as a filtration medium for more specific purposes. This activated carbon is used for adsorption media to remove organic matter. The membrane filter is used in the last process after nanofiltration, as a filter medium for filtering materials, where the size is much smaller than the particle size (suspended solid). In this process, disinfection is carried out by giving chemicals in form of a solution of chlorine and/or ozone into the water. This creates contact between the materials and microorganisms, which leads to the death of microorganisms. These chemicals are mostly used in water treatment plant to disinfect drinking water.

Raw Water Quality Status Assessment Results

A previous report showed that the average rainfall in 2021 is around 524.7 mm. Generally, the dam is equipped with a strainer unit to filter raw water from potential contamination due to dirt and other particles that can be carried away when it flows. The strainer maintenance with cleaning is carried out manually every week and more often when the daily rainfall is very high. This is because impurities carried by high rainwater along the flow path can clog the strainer.

Table 1 shows the results of routine inspections for raw water, which is the source of drinking water in the PTFI Concentrating Division. The laboratory test results for physical parameters are declared to fulfill the requirements because no value exceeds the quality standard. The average value of the temperature is 11.7°C because the dam location is in the highlands, which have a relatively cold ambient temperature on average ranging from 11 to 14°C. The temperature in aquatic ecosystems is influenced by many factors, including humidity and sun exposure. The ambient temperature and humidity as described in Figure 3 are the main factors that determine the water temperature.

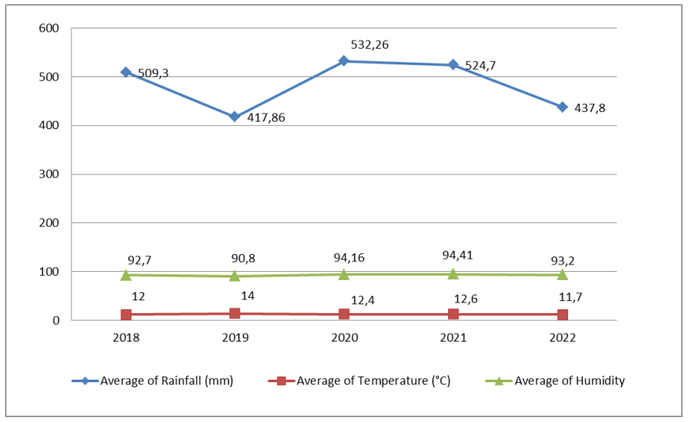


Figure 3. Rainfall, Environmental Temperature, and Humidity in the PTFI Concentrating Division Table 1. Measurement results of physics, chemistry and biology

Parameter	Unit	Standard	Minimum	Maximum	Mean
TDS	mg/L	1000	59	441	134,5
Temperature	oC	± 3	9,01	11,6	10,03
Turbidity	NTU	25	<0,05	4,42	1,04
Color	TCU	50	<3	3	3,00
pH		6,5-8,5	6,88	7,22	7,066
Nitrate	mg/L	10	0,009	0,35	0,228167
Nitrite	mg/l	1	< 0,005	< 0,01	0,01
Sulfate	mg/L	400	14,5	281	62,033
Fluoride	mg/L	1,5	< 0,02	0,13	0,06
Cianide	mg/L	0,1	< 0,004	< 0,004	0,004
Cadmium	mg/L	0,005	< 0,001	< 0,001	0,001
Chromium	mg/L	0,05	< 0,001	< 0,001	0,001
Lead	mg/L	0,05	< 0,005	< 0,005	0,01
Mangan	mg/L	0,5	< 0,0002	0,0294	0,01
Selenium	mg/L	0,01	< 0,005	< 0,005	0,01
Total Coliform	CFU/100ml	50	1	2	1
E. Coli	CFU/100ml	0	0	0	0

Other physical parameters are color, TDS, and turbidity. The color usually comes from the presence of plankton and dissolved metal ions. Based on the results, the raw water is colorless because the content of plankton and dissolved metal ions is very low. TDS is a physical parameter influenced by chloride and organic substances. The TDS value obtained is below the quality standard due to the low content of chloride and organic matter. The turbidity parameter does not exceed the quality standard because the raw water source from the surface is not contaminated by pollutant substances.

The results showed that no chemical parameter exceeds the established quality standard. Parameters of pH, nitrite, and sulfate are usually influenced by domestic and industrial wastes. The raw water used as a source of drinking water in the PTFI Concentrating Division has a pH value ranging from 6.5 to 8.5. Meanwhile, a previous report stated that nitrite and sulfate are harmful to respiratory health when consumed. Based on this study, the values of nitrite and sulfate are below the quality standard because the location of the dam is far from industrial activities and at a fairly high elevation from industrial and domestic waste disposal.

The quality of raw water on microbiological parameters, namely total coliform has an average value of 2 CFU/100 ml, and *E. coli* is 0 CFU/100 ml. Since the microbiological parameters fulfill quality standards, the sample tested is safe to use as drinking water. The raw water is free from microbiological contamination

because the location of the dam is far from human activities, therefore, it is not contaminated with *E. Coli* from human feces. It is important to note that there are still living aquatic plants around the dam that are intentionally used to reduce contamination. Moreover, total coliforms can also come from dead aquatic plants called non-fecal total coliforms. Total non-fecal coliforms for example *spp, Enterobacter spp,* and *Klebsiella spp*.

Table 2. Results of Analysis of IP and STORET Methods and their Classification

Method	Result Analysis	Classification
IP	0,612	Meet quality standards
STORET	0	Meet quality standards

The score for water quality using the IP method is 0.612, which is below 1.0, thereby fulfilling the quality standard. The STORET method obtained a value of 0, indicating that the raw water sample fulfills the standard. The two analysis results meet the standard requirements because no contamination affects physical, chemical, and microbiological parameters. Therefore, to use the water properly according to its designation, it must be kept unpolluted.

The raw water which is the source of drinking water in the PTFI Concentrating Division needs to be maintained. The quality can be maintained in several ways, such as cleaning the strainer regularly at least once a week and testing the raw water regularly. The use of raw water distribution piping from the dam to the water treatment plant does not have a cross-connection with the pipeline for dirty water or domestic waste below ground level. Therefore, dam protection must also be carried out in form of making a protective fence to prevent people from entering the dam location. Other factors that need to be considered are ensuring that vectors or nuisance animals do not enter and breed and improving environmental health.

CONCLUSIONS AND SUGGESTIONS

The raw water quality analysis using the IP method has a score of 0.612 and the STORET score is 0. The classification of raw water is categorized as fulfilling the quality standard because the values of all physical, chemical and microbiological parameters are below the standard. To maintain this quality, there is a need to prevent the water from pollution and contamination. Furthermore, laboratory tests or routine daily checks for the content of all parameters need to be carried out. When the results of these tests and inspections showed contamination levels that exceed the quality standards, corrective action must be taken immediately.

ACKNOWLEDGEMENTS

This study has been developed under the HSE (Health Safety & Environmental) Department, Concentrating Division of PT Freeport Indonesia, promoted by Environmental and Industrial Health Project Section. The authors wish to thank the organizations that agreed to participate in this study. Particularly, the authors would like to acknowledge Anthony Manuel as Vice President of Concentrating Division.

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Segmented And Scalable Online Monitoring Approach To Reduce The Risk Of Greywater Pollution In Indonesia

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ABSTRACT

With majority of Indonesian population still rely on on-site septic tank, there is a tendency that while the blackwater is mostly kept contained, the greywater is continuously discharged without prior treatment. The government has put some efforts as a response through development of DEWATS system as part of SANIMAS program whereas other ready-onsite "Sewage Treatment Plant" (STP) products are also available. However, recent studies mention that lack of monitoring and maintenance contribute as two of several drawbacks. In brief, this study aims to find out the importance of online monitoring and how it can contribute to help sustaining different scale of decentralized greywater treatment system by means of segmented and scalable approach. It is also expected that the proposed online monitoring approach can support existing government online monitoring program as well as to accelerate the adoption of government programs related with sanitation and clean river.

KEYWORDS: greywater pollution, on-site treatment, segmented and scalable online monitoring

BACKGROUND

With most population relying on on-site collection [1, 2, 3, 4], it is certain that while most of the blackwater is kept in the containment, the greywater is discharged mostly without further treatment. Currently there are existing programs e.g., on-site communal septic tank and DEWATS system through SANIMAS program as well as compact and "plug-and-play" STP-ready package to reduce greywater pollution. However, the adoption of these systems is hindered by lack of monitoring, maintenance, unclear payment scheme, lack

of laws, regulation and standard [4, 6, 8, 16, 17]. This study underlines how online monitoring may help to tackle the first two and the latter points thus helping to close current gap.

METHODOLOGY

A stepwise approach is introduced: analyzing the importance of online monitoring and proposing an online monitoring approach based on segmentation made in this study to close the gap mentioned earlier. The authors also perform literature studies both from external sources (literatures: Google Scholar, Scopus, and Elsevier; Reports: Asian Development Bank, UNDP, ARCOWA and IFS; regulations and standards: BORDA and PERMEN KLHK) and internal sources (public information of Endress+Hauser).

A segmented approach for greywater online monitoring with different level and scale is stressed in this study (range is derived independently from common range of DEWATS capacity in [5]):

Small: local on-site treatment (1-30 m^3/day)

Medium: small commercial buildings and public facilities (30-80 m^3/day)

Large: DEWATS or centralized Wastewater Treatment Plant (WWTP) (> 80 m^3/day)

RESULTS AND DISCUSSIONS

IMPORTANCE OF ONLINE MONITORING

Monitoring as a key of decision making was once known as a costly approach if brought online but thanks to more mature Internet of Things (IoT) infrastructure, it is now possible to find more efficient way to connect field instruments to the cloud. The level of applicability and dependability of sensors may also vary depending on the needs and level of application, thus optimizing the online monitoring cost. Furthermore, in order to sustain the whole processes and to walk the journey through sustainability, online monitoring plays a critical role. It is also explained in this study that importance of data, reliable data collection, turning data into insights and decision-making tools as well as turning it into actions are all started with reliable online monitoring system.

Two major parts involved in operations of decentralized greywater treatment plant are instrumentation and treatment module. Instrumentation plays critical role to measure parameters and to indicate treatment modules performance. One way to help operators to save times and come prepared for maintaining instruments is by utilizing “Asset Health Monitoring” (AHM) system. The operators can then focus only on the maintenance-required instruments instead of performing periodical checking. Meanwhile, a treatment modules deterioration can be tracked through measured parameters. The online monitoring approach in this study is also targeted to improve spatial data density of existing online monitoring programs i.e., “Online Monitoring” (ONLIMO) and “Continuous and Inline Wastewater Quality Monitoring System” (SPARING) by Ministry of Environment and Forestry (KLHK).

ONLINE MONITORING INFRASTRUCTURE

IoT system studies for wastewater monitoring in Indonesia have been developed [7, 13, 14, 15, 16]. However, they are still considerably rare and most of them only address a specific condition of utilization with less variation on the infrastructure and level of applicability. Current research is then developed to emphasize the applicability of different online monitoring approaches for different level of greywater treatment facility as follows:

Basic: Small-scale communal on-site treatment (household & residential cluster)

Measurement with “basic” products focusing on the quantity (flow), Total Suspended Solids (TSS), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) where the last three can be approximated using single multiparameter spectrometer to minimize cost. The connectivity utilizes WLAN where the data will be carried over through the available “free” network hence keeping the cost low.

Intermediate: Medium-scale communal on-site treatment (commercial and public facilities)

Similar sensors combination and connectivity as the basic segment. The difference lies in the capacity (flow), numbers of STP-package used and sensor packages. pH along with Dissolved Oxygen (DO) and bottom sludge level sensor can also be added.

Advance: Large DEWATS system and Centralized WWTP

Similar parameters with basic and intermediate segment are also expected for greywater monitoring. Involvement of more parameters to be measured such as pH, Ammonium, Ammonia, Nitrate, DO, Total Dissolved Solids (TDS), conductivity and sludge level is recommended. A GSM module or connection to fiber optics network can be established as an option. The online monitoring for the centralized WWTP itself will be managed by the SPARING program [19].

CONCLUSION

Unlike blackwater that mostly kept contained, greywater is continuously discharged without prior treatment. Factors such as lack of monitoring, maintenance, strict regulation, and unclear funding scheme persist hindering the development of decentralized treatment in tackling the greywater problem. Our study is then developed to address the first three factors by proposing segmented, scalable, and efficient online monitoring system by also stressing the importance of online monitoring.

Segmented online monitoring matched with different scale and level of greywater treatment can help to standardize and find most suitable combination of sensors and connectivity infrastructure. Operations and maintenance can also be technically improved assuming that AHM and treatment module performance monitoring are adopted. It is also aimed to strengthen coverage of current online monitoring programs such as ONLIMO and SPARING by KLHK by also providing more visibility. Development of standard to integrate STP-ready package and DEWATS with online monitoring is also wide open.

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Right to Water in the Perspective of Human Rights Law: The concept of Ius Constituendum and its relation to the Sustainable Development Goals in Indonesia

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BACKGROUND

Water has always been an important part of human life. In the last few decades, water polemics have increased and the main problem is due to the absence of effective water management and water security (water protection) instruments. Therefore, the lack of access to clean water always occurs and at its worst, also has a serious impact on human rights aspects and is a major obstacle to sustainable development.

In the international scope, the water sector is characterized by a very complex and problematic situation. The operation of water services, the legal framework and water conditions are key issues for this problem, which are not only regional, but exists in most developing countries. The right of every human being to safe drinking water and basic sanitation must be recognized and realized. This situation requires more attention for the international community, particularly those who have committed to the Sustainable Development Goals (SDGs), including Indonesia.

The legal and political representation of Natural Resources (SDA) management is constitutionally contained in the 1945 Constitution of the Republic of Indonesia (UUD NRI 1945) which states that the earth, water, and the wealth contained therein are controlled by the state and used as much as possible for people's prosperity.[3] The form of the right to control the state itself is in the form of regulating the allocation, use, supply, and maintenance of water.[4]

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3 Article 33 paragraph (3) of the 1945 Constitution of the Republic of Indonesia.
4 Regulates the legal relationship between people and water and the legal relationship between people and legal actions regarding water (Article 2 paragraph (2) of Law Number 5 of 1960 concerning Basic Regulations on Agrarian Principles).

In the context of the Indonesian state as a democratic country which prioritizes the public interest, the importance of water as a basic human need that requires guaranteed access for citizens has been realized by the founding fathers as stated in Article 33 of the 1945 Constitution of the Republic of Indonesia. The right to water for this is the embodiment of the fulfillment of the human rights of Indonesian citizens.

Human rights are one of the modern legal concepts that clearly distinguish individuals as rights holders and the state as duty holders/bearers.[5] In principle, the state has 3 (three) obligations, namely: (1) the obligation to fulfil; (2) The obligation to protect; and (3) the obligation to respect. The right to water itself is included in the group of economic, social and cultural rights as positive rights, which means that these rights require a large state involvement in their fulfilment.[6]

The right to water is a human right that does not come from the state, but a certain ecological context of human existence that gives rise to the right to water.[7] As an irreplaceable essence of life, the vitality of water for human life is the same as oxygen. Without water, not only humans, but also all living things on earth cannot survive. Therefore, the right to water is a fundamental right for life as stated in the United Nations (UN) covenant. The unguarded existence of water as a human right has the potential to cause human rights violations, as emphasized in the UN general assembly which reads as follows:

"The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights."

This means that each state is responsible for providing clean water for consumption and clean water used for sanitation to all its citizens. Without water, other human rights cannot be implemented.

The 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) establish a universal framework for global action and goals to end extreme poverty and combat inequality and injustice based on the principles of sustainable development. This new agenda, adopted by the United Nations for the period 2015-2030, is the product of the discussions that took place after the United Nations Conference on Sustainable Development in Rio de Janeiro in 2012 and negotiations to define a post-2015 development agenda. By leveraging the success of the Millennium Development Goals and learning from their weaknesses, the 2030 Agenda provides more ambitious targets that are expected to be better adapted to the different regional, national and local situations in which they will be implemented. The SDGs form a set of interconnected and coherent targets that must be tackled together. Water and sanitation services are handled directly by the SDGs, in line with the human right to water and sanitation.

As it is understood that one of the weaknesses in the management of water resources is the uncertainty of the equipment, especially in the form of legal rules, especially after the Constitutional Court's decision on Law Number 7 of 2004 concerning Water Resources. Naturally, this challenge is getting more severe with the increasing need as the most vital life support. Meanwhile, at the same time, driven by unavoidable needs, the need for water in office centres, shopping, industry, agriculture, mining, as well as needs in other sectors continues to develop.

Therefore, this research is aimed at analysing right to water in the perspective of human rights law from the concept of *ius constituendum* and its relation to the sustainable development goals particularly in the context of Indonesia. It will criticize on how the goals of the constitution is aligned with the law in manifesting the right of citizens to water. This analysis will then be linked with the global target of sustainable development goals in order to see the benchmark of its fulfilment.

METHODOLOGY

In order to find answers on how the framework for regulating the right to water applies in Indonesia, as well as what the ideal concept of regulation of the right to water according to human rights law and the SDGs, this research will employ the method of normative-doctrinal approach. As for the data collection method according to this type of research, the author will rely on library studies to obtain concepts related to the object and problem of the research.

RESULTS

Nicolola Colbran explained that there are 4 (four) indicators of the content of the right to water, namely[8]: (1) adequate and continuous supply or continuous (available); (2) safe and acceptable; (3) can be accessed physically (physically accessible); and (4) affordable. All four are used for personal and domestic use. Decent water means that it must be suitable for dignity, life and health. The

5 Eko Riyadi dan Supriyanto Abdi (ed.), *Mengurai Kompleksitas Hak Asasi Manusia (Kajian Multi Perspektif)*, PUSHAM UII, Yogyakarta, 2007, hlm. 244.
6 *Ibid* p.246
7 Maude Barlow in Vandana Shiva, Water Wars: Privatization of Profit and Pollution, Insist Press, Yogyakarta, p. 100

8 Nicola Colbran, Right to Water, Indonesian Program Norwegian Center of Human Rights, p. 8, in the handout delivered at the Study Visit and Reflection on the Right to Water and Housing, by PUSHAM UII Yogyakarta in collaboration with NHCR (Norwegian Center for Human Rights), Yogyakarta, 2009. See also General Comment No. 5 on the Right to Water, Committee on Economic Rights. , Social and Cultural

feasibility in question cannot be interpreted narrowly, which does not only refer to the quantity and technology used, but water must also be treated as an item that has social and cultural value, not only as an economic good. So the nature of its fulfilment must be sustainable. Adequate and continuous availability of water is related to the management of obligation holders in ensuring the fulfilment of the right to water proportionally. This relates to the quantity of water available to each person. The World Health Organization (WHO) states that everyone needs between 50 and 100 litters of water per day to ensure that most basic needs are met and some health problems arise.[9]

The United Nations Commission on Human Rights (UNHCR) states that the right to drinking water and sanitation services is a human right. Likewise, the resolution of the Sub Commission on the Prevention of Discrimination and Protection of Minorities states that the right to drinking water and sanitation for every man, woman and child is a fundamental principle of equality, human dignity and social justice. Thus, eliminating a person's free access to water is nothing but a violation of human rights related to the rights to life and freedom and personal security which are very fundamental.[10]

In terms of the right to water, Indonesian citizens are guaranteed by Article 33 paragraph (3) of the 1945 Constitution of the Republic of Indonesia which contains written provisions regarding earth, water and the wealth contained therein. Even though the perspective is state control, it can be understood as state obligation, as an implication of the existence of citizens' interests over the earth, water, and the wealth contained therein where the state is obliged to control (and protect) them in such a way that they can be used for the greatest possible benefit. It is hoped that the reality of water scarcity should not be seen as an economic opportunity as in neoliberal-capitalism logic, but rather see it as a threat to human survival, so that what should be put forward is the constitutional protection of human rights to water and access to its sources. This includes the protection of the state over water resources itself, which must be preserved in order to protect the constitutional rights of future generations to one of the most important sources of life, namely water. In this perspective, regulations should be made and enforced not only to protect private property rights, which are implemented in providing the widest possible space for the private sector to capitalize on water as a trading commodity, but to protect water as a basic human need so as not to waste, over-exploit, destroy or negate its resources.

9 *Fact Sheet* No. 15 *The Right to Water, United Nations High Commissioner for Human Rights*, hlm. 8-9.
10 Article 3 of the Universal Declaration of Human Rights states: "Everyone has the right to life, liberty and security of person".

In almost all legal systems in the world, water has historically been recognized as a public resource. The theory of public goods was first introduced by Paul Samuelson in paper he wrote in 1954, "The Pure Theory of Public Expenditure". In the public good inherent non-excludable nature, which means it is impossible to prevent/exclude/ negate someone's right to consume it. An object that is non rivalry but non-excludable is usually referred to as a common pool of resources.

The position of water as an economic good is directly related to the fact that water as a resource has been, is, and will become an increasingly scarce item (scarce good). Among the things behind it is the amount of water reserves that are not evenly distributed between one region and another. The contribution of water to economic and social development is also seen as very vital.[11] Seeing this fact, we cannot rule out the position of water as a public good. Because in general people buy water as an option because of their purchasing power. However, in a society that does not have purchasing power, if you treat water as an economic good with its market logic, it will hinder people from being able to access water to fulfil their basic needs. This last reason raises the idea of the need to include the right to water as a human right, so that human rights to water as a basic need for life are protected from the violence of the economization/ commoditization of water.

Based on the entire description above, it can be concluded that the breakthrough the author initiated, namely returning to the value of social justice as the ideals of the nation that had been built by the nation's founders; placing water as part of human rights and public goods as well as carrying out the politics of the right to control the state are relevant to be enforced. The reason is, there have been 2 (two) laws that were formed by state administrators, but both of them have liberal-capitalist influences in which they have legalized covert privatization even after the Constitutional Court issued a conditional constitutional decision and 6 (six) principles of natural resource management. It should be remembered that the fourth main idea of the 1945 Constitution of the Republic of Indonesia (a state based on the One Godhead according to a just and civilized humanity), contains content that obliges the government and state administrators to maintain noble human character and uphold the moral ideals of the people. With the fulfilment of the imperative of social justice, it is hoped that the long cry of the Indonesian people to get out of the shackles of poverty and suffering can find their dream of happiness.

The establishment of SDG 6, Ensure the availability and sustainable management of water and sanitation for all, reflects the increasing attention

11 Akhmad Fauzi, Ekonomi Sumber Daya Alam dan Lingkungan, Gramedia Pustaka Utama, Jakarta, 2004, p. 165.

to water and sanitation issues on the global political agenda. Agenda 2030 lists increasing inequality, natural resource depletion, environmental degradation and climate change among the greatest challenges of our time. It is recognized that social development and economic prosperity depend on the sustainable management of water resources and ecosystems in line with the SDGs targets.[12]

Water in sufficient quantity and quality is essential for all aspects of life and sustainable development. The human right to water and sanitation is widely recognized by UN Member States. Water resources are embedded in all forms of development (eg food security, health promotion and poverty reduction), in sustaining economic growth in agriculture, industry and energy generation, and in maintaining healthy ecosystems.

Water-related ecosystems and environments have always provided natural sites for human settlement and civilization, bringing benefits such as transportation, nature purification, irrigation, flood protection and biodiversity habitat. However, population growth, agricultural intensification, urbanization, industrial production and pollution, and climate change are starting to overwhelm and weaken nature's ability to provide key functions and services. Estimates suggest that if the natural environment continues to be degraded and unsustainable pressures are placed on global water resources, 45 percent of global gross domestic product, 52 percent of the world's population and 40 percent of global grain production will be threatened by 2050. the marginalized will be disproportionately affected, further exacerbating rising inequality.[13]

SDG 6 aims to provide universal access to water and sanitation, ensuring that no one is left behind. The SDGs therefore seek to create an overall vision that focuses on providing sustainable services for all, rather than a project-based approach whose main objective is to develop infrastructure: For water, this means expanding coverage beyond access by also working to ensure the availability and affordability of services and quality water.[14]

These monitoring indicators set benchmarks whose definitions provide concrete criteria for practice across various sectors. Therefore, water and sanitation indicators determine the level of service to be achieved by 2030, i.e. that services must be managed accordingly. To ensure countries remain optimistic about the ambitious targets set by the SDGs, and to monitor progress more accurately, a legal framework is needed that can support both management, infrastructure provision, as well as sanctions for water abuse violations.

12 United Nations, Sustainable Development Goals 6, Synthesis Report on Water and Sanitation, New York 2018, ISBN: 978-92-1-101370-2
13 *Ibid*
14 Colette Génevaux, programme Solidarité-Eau, The Sustainable Development Goals for Water and Sanitation Services Interpreting the Targets and Indicators, Paris, 2018 www.pseau.org/en/agenda-2030

To ensure sustainable development, even though it is not legally binding, Indonesia has a strong commitment to support the Sustainable Development Goals (SDGs) which have been initiated by the United Nations General Assembly since 2015 with the main targets to end poverty, protect the earth, and ensure a sustainable life. peace and prosperity for all citizens of the world by 2030.[15]

Efforts are still needed to achieve universal access to clean and safe drinking water for all. Business-as-usual projections will still leave around 70 million people without access to safe drinking water. A well-designed program should accelerated to provide safe drinking water for all. Not only that, stronger leadership and technical support for local implementation from the central government through clear regulations and guidelines is needed to address the challenges of providing clean sanitation for all. Prioritize adequate conditions for sustainable sanitation services (regulatory, institutional, and financing) at the district level and ensure local government commitments, continue infrastructure development for safe sanitation access (centralized or localized) and Increase financial support.

It is undeniable that in carrying out the mandate of the Law, there are several main challenges in the management of water resources that have an impact on the realization of human rights. First, Indonesia as part of the international community, in relation to the Millennium Development Goals (MDGs) and the Johannesburg Summit in 2002, has set a target to reduce the number of people who do not have access to clean water and sanitation services. In 2002, half by 2015. The main challenge for Indonesia in achieving this goal is the fact that the current level of clean water and sanitation services is still relatively low, especially for people living in urban, rural, and small islands slum areas. and coastal areas. Second, lack of cooperation and coordination between sectors and districts in water resources management and overlapping tasks and functions between institutions in water resources management. Third, the lack of correct and accurate data and information about water resources and the absence of an integrated design in the planning for the development of drinking water services that safety and waste water management. This results in no synergy in the development of the two sectors. Fourth, the low level of public access to domestic wastewater management services and public awareness of the importance of domestic wastewater management. Fifth, there are not enough legal instruments to regulate domestic wastewater management and weak law enforcement for waste water disposal actors into clean water. Finally, the weak institutional function at the provincial or district level in implementing domestic wastewater management and limited government funds for domestic wastewater management activities.

15 Jayanti, Ery & Muhammad, Said & Nazamuddin, B S & Zulham, Teuku & Abd. Majid, M. Shabri. (2019). Does Quality of Life Matter for Achieving Sustainable Development Goals in Indonesia?. 11. 119-132.

In tackling these challenges, there are several ways that the Indonesian government can take. The first is to develop strategic steps that are in accordance with the SDGS targets in an effort to improve water resource management by prioritizing the concept of “one river basin, one management”. With a concept like this, water management will be built based on each watershed area, not by the local government itself. However, this step cannot be concreted because currently there is no mechanism for implementing the protection of water and river resources. Second, improve coordination between institutions and sectors through discussions on efforts to overcome implementation challenges and measures for water resources sustainability and gradually improve infrastructure for water availability. Third, improve supervision and legal basis for water resources management with the support of investigators in the field of water resources management appointed in each agency that specifically handles water resource management. Fourth, providing facilitation of water supply infrastructure safe drinking for the community. Fifth, advocate for the improvement of drinking water services, assistance and support from local governments by the central government and improve planning for the development of safe drinking water and sanitation facilities in districts/cities.

CONCLUSION

In order to realize the legal politics of state control over natural resources, the social functions of water and social justice in the field of natural resources must be prioritized. One of the efforts that can be taken is through the revaluation of legal products in the field of natural resource management which are contrary to the constitution and the value of social justice. In this case the consequence of the state as a regulator and manager of production branches that are important to the state and control the livelihoods of many people. Based on the above points, the direction of legal politics towards the management of natural resources as a necessity for the realization of natural resource sovereignty in Indonesia is directed at the legal construction of the state’s right to control natural resources based on the values of social justice which are coloured by the principles of human rights. Reconstruction of legal politics is carried out at the basic level, subject matter, purpose, substance, and consequences so that a natural resource management design based on Indonesian neo-socialism is realized by emphasizing broad people’s participation in the field of natural resource management in the future.

Water is a basic need and source of life for every living creature, therefore it needs to be protected and guaranteed its sustainability. Use of water for various purposes need to be managed to prevent potential conflicts in their use and to ensure that everyone has sustainable access to water. Therefore, taking into account the increasing population and decreasing water supply, it is necessary to formulate an efficient and consistent management of water resources with the SDGs targets. This can be achieved by utilizing supply and demand management which aims to increase the effectiveness and efficiency of water use and consumption as well as capacity and dependence on water availability. Another important aspect that must be considered related to water resource management and in the goals of the SDGs is to specifically set targets to be achieved at each stage as a control mechanism in water resources management that guarantees the rights of the Indonesian population.

Reflection on the community-based rural water supply and sanitation program (PAMSIMAS) in Indonesia

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BACKGROUND

To tackle the problem of water access in peri-urban and rural areas, the Indonesian government launched the community-based rural water supply and sanitation program, called “Program Penyediaan Air Minum dan Sanitasi Berbasis Masyarakat (PAMSIMAS)” in Bahasa, in 2006. There have been three periods of the PAMSIMAS program until now: PAMSIMAS I (2008–2012), PAMSIMAS II (2013–2015), and PAMSIMAS III (2016–2021). PAMSIMAS has benefited about 21.6 million people in 32 thousand villages throughout Indonesia until May 2021. This makes PAMSIMAS one of the biggest water and sanitation access programs in the world.

METHOD

We conducted analyses using multiple methods, i.e., multinomial logistic regression, Bayesian belief network (BBN) model, and system dynamic (SD) model, and using almost 29,000 PAMSIMAS villages data in the country and also a study case from Magelang Regency, Province of Central Java, to gain insights on the factors related to the sustainability or functionality of PAMSIMAS project in Indonesia.

RESULTS

The latest data in May 2021 indicates that 85.4% of the water supply systems were fully functioning, 9.1% were partially functioning, and 5.5% were not functioning. The regression analysis shows that good management of the water board ("KPSPAMS" in Bahasa), e.g., the existence of a list of PAMSIMAS assets, bookkeeping, and work plan, is positively associated with the functionality. Furthermore, a high investment per capita in the PAMSIMAS project is negatively associated with the functionality, suggesting the need for comprehensive economic analysis in the feasibility study in scattered housing sites and remote-undeveloped areas. Moreover, the household connection is more likely to be functioning than the communal connection.

In general, there are two types of community contributions on the project: (1) in-kind, i.e., related to physical contribution in various activities, and (2) in-cash, i.e., cash contribution. If we only analyze factors related to the community contribution, the regression analysis shows that the effect of monthly or regular in-cash or financial contributions on the functionality is significantly larger than all variables related to the in-kind contributions at the beginning of the project, e.g., planning or pipe system construction. This finding is supported by the BBN analysis: if the beneficiaries do not pay for water, the probability of not functioning systems is 20 times higher than systems with fee collection.

Using the study case of Magelang Regency, the scenario analysis of the SD model shows that external fund is critical to support the program financially, especially at the beginning of the. Moreover, human factors, i.e., the performance of the water board and support from the community, positively influence the sustainability of the PAMSIMAS program.

DISCUSSION

Our studies suggest that there should be an alternative investment and construction scheme for scattered housing sites and remote-undeveloped areas to reduce investment costs. Moreover, fund contribution not only creates a sense of ownership towards the PAMSIMAS program but also provides sufficient funds for the water board (KPSPAMS) to perform their tasks, e.g., operation & maintenance, and repairs. Furthermore, the influence of monthly or regular in-cash contributions on the functionality is higher than in-kind contributions, suggesting the necessity to collect water fees from all water supply beneficiaries. Our studies argue strong and good performance of the water board, i.e., KPSPAMS, is necessary to keep the piped system functioning sustainably. It is related to the high trust of the beneficiaries in the KPSPAMS and then positively influences the functionality of the system, e.g., via regular payment.

CONCLUSION

Our comprehensive studies found that there are many factors associated with a successful PAMSIMAS program. Those factors are interrelated, i.e., connected and influencing each other. All those findings should be taken into account in the implementation of PAMSIMAS or other community-based rural water supply programs in Indonesia and developing countries to increase the chance of sustainability.

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Marine Porous Biosilica as Prospective Renewable Biomaterial for Microbial Removal Grade Filter in Drinking Water Processing

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ABSTRACT

Routine procurement of various consumables of supporting materials, such as membrane- based filters, separation matrix, flocculant, and etc., commonly contributes to high expense in some stages of drinking water purification activities. Origin of many supporting materials are consideredfrom nonrenewable resources, either chemically synthesized or directly obtained from natural deposit, so that there would be possibilities of material shortage during drinking water manufacturing that could disturb water resilience. Renewable sources of those materials are ought to thoroughly explored and properly developed, subsequently, in order to support supply chain aspect of supporting materials that are regularly consumed in water processing activities. Marine diatoms as cultivable microalga group can produce silica-based biomaterial with micrometer-sizedof organized pores. Due to broad chemical stability and specific size of pores, natural marine biosilica from cultivable diatoms, could be prospectively utilized as main component of separationmatrix for removing and/or reducing waters' particulates. Regarding bioburden reduction perspective, the inert-porous-biomaterial may display potential microbial-sieving properties based on their pore appearances of some marine diatom species taken by SEM imaging. Some studies displayed diatoms SEM results showed that the biosilica surface of some pennate and centric diatoms were visually appeared in ordered sizes around 0.2 µm. Technically, those diameter of micrometer-sized porous biosilica could provide prospective capturing capabilities for *Brevundimonas diminuta* (*B. diminuta*) ATCC 19146 as industrial standard for sterilizing grade filter. This review will describe some diatoms species that may have related capabilities accordingto their pore sizes and characteristic as well

as consideration of their cell shaped. Through illustrative schematic diagram, visual modelling of particle or microbial capturing will be explained. Cultivability features of diatom implies that these marine resources bioprocessing could also support supply chain of consumables supporting material that are essential in water purification rather than utilization of diatomaceous earth that are categorized as nonrenewable natural deposit. As a suggestion, proper collection technique of diatom biosilica, optimization of upstream process of diatom biomass collection, consideration of economic aspects of choosing organic solvent and reagents being used in biosilica collection, as well as further chemical modification of biosilica functional groups should be steadily developed in order to provide fine grade of natural marine diatom biosilica with broader function for drinking water purification purposes.

KEYWORDS

Biosilica, Diatom, Filter, Porous Biomaterial, Water Purification

Policies on the Protection of Groundwater Sources to Obtain Sustainable Water Supply for Regional Drinking Water Companies

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ABSTRACT

The availability of natural resources, especially water, is of great importance as it directly affects the resilience of a nation. Water is a fundamental component of life, and thus, the sustainable and professional management of this resource is essential for preserving its quality and quantity. The right to water is an indispensable human right, essential for living a life with dignity. It is a prerequisite for realizing other human rights, which means that every country has the responsibility of providing clean drinking water and sanitation to all who reside within its borders. Accordingly, without access to water, other human rights cannot be realized. In 2012, UNESCO declared that the basic human right to water is 60 liters per person daily for both consumption and sanitation needs. The National Standardization Agency has stated that the use of water for domestic purposes is determined based on the population in both urban and rural areas. In this regard, it has been stated that urban and rural residents require at least 120 and 60 liters/day/capita, respectively. This means that water needs can be calculated and planned accordingly. Regional Drinking Water Companies manage drinking water at the district or city level, ensuring the provision of safe drinking water for all.

KEYWORDS: Policy; Sustainability; Water Resources; Quality

OBJECTIVE This research aims to analyze the regulation, implementation, and strengthening of Local Government Policies toward protecting groundwater sources, thereby ensuring that Regional Drinking Water Companies Obtain a sustainable water supply.

METHOD The methodology employed in this research is empirical juridical. Furthermore, both primary, secondary, and tertiary data were analyzed qualitatively. The data was collected by direct observation and interviews, and the research was conducted in Kuningan Regency.

RESULT The results show that water resources management policies at the central level are regulated in the Indonesia Constitution such as Law Number 23 of 2014 concerning Regional Government, Law Number 30 of 2014 concerning Government Administration, Law Number 37 of 2014 concerning Land and Water Conservation, Law Number 17 of 2019 concerning Water Resources, Indonesia Presidential Regulation Number 59 of 2017 concerning the Implementation of Achieving Sustainable Development Goals, and Environment Minister Regulation Number 12 of 2009 concerning Rainwater Utilization. Accordingly, some local government policies towards the effective management of water resources include Regional Regulation Number 13 of 2007 concerning Water Resources Conservation, Regional Regulation Number 12 of 2011 concerning the Implementation of the Kuningan Botanical Garden, Regional Regulation Number 11 of 2013 concerning Urban Forests, and Regional Regulation of Kuningan Regency Number 2 of 2021 concerning Basic Provisions for Services of the Regional Drinking Water Company Tirta Kamuning Kuningan Regency.

IMPLEMENTATION Regarding the local government policy on water resource management, Kuningan Regency has 523 springs, 104 reservoirs, 5 urban forests, 1 Kuningan Botanical Garden, and 1 Mount Ciremai National Park. In this regard, Tirta Kamuning Regional Drinking Water Company, a company responsible for the implementation of water resources, works to optimize services by managing 18 springs that are used as raw water sources from the 523 springs in Kuningan district, and this is achieved through its 12 branch offices and dedicated services.

CONCLUSION To strengthen local government policies in protecting groundwater sources and ensure that regional drinking water companies obtain Water Supply Sustainably, it is recommended to update the regional regulations related to building permits. This includes adding the obligation to plant trees, make infiltration wells, and construct bio pore holes, as well as to maintain the quantity and quality of usable water resources. By implementing these policies, people can access clean water and sanitation, which is appropriate to the Sustainable Development Goals.

RECOMMENDATION This research highlights the need to strengthen local regulations directed towards optimality in meeting the needs for clean water and the improvement of company performance. These regulations will ultimately lead to the optimal fulfillment of clean water requirements in the region.

Progress in Drinking Water Wells among Households in Indonesia: Impact of Population Density

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INTRODUCTION

Contaminated food or water with human or animal feces contribute to the spread of diarrhea disease. This contamination could occur as a result of poor sanitation[1] and insufficient drinking water source protection.

According to the Indonesia Basic Health Research (RISKESDAS), the prevalence of diarrhea disease slightly increased from 7% in 2013 to 8% in 2018 (reported by health labor and household members). The 2017 Indonesia Demographic and Health Survey (IDHS) showed that 38.02 percent of Indonesian households still used wells for drinking and non-drinking water. However, only 67 percent of 38.02 percent Indonesian households had access to drinking water well that was at least 7 meters away from the nearest septic tank.

According to National Standard of Indonesia (SNI) coded2398:2017, the drinking water well should be at least 11 meters away from the septic tank. The IDHS, on the other hand, established access to drinking water wells to the nearest septic tank at least 7 meters away. Back then, the distance between the well and the septic tank was critical because improved sanitation required consideration of all potential sources of drinking water contamination[2–5]helminth at point of foot contact, and number of flies. Additionally, samples were collected from comparable surfaces in the household, and a questionnaire on management and use, combined with a visual inspection of the latrine's design was conducted. In total, 341 latrines were sampled. The MDG classifications \"improved\" vs \"unimproved\" did not describe the observed differences in E. coli concentrations. Disaggregating the data into the JMP sanitation ladder, on average \"shared\" facilities were the least contaminated: 9.2 vs 17.7 (\"improved\".

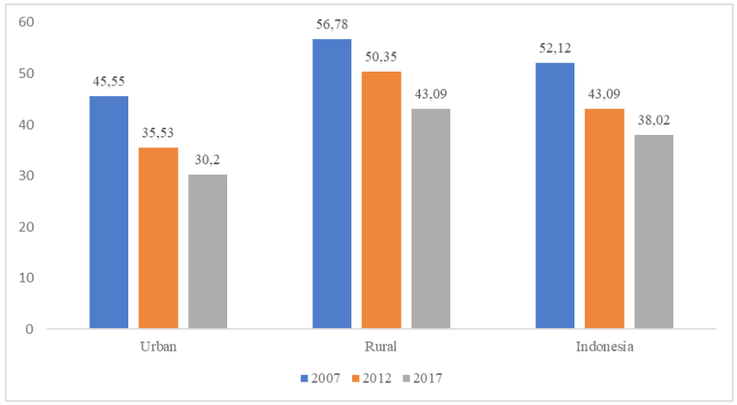

Figure 1. Trend of households using drinking water from wells by households. Source: IDHS (calculated by authors)

Previous research found that population density was a significant predictor of well contamination[6–8]both directly for the household making the decision and indirectly for its neighbors due to positive externalities. Nevertheless, construction and use of improved sanitation systems in much of the developing world continues to lag. Many recent interventions such as Community Led Total Sanitation (CLTS, despite the fact that other studies confirmed that improved septic tanks could prevent fecal pollution in high-density areas[5,7]where sanitation is poor, and untreated drinking water extracted from shallow (<43 m. Indonesia's crude population density continued to rise, reaching 142/km in 2021[9]. Furthermore, Indonesia must address the issue of unequal population distribution. In 2015, the island of Java, which accounted for only about 7% of Indonesia's land area, was home to approximately 57 percent of the Indonesian population, with the remaining 43 percent living outside of Java-island[10].

Identifying sanitation trends in densely populated areas will become increasingly important as the population grows. The study will then look at sanitation progress at the household level and identify factors influencing it.

METHODS

The IDHS data were used in this study. The unit of analysis is a household that used drinking water wells and answered questions about the distance between the wells and the nearest septic tank. IDHS 2017 recorded 17,424 households, IDHS 2012 recorded 16,457 households, and IDHS 2017 recorded 16,815 households, respectively. Missing data was omitted.

The outcome variable is the distance from the well to the nearest septic tank, which is divided into two categories: less than 7 meters and 7 meters or more. Household demographics included wealth index (poor-middle, rich), education level of the head of household (primary, secondary, high), number of members of the household (≤5, >5), geography (Java-Bali, outer Java Bali), and type of residence (rural, urban).

The descriptive analysis was used to examine the household characteristics in each survey wave. Binary logistic regression was used to examine the relationship between explanatory variables and outcome variables, which reported an adjusted odds ratio in each wave. The svyset command was used in STATA 17.

RESULTS

Table 3 revealed that households in Java-Bali were more likely than those outside of Java-Bali to have a well less than 7 meters from the nearest septic tank (range AOR: 1.24-1.37). Furthermore, those who lived in urban were at a higher risk than those who lived in rural areas (range AOR: 1.28-1.46). During the three waves, heads of households with a higher education consistently have a lower risk (range AOR: 0.65-0.78). Between 2007 and 2012, household wealth had no significant association with the distance between wells and the nearest septic tank. However, in 2017, rich households had a lower risk than middle and lower-income households (AOR: 0.88).

DISCUSSION

During the ten-year period, the proportion of households accessing drinking water wells at least 7 meters from the nearest septic tank increased slightly, rising from around 60 percent in 2007 to 63 percent in 2012, then gradually increasing to 67 percent in 2017. However, the findings confirm that households in densely populated areas, either in urban or in the Java-Bali islands, were less likely to have a drinking water well at least 7 meters away from the nearest septic tank. Furthermore, in the previous 5 years, the wealth index was not a significant predictor of households with improved drinking water wells. However, in 2017, poor and middle-income households became less likely to have access to improved drinking water[11,12]. At the current rate of population growth and inclined population density, access to improved drinking water wells may be difficult for poorer and middle-income households.

From 2007 to 2017, after controlling for other predictors, the level of education of the household head was a consistent significant predictor of access to improved drinking water wells. This finding highlighted the importance of education in

comprehending the need for a distance between the drinking water well and the septic tank[13].

Because poor sanitation and high population density in combination posed a threat to health[14], efforts such as providing improved sanitation and health services should be directed toward poorer and middle-income households[15].

CONCLUSION

Population density was associated with fewer households having access to drinking water wells located 7 meters or more from the nearest septic-tank. At the current rate of population growth and inclined population density, poorer and middle-income households were less likely to have access to this improved drinking water well. Considering mediating perspectives, improved sanitation and health care services must be made available to low- and middle-income households.

KEYWORDS: drinking water wells, septic tank, sanitation, region

APPENDIX

Table 1. Characteristics of household that uses drinking water from wells, 2007-2017

Characteristics	2007		2012		2017	
	n	%	n	%	n	%
Wealth						
Poor-middle	10,713	61.49	11,438	69.5	11,319	67.31
Rich	6,710	38.51	5,019	30.5	5,496	32.69
Education level of head of household						
Primary or less	10,944	62.94	10,762	65.54	10,066	59.93
Secondary	5,548	31.90	4,950	30.14	5,802	34.54
High	898	5.16	709	4.32	928	5.53
Number of household members						
<=5	13,751	78.92	13,486	81.95	14,247	84.72
>5	3,672	21.08	2,970	18.05	2,569	15.28
Region						
Outer Java Bali	5,951	34.16	5,502	33.43	5,986	35.6
Java Bali	11,472	65.84	10,955	66.57	10,830	64.4
Type of residence						
Rural	10,837	62.19	9,733	59.14	10,236	60.87
Urban	6,587	37.81	6,724	40.86	6,579	39.13
Distance between the well and nearest septic tank						
>= 7m	12,634	72.51	11,943	72.58	12,267	72.95
< 7 m	4,789	27.49	4,513	27.42	4,549	27.05
Total	17,424	100.00	16,457	100	16,815	100

Table 2. Percentage of households that use drinking water from wells by distance from the nearest septic tank, 2007-2017

Characteristics	Distance between the well and nearest septic tank < 7 m (%)		
	2007	2012	2017
Wealth			
Poor-middle	25.72	26.78	28.31
Rich	30.31	28.9	24.45
Education level of head of household			
Primary or less	27.35	27.96	27.31
Secondary	28.75	26.71	27.25
High	21.47	24.47	22.77
Number of household members			
<=5	27.88	27.29	26.96
>5	26.02	28.06	27.53
Region			
Outer Java Bali	22.39	23.66	22.83
Java Bali	30.13	29.31	29.39
Type of residence			
Rural	24.6	25.08	23.66
Urban	32.24	30.83	32.33

Table 3. Logistic regression results for households with a nearest well less than 7 meters from the septic tank, 2007-2017

Characteristics	2007		2012		2017	
	AOR (95% CI)	p	AOR (95% CI)	p	AOR (95% CI)	p
Wealth						
Poor-middle	1		1		1	
Rich	1.11 (0.95-1.31)	0.196	1.03 (0.90-1.19)	0.645	0.88 (0.78-0.98)	0.019
Education level of head of household						
Primary or less	1		1		1	
Secondary	1.01 (0.87-1.16)	0.938	0.91 (0.81-1.04)	0.163	0.98 (0.89-1.08)	0.651
High	0.65 (0.50-0.83)	0.001	0.78 (0.59-1.02)	0.073	0.76 (0.61-0.93)	0.008
Number of household members						
<=5	1		1		1	
>5	0.91 (0.79-1.05)	0.179	1.05 (0.92-1.19)	0.493	1.04 (0.93-1.16)	0.54
Region						
Outer Java Bali	1		1		1	
Java Bali	1.37 (1.18-1.58)	0.000	1.24 (1.08-1.42)	0.002	1.27 (1.10-1.45)	0.001
Type of residence						
Rural	1		1		1	
Urban	1.36 (1.14-1.64)	0.001	1.28 (1.09-1.50)	0.003	1.46 (1.27-1.68)	0.000

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Evaluasi Penerapan Sanitasi di Tempat Wisata Danau Sipin Kota Jambi (Assessment of Sanitation Implementation In Lake Sipin Tourism Jambi City)

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Danau Sipin merupakan salah satu tempat wisata bagi masyarakat yang berada di Kota Jambi. Jarak dan kemudahan akses menuju Danau Sipin menjadikan destinasi ini salah satu pilihan utama bagi masyarakat Kota Jambi dan sekitarnya. Tempat wisata Danau Sipin memerlukan dukungan manajemen dan fasilitas sanitasi yang mendukung terciptanya wisata yang sehat. Penelitian ini dilakukan untuk mengevaluasi penerapan sanitasi Danau Sipin, Kota Jambi. Penelitian ini dilakukan menggunakan kombinasi metode kualitatif dan kuantitatif. Penilaian sanitasi dilakukan menggunakan formulir penilaian pemeriksaan kesehatan lingkungan (Inspeksi Sanitasi) Objek Wisata (Peninggalan sejarah, taman rekreasi, wisata alam, dan lain-lain) sedangkan informasi pengelolaan sanitasi didapatkan dari wawancara mendalam kepada pengelola wisata serta beberapa pedagang dan pengunjung. Penilaian sanitasi tempat wisata Danau Sipin mendapatkan skor Variabel Upaya I (Komponen Lingkungan) sebesar 60 %, Variabel Upaya II (komponen Fasilitas Sanitasi) sebesar 48,7 %, Variabel Upaya III (Komponen Lain) sebesar 22,5 %, sedangkan total skor keseluruhan variabel sanitasi yang diperoleh sebesar 41,2 %. Sanitasi Danau Sipin dinyatakan tidak laik sehat karena skor keseluruhan variabel di bawah 65 %.

KATA KUNCI: Evaluasi; sanitasi; Danau Sipin; Kota Jambi

ABSTRACT:

One of the tourism destinations available for public in Jambi City is Sipin Lake. Sipin Lake is a popular choice of tourism among residents of jambi city and the area due to its accessibility and distance from the city. Sipin Lake as one of tourist destination in Jambi City need managerial and sanitary amenities to organize proper tourist attractions. This study was done to assess sanitation practice in Sipin Lake, Jambi City. Qualitative research methodologies were used to carry out this study. Sanitation assessment was conducted using an environmental health inspection assessment form (sanitation inspection) and tourism object (historical heritage, recreational parks, nature tourism, etc.). According to a sanitation assessment of the Lake Sipin tourist destination, effort variable I (the environmental component) received a score of 60%, effort variable II (the sanitation facilities component) received a score of 48.7%, effort variable III (the other component) received a score of 22.5%, and the overall sanitation variable received a score of 41.2%. Because the aggregate variable score was below 65%, Sipin Lake Sanitation was not good enough for usage.

LATAR BELAKANG

Entjang (2000) mendefinisikan sanitasi lingkungan sebagai pengawasan lingkungan fisik, biologis, sosial dan ekonomi yang memengaruhi kesehatan manusia. Kondisi lingkungan yang baik, sehat serta berguna bagi kesehatan manusia perlu ditingkatkan. Sanitasi ini mencakup pengawasan penyediaan air minum, pembuangan tinja dan air limbah, pembuangan sampah, vektor penyakit, kondisi perumahan, penyediaan dan penanganan makanan, kondisi atmosfer dan keselamatan lingkungan (Sasimartoyo, 2002).

Dalam rangka menunjang kesehatan masyarakat, maka sanitasi yang baik mutlak diperlukan, terutama di tempat umum. Tempat umum atau sarana pelayanan umum merupakan tempat yang memiliki fasilitas dan berpotensi terhadap terjadinya penularan penyakit. Salah satu tempat umum tersebut adalah lokasi wisata. Ketersediaan sanitasi yang baik di tempat wisata dapat menjadi nilai tambah dan penarik wisatawan untuk berkunjung ke lokasi tersebut, selain karena objek wisata yang akan dinikmati. Para wisatawan yang berasal dari berbagai daerah dan lapisan masyarakat akan berpengaruh terhadap kesehatan lingkungan. Kesehatan lingkungan menjadi penting untuk diperhatikan agar tidak menimbulkan suatu penyakit. Perhatian harus diarahkan kepada pemenuhan fasilitas sanitasi di tempat wisata, sanitasi makanan, hingga pengelolaan limbah (Purnama, 2018).

Provinsi Jambi merupakan salah satu daerah dengan destinasi wisata alam dan bangunan bersejarah yang digemari wisatawan lokal dan mancanegara. Berdasarkan data Dinas Pariwisata dan kebudayaan Kota Jambi (2019) terdapat lebih dari 50 tujuan wisata yang berada di Kota Jambi mulai dari wisata alam, wisata budaya, wisata sejarah, hingga wisata religi. Danau Sipin merupakan salah satu tempat wisata popular yang terletak di Kota Jambi, Indonesia. Berdasarkan pengamatan langsung beberapa fasilitas wisata yang terdapat di Danau Sipin adalah:

- Keindahan alam, Danau Sipin memiliki keindahan alam yang menawan. Air danau yang jernih dan suasana yang asri, serta adanya pulau-pulau kecil di tengah-tengah danau. Keindahan ini dapat dinikmati menggunakan perahu kano atau jet ski yang tersedia di sekitar danau. Danau Sipin juga banyak digunakan sebagai tempat piknik bagi keluarga.
- Fasilitas olahraga air, danau ini juga menjadi primadona bagi penikmat olahraga air seperti perahu kano dan jet ski. Pengunjung juga dapat menyewa perahu atau jet ski yang tersdedia di sekitar danau.
- Spot Fotografi, Danau Sipin juga menjadi tempat yang tepat bagi pengunjung yang ingin berfoto-foto. Keindahan alam danau serta pulau-pulau kecil di tengah danau menjadi latar belakang foto yang menarik.
- Kuliner, keberadaan berbagaimacam pedangang makanan dan minuman yang menjual kuliner khas Jambi, seperti mi celor dan kuliner lainnya membuat Danau Sipin menjadi salah satu tujuan Kuliner dengan spot pemandangan yang indah.

Sanitasi memiliki peranan yang penting terhadap daerah wisata. Ketersediaan sarana dan prasarana sanitasi memiliki hubungan yang kuat dengan tingkat kenyamanan pengunjung daerah wisata (Yuantari & Andrean, 2022) Peralatan makan pada kawasan wisata dapat terkontaminasi oleh mikroorganisme patogen (Adhitya et al., 2022). Penelitian-penelitian selama masa pandemi yang berkaitan dengan sanitasi pada daerah wisata tidak banyak yang berfokus pada pengelolaan risiko penyakit pada daerah wisata (Chen et al., 2021). Citra lingkungan daerah wisata memiliki korelasi positif dengan loyalitas pengunjung khususnya berkaitan dengan tingkat kepuasan (Han et al., 2021). Kepuasan pengunjung dapat ditingkatkan dengan daerah menjadikan daerah wisata yang bersih dan tersedianya sarana pembuangan sampah (Ma'rifat et al., 2018). Oleh karena itu penelitian ini bertujuan untuk melihat bagaimana penerapan standar sanitasi tempat umum-tempat umum (STTU) khususnya pada daerah wisata Danau Sipin, Kota Jambi.

METODE PENELITIAN

Pengumpulan data diambil dari data primer. Data primer diperoleh dari hasil observasi mendalam dengan dilengkapi instrumen panduan wawancara dan lembar ceklist Penilaian pemeriksaan kesehatan lingkungan (inspeksi sanitasi) objek wisata (peninggalan sejarah, taman rekreasi, wisata alam, dan lain-lain) oleh Sujarno & Mulyani (2018). Pengolahan data menggunakan analisis konten, dilengkapi dengan teknik keabsahan data dengan triangulasi sumber dan teknik.

Indikator penilaian variabel upaya yang digunakan untuk menilai sanitasi di area wisata Danau Sipin, Kota Jambi dapat dilihat pada tabel 1. Suatu fasilitas dinyatakan laik sehat apabila memperoleh nilai sekurang-kurangnyan 65% dengan catatan skor minimal untuk masing-masing variabel upaya sesuai tabel 1. Terdapat tiga variabel upaya yang dijadikan tolok ukur sanitasi dalam proses penilaian. Variabel upaya 1 merupakan variabel umum, dimana aspek kebersihan lingkungan, ada atau tidaknya genangan air dan tersedianya drainase air buangan menjadi acuan dalam penilaian. Variabel upaya 2 merupakan variabel dimana air bersih, toilet umum, pembuangan air limbah, dan ketersediaan tempat sampah menjadi aspek yang dinilai dalam variabel ini. Sedangkan, Variabel upaya 3 merupakan variabel dimana aspek sarana penyuluhan, fasilitas kesehatan dan alat pemadam kebakaran menjadi tolok ukur dalam penilaian dalam variabel ini.

Tabel 1. Indikator penilaian variabel Upaya

VARIABEL UPAYA		
I	II	III
70%	65,5%	60%

Variabel Upaya I = ***Jumlah score penilaian/jumlah score penelitian (80)x100%***
Variabel Upaya II = ***Jumlah score penilaian/jumlah score penelitian (604)x100%***
Variabel Upaya III = ***Jumlah score penilaian/jumlah score penelitian (320)x100%***
Score Keseluruhan = ***Jumlah score penilaian/jumlah score penelitian (1004)x100%***

HASIL

SUMBER DAYA MANUSIA (SDM)

Komponen sumber daya (SDM) manusia sangat penting dalam membantu mengelola, memelihara, dan menjaga kebersihan dan fasilitas kebersihan yang ada. Selain itu SDM memainkan peranan penting dalam upaya pemenuhan sanitasi, karena SDM bertanggung jawab untuk memastikan bahwa infrastruktur sanitasi dapat dioperasikan dan diperlihara dnegan baik.

Pengamatan yang dilakukan menemukan bahwa kuantitas dan kualitas di wisata Danau Sipin belum memadai. Hal ini diketahui dari pernyataan dari salah satu pengelola Danau Sipin, Pak Raden Hasanudin. Pak Raden sudah empat tahun bekerja sebagai staff DLH Danau Sipin, bersama dua orang lainnya.

"Dikawasan Danau Sipin ada 3 orang petugas, pekerjanya berupa bersih bersih area danau sipin, dan memangkas pepohonan yang tumbuh tinggi serta semak yang tumbuh, pak raden bekerja dari jam setengah 7 sampai jam 9/10."

Beberapa aspek yang perlu diperhatikan pada komponen SDM dalam kaitannya dengan upaya pemenuhan sanitasi yaitu pengembangan SDM, pemilihan SDM, Kesadaran dan partisipasi masyarakat, pengawasan dan pengawalan (United Nations Human Settlements Programme (UN-Habitat), 2020). Dalam rangka pemenuhan sanitasi, keterlibatan SDM sangat penting. SDM yang terlatih dan terampil dapat memastikan bahwa infrastruktur sanitasi dapat dioperasikan dan dipelihara dengan baik, serta membantu meningkatkan kesadaran masyarakat tentang pentingnya sanitasi dan kesehatan lingkungan

PROGRAM KEBERSIHAN

Program kebersihan dapat membantu dalam memenuhi standar sanitasi yang diperlukan. Misalnya, propgram kebersihan yang baik di lingkungan tempat tinggal, sekolah atau tempat kerja dapat membantu dalam menjaga kebersihan lingkungan tersebut dan mencegah penyebaran penyakit melalui kontak dengan permukaan yang kotor dan berbahaya. Selainitu, program kebersihan juga dapat membantu dalam meningkatkan kesadaran masyarakat tentang praktik sanitasi yang benar dan pentingnya menjaga kebersihan lingkungan. Program kebersihan dapat mencakup berbagai aktivitas, seprti membersihkan dapat mencakup berbagai aktivitas, seperti membersihkan tempat-tempat umum, mempromosikan kebersihan tangan mengatur penanganan sampah yang benar, dan melakukan kegiatan sosialisasi dan edukasi tentang sanitasi dan kebersihan.

"Biasanya untuk kegiatan ataupun program kesehatan lingkungan di Danau Sipin ada dilakukan di hari hari tertentu, tetapi jika musim hujan atau banjir akan dilakukan setiap hari, baik membersihkan danau sipin ataupun pinggirannya. Penyuluhan dilakukan oleh petugas kebersihan (Staff dlh kota jambi) terkait pembuangan sampah pada tempatnya. Setiap hari Pak Raden Hasanudin melakukan pemberitahuan ke pedagang agar membuah sampah pada tong sampah."

Sesuai dengan hasil wawancara di atas, Wisata Danau Sipin belum memiliki program khusus atau regular dalam upaya pemenuhan sanitasi. Program yang ada masih bersifat lisan dan tidak terdokumentasi. Program pengelolaan sanitasi/ kebersihan dilakukan masih dalam upaya mengingatkan dan menghimbau pedagang dan pengunjung untuk menjaga kebersihan dan membuang sampah pada tempatnya.

DANA

Dana dapat digunakan untuk membiayai berbagai upaya pemenuhan sanitasi, seperti pembangunan infrastruksur sanitasi, program pengelolaan sampah, pengembangan air bersih, dan promosi kesehatan dan sanitasi. Dari hasil wawancara diketahui bahwa belum ada pendanaan khusus dari dinas terkait. Pendaan didapatkan dari pengelolaan area wisata, misal dari biaya parkir dan pemungutan uang penggunaan toilet.

"Untuk masalah toilet umum yang hanya berjumlah 2 petugas atau warga sekitar mematok harga 2 rb rupiah untuk uang kebersihan, dilain sisi ada juga beberapa warung yang membuat toilet pascabayar".

Penting bagi pengelola untuk dapat memastikan bahwa dana yang digunakan dalam upaya pemenuhan sanitasi digunakan secara efektif dan efisien. Pengelolaan dana yang baij dan transparan serta keterlibatan komunitas dalam pengambilan keputusan tentang penggunaan penggunaan dana dapat membantu memastikan bahwa dana tersebut digunakan untuk mendukung upaya pemenuhan sanitasi yang optimal dan berkelanjutan.

SARANA DAN PRASARANA

Sarana dan prasarana memiliki peran penting dalam upaya pemenuhan sanitasi karena keduanya merupakan faktor yang sangat mempengaruhi kesehatan dan kenyamanan lingkungan di sekitar kita. Sarana sanitasi yang mencakup tempat pembuangan air limbah, toilet, dan tempat sampah, harus tersedia dan berfungsi dengan baik agar limbah dapat diolah dengan benar dan tidak menimbulkan pencemaran lingkungan serta penyakit. Selain itu, sarana sanitasi juga harus mudah diakses oleh masyarakat agar mereka dapat memenuhi kebutuhan sanitasi secara efektif dan efisien.

Prasarana sanitasi seperti sistem pengolahan air minum dan limbah, instalasi pipa air bersih, dan jaringan listrik juga sangat penting dalam upaya pemenuhan sanitasi. Prasarana ini harus terus dijaga dan ditingkatkan kualitasnya agar dapat memenuhi kebutuhan sanitasi masyarakat dengan baik. Selain itu, peran sarana dan prasarana juga berkaitan dengan pengelolaan limbah dan air limbah. Pengelolaan yang baik dapat meminimalkan dampak buruk terhadap lingkungan dan kesehatan masyarakat, sehingga sarana dan prasarana sanitasi harus dirancang dan dioperasikan dengan baik agar dapat memenuhi tujuan tersebut.

Gambar 1. Kondisi Sanitasi dan Pengelolaan Sanitasi Wisata Danau Sipin

Sebagian besar sarana dan prasarana berasal dari Dinas Lingkungan Hidup (Gambar 1). Untuk alat kebersihan di Danau Sipin disediakan oleh DLH kota berupa tong sampah, sapu, serokan, dan parang. Untuk jumlah tong sampah hanya berjumlah 5 buah, dan wc hanya berjumlah 2 unit lengkap dengan septictank. Air yang digunakan oleh pedangan berupa air dari galon, sedangkan air yang digunakan di wc umum merupakan air dari danau sipin, sedangkan warung menggunakan air bor.

"Fasilitas sanitasi danau sipin tergolong kurang mencukupi mengingat di sepanjang track hanya ada 5 tong sampah, dan juga 2 wc umum, untuk tongsampahnya ukurannya cukup kecil sehingga seringkali sampah sampai menumpuk, dan juga untuk priode pengangkutan yang cukup lama, jika dibandingkan dengan jumlah pengunjung yang ramai 2 wc umum sebenarnya bisa dibilang kurang mencukupi. Terkait sumber air bersih juga masih tergolong cukup sulit karena tidak adanya jaringan air PDAM padahal danau sipin letaknya cukup dekat dengan unit pengolahan air bersih broni".

KEBIJAKAN

Kebijakan memaninkan peranan penting dalam upaya pemenuhan sanitasi, karena kebijakan dapat memberikan arahan, mengatur dan mengawasi pelaksanaan program dan kegiatan sanitasi untuk mencapai tujuan yang diinginkan. Kebijakan yang ada dan diterapkan pada area wisata Danau Sipin masih bersifat lisan, belum ada pendokumentasian yang baik terkait dengan peraturan dan kebijakan yang ditetapkan. Hal ini terlihat dari hasil wawancara yang didapatkan.

"Setiap pedangan wajib membuang sampah ke tongsampah, dan sampah tidak boleh dibakar, nanti setiap hari rabu dan jumat petugas dlh kota akan mengangkut sampah menggunakan mobil pickup".

Mendorong partisipasi masyarakat: Kebijakan yang didukung oleh partisipasi masyarakat yang aktif dapat membantu meningkatkan kebersihan dan kesehatan lingkungan. Kebijakan seperti kampanye kesadaran sanitasi, penyuluhan, penggalangan dana, dan kerja sama dengan pihak swasta dapat membantu meningkatkan partisipasi masyarakat dalam upaya pemenuhan sanitasi.

Peranan kebijakan dalam upaya pemenuhan sanitasi meliputi:

- Menetapkan standar sanitasi yang lebih tinggi: Kebijakan sanitasi dapat menetapkan standar sanitasi yang lebih tinggi untuk menciptakan lingkungan yang lebih bersih dan sehat bagi masyarakat. Standar ini dapat mencakup pengelolaan limbah, sanitasi air dan sanitasi toilet.
- Mengatur pengelolaan limbah: Kebijakan sanitasi dapat mengatur pengelolaan limbah dengan menentukan peraturan dan aturan yang mengatur pembuangan limbah dan persyaratan yang harus dipenuhi oleh lembaga atau perusahaan yang membuang limbah. Hal ini dapat membantu mencegah pencemaran lingkungan dan penyebaran penyakit.
- Menyediakan sarana sanitasi: Kebijakan sanitasi dapat menyediakan sarana sanitasi, seperti toilet umum, fasilitas mandi dan cuci, dan fasilitas air minum. Hal ini dapat membantu meningkatkan sanitasi lingkungan dan mencegah penyebaran penyakit yang terkait dengan sanitasi yang buruk.
- Meningkatkan pendanaan dan dukungan: Kebijakan sanitasi dapat meningkatkan pendanaan dan dukungan untuk upaya pemenuhan sanitasi, termasuk dukungan untuk inisiatif masyarakat lokal dan organisasi yang mempromosikan sanitasi yang lebih baik.

MONITORING, PENCATATAN DAN PELAPORAN

Monitoring, pencatatan, dan pelaporan sangat penting dalam upaya pemenuhan sanitasi. Ini adalah tiga elemen utama yang membantu untuk memastikan bahwa praktik sanitasi yang tepat dilakukan dan bahwa lingkungan yang sehat dipertahankan.

Monitoring melibatkan pengawasan secara terus-menerus atas praktik sanitasi yang dilakukan dan kondisi sanitasi yang ada. Ini dapat dilakukan oleh petugas sanitasi yang dilatih atau oleh individu dalam komunitas yang bertanggung jawab atas sanitasi. Tujuannya adalah untuk mengidentifikasi masalah sanitasi dan memperbaiki mereka secepat mungkin.

Pencatatan melibatkan dokumentasi semua praktik sanitasi yang dilakukan dan semua perubahan yang terjadi pada kondisi sanitasi. Ini termasuk catatan tentang penggunaan toilet, pembersihan lingkungan, dan penyediaan air bersih. Pencatatan ini membantu memantau kemajuan yang dibuat dalam memenuhi standar sanitasi dan juga membantu mengidentifikasi masalah yang muncul.

Pelaporan melibatkan komunikasi hasil monitoring dan pencatatan kepada pihak yang berwenang dan masyarakat setempat. Tujuannya adalah untuk memastikan bahwa semua orang yang terlibat dalam upaya pemenuhan sanitasi mengetahui masalah yang ada dan langkah-langkah yang diambil untuk memperbaikinya. Pelaporan yang tepat juga dapat membantu dalam memperoleh dukungan dan sumber daya untuk mengatasi masalah sanitasi.

Belum teroganisirnya dokumentasi dalam pengelolaan sanitasi di area wisata Danau Sipin. Terbukti dari hasil wawancara yang dilakukan pada pengelola wisata. Pengelola mengatakan bahwa pelaporan dilakukan dengan foto atau video saja.

“Untuk pelaporan biasanya menggunakan foto ataupun video kegiatan pak raden, terkait pengawasan dari dlh kota tidak ada jadwal tertentu”.

PEMERIKSAAN DAN PENILAIAN

Pemeriksaan dan penilaian memiliki peran penting dalam upaya pemenuhan sanitasi yang baik. Peran penting dari pemeriksaan dan penilaian dalam upaya pemenuhan sanitasi adalah meningkatkan kesadaran dan pemahaman, Pemeriksaan dan penilaian sanitasi dapat meningkatkan kesadaran dan pemahaman tentang praktik sanitasi yang baik di antara masyarakat dan pekerja sanitasi. Selain itu, menentukan tingkat kebersihan, pemeriksaan sanitasi membantu menentukan tingkat kebersihan dan keamanan suatu tempat atau lingkungan, seperti rumah, sekolah, atau fasilitas umum.

Pemeriksaan dan pemilaian juga dapat berperan dalam mengidentifikasi masalah sanitasi. Penilaian sanitasi dapat membantu mengidentifikasi masalah sanitasi, seperti air yang tercemar, limbah yang tidak dikelola dengan baik, atau kebersihan yang buruk di area umum. Pemeriksaan dan penilaian juga dapat menentukan tindakan perbaikan, berdasarkan hasil pemeriksaan dan penilaian sanitasi, dapat ditentukan tindakan perbaikan yang diperlukan untuk meningkatkan sanitasi di lingkungan yang bersangkutan.

Tabel 2. hasil penilaian variabel upaya sanitasi

Penilaian Variabel Upaya			Skor Keseluruhan
I	II	III	
60%	48%	22%	41%

Mengukur kemajuan melaui pemeriksaan dan penilaian sanitasi juga dapat digunakan untuk mengukur kemajuan dalam upaya pemenuhan sanitasi dan memastikan bahwa target yang telah ditetapkan tercapai. Hasil penilaian variabel upaya yang didapatkan menunjukkan tempat wisata di Danau Sipin dinyatakan tidak laik sehat karena skor keseluruhan tidak memenuhi persyaratan tiga variabel upaya (41,2%) sanitasi tempat-tempat umum dan seluruh Variabel Usaha tidak memenuhi persyaratan minimum (Tabel 1).

DISKUSI

Sumber daya manusia (SDM) dan pemenuhan sanitasi memiliki kaitan yang erat. SDM merupakan salah satu faktor kunci dalam menjaga keshatan dan kebersihan lingkungan termasuk sanitasi yang baik sementara sanitasi yang baik secara langsung akan meningkatkan kesehatan dan kesejahteraan. Kebutuhan jangka panjang harus menjadi fokus dalam pelatihan dan pengembangan SDM untuk upaya pemenuhan sanitasi tempat wisata (Sudarsana, 2019). Hal ini berkaitan dengan hasil atau target produksitvitas dan efektivitas sarana/prasarana sanitasi yang akan digapai dan juga kepuasan pelayanan pengunjung pada area wisata.

Berdasarkan pengamatan peneliti. Sampah di tong sampah terendam oleh air hujan. Selain itu berdasarkan informasi dari petugas awal tahun kemarin terjadi longsor di danau sipin tetapi sampai sekarang belum ada upaya perbaikan fasilitas dari instansi terkait. Selain itu banyak juga besi pengaman danau hilang dan beton tiang hancur, di sisi lain masih banyak nya sampah yang ada di pinggir Danau Sipin, dan juga adanya pendangkalan atau sedimentasi pada saluran drainase tertutup di Danau Sipin.

Sumber daya manusia(SDM) yang tersedia selain kurang dalam jumlah kuantitas juga kurang secara kualitas. SDM menjadi salah satu komponen yang penting untuk diperhatikan, yakni dalam bentuk jumlah pekerja yang kompeten (World Health Organization, 2020). Dengan luas wisata Danau Sipin yang mencapai kurang lebih 89ha, tiga orang pengelola dirasa sangat kurang. SDM yang memiliki pengetahuan dan kesadaran yang baik tentang sanitasi akan lebih mudah membantu mempromosikan perilaku sanitasi yang baik di lingkungan. Kualitas SDM yang baik juga akan meningkatkan produktivitas dan kualitas kerja (IUWASH, 2015). Hal senada juga diungkapkan (Zubaidah, 2007) yang menemukan bahwa pengetahuan dari pengelola sanitasi sangat berpengaruh dengan hasil kinerja yang dilakukan oleh SDM yang ada.

Dalam rangka pemenuhan sanitasi, peran sarana dan prasarana menjadi sangat penting dan harus terus ditingkatkan baik dari segi kuantitas maupun kualitas. Dengan adanya sarana dan prasarana yang memadai, diharapkan dapat membantu masyarakat untuk memenuhi kebutuhan sanitasi mereka dan mengurangi dampak buruk terhadap lingkungan dan kesehatan (World Health Organization, 2015)sanitation and hygiene (WASH.

Diperlukan adanya peningkatan dalam hal kualitas dan kuantitas poengelola wisata Danau Sipin untuk dapat memaksimalkan pengelolaan dan pemenuhan sanitasi di Wisata Danau Sipin. Tantangan yang dihadapi salah satunya adalah

tidak semua instansi pemerintahan atau komunitas yang memiliki hak dalam pengelolaan suatu fasilitas public memliki anggaran yang cukup untuk membiayai upaya pemenuhan sanitasi. Oleh karena itu, adanya dukungan dana dari pihak lain, seperti organisasi non-profit, yayasan, atau donor, dapat sangat membantu dalam meningkatkan akses sanitasi bagi masyarakat yang membutuhkan.

Dalam rangka untuk mencapai tujuan pemenuhan sanitasi, monitoring, pencatatan, dan pelaporan harus dilakukan secara teratur dan dengan ketekunan. Dengan melakukan ketiga elemen ini, akan lebih mudah untuk memastikan bahwa praktik sanitasi yang tepat diikuti dan bahwa lingkungan yang sehat dipertahankan. Dalam upaya pemenuhan sanitasi yang baik, pemeriksaan dan penilaian sanitasi sangat diperlukan untuk memastikan bahwa lingkungan, makanan, dan air yang dikonsumsi aman dan sehat bagi masyarakat.

World Health Organization (2018) juga mengatakan bahwa penerapan sanitasi wisata sangat penting untuk menjaga kesehatan dan keamanan pengunjung serta karyawan di industri pariwisata. Sehingga peenting dilakukan evaluasi penerapannya. Evaluasi penerapan sanitasi wisata dapat dilakukan dengan beberapa cara, antara lain:

- **Inspeksi sanitasi:** Dilakukan dengan melakukan pemeriksaan langsung ke lokasi wisata untuk mengevaluasi kondisi sanitasi. Inspeksi sanitasi meliputi pengecekan kebersihan fasilitas, pengelolaan limbah, penyediaan air bersih, dan sanitasi makanan dan minuman.
- **Wawancara:** Melakukan wawancara dengan pengunjung dan karyawan untuk mengetahui pendapat mereka mengenai penerapan sanitasi wisata di lokasi tersebut. Hal ini dapat memberikan informasi yang berharga mengenai bagaimana efektifnya penerapan sanitasi wisata di lokasi tersebut.
- **Pengawasan kesehatan:** Mengawasi kesehatan pengunjung dan karyawan untuk mengetahui apakah ada peningkatan kasus penyakit yang terkait dengan sanitasi di lokasi tersebut. Hal ini dapat dilakukan dengan meminta data dari pusat kesehatan atau melakukan survei kesehatan.
- **Analisis data:** Mengumpulkan dan menganalisis data sanitasi untuk mengetahui tingkat keberhasilan penerapan sanitasi wisata. Data yang dapat dianalisis meliputi laporan inspeksi sanitasi, jumlah kasus penyakit terkait sanitasi, dan survei kepuasan pengunjung.

KESIMPULAN

Hasil penelitian menunjukkan upaya pemenuhan sanitasi di wisata Danau Sipin masih belum maksimal. Hal ini dapat dilihat dari minimnya ketersediaan sumber daya manusia (SDM) baik dari segi kualitas dan kuantitas, minimnya program kebersihan reguler, tidak adanya sumber dana tetap untuk pengelolaan dan pemeliharaan sanitasi, ketersediaan sarana dan prasarana yang minim, minimnya kabijakan, monitoring, pencatatan dan pelaporan. Pemeriksaan dan Penilaian yang dilakukan terhadap penerapan sanitasi tempat wisata Danau Sipin mendapatkan skor Variabel Upaya I (Komponen Lingkungan) sebesar 60 %, Variabel Upaya II (komponen Fasilitas Sanitasi) sebesar 48,7 %, Variabel Upaya III (Komponen Lain) sebesar 22,5 %, sedangkan total skor keseluruhan variabel sanitasi yang diperoleh sebesar 41,2 %. Sanitasi Danau Sipin dinyatakan tidak laik sehat karena skor keseluruhan variabel di bawah 65 %.

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Drinking Water, Sanitation, Handwashing facility, Environmental Hygiene and Diarrhoea among Under-Five (U5) in Indonesia

Adrian Chrisnahutama, Ni Made Sukartini

BACKGROUND:

Provision of clean drinking water, improved sanitation and basic handwashing facility are essential to prevent people to suffer various waterborne diseases, such as diarrhoea. Thus, leads to improving human health and human capital. This condition can lead to improve economic participation, hence help to increase national incomes, and reduce poverty. Globally, there are 1.7 billion cases of under-five (U_5) diarrhoea every year. Moreover, diarrhoea is also responsible for killing 525.000 U_5 every year, making one of the leading causes of children deaths. These high numbers are mainly contributed by numerous low- and middle-income countries. Lack of the provisions of those infrastructures are believed to be the cause of high incidence of diarrhoea. Furthermore, the drinking water in those countries are often contaminated due to pollution, making diarrhoea alleviation in these countries a complex issue. Indonesia also reflects this pattern.

DATA AND METHODOLOGY:

This study provided the empirical evidences of the effect of various sources of drinking water, sanitation, handwashing facility and environmental hygiene on diarrhoea incidents among under-five (U_5) in Indonesia at household level. This study applied logistic regression analysis on 2012 and 2017 Indonesian Demographic and Health Survey (IDHS), a nationally representative dataset. This study divided drinking water as follows: 1) Surface water; 2) Unprotected dug well or spring; 3) Bottled/refill water; 4) Protected dug well or spring; and 5) Piped water. Sanitation facilities were divided as follows: 1) No facility; 2) Pit latrine; 3) Flush toilet which is shared/public; 4) Flush toilet with no septic tank, and 5) Flush toilet using septic tank. Handwashing facility were divided into: 1) No facility; 2) Facility on premises without water/soap presence; and 3) Facility on premises with water and soap presence. Environmental hygiene was measured using proportion of open defecation within community.

RESULTS AND DISCUSSIONS:

The provision of clean drinking water, improved sanitation and basic handwashing facility are improved substantially between 2012 and 2017. This indicated that Indonesia had successfully provided those infrastructures. On the other hand, diarrhoea prevalence among U_5 in 2012 and 2017 did not reduce significantly. Diarrhoea prevalence among U_5 in Indonesia was reported by 14.4 percent in 2012 and 14.2 percent in 2017. Moreover, the prevalence was higher on younger, poorer, and children who lived in rural area. After controlling individual and household factors, this study found that higher quality of drinking water was significantly associated with diarrhoea prevalence reduction, with piped water had the highest effect. Furthermore, only flush toilet using septic tank type of sanitation was significantly associated with diarrhoea prevalence reduction. However, this study also found that these effects were fading when the provision of higher quality infrastructures were improved within community. The provision of various handwashing facility at household was not associated with diarrhoea prevalence. The proportion of open defecation in the community as environmental hygiene indicator was associated with diarrhoea incidence escalation. This illustrates the importance of environmental factors on diarrhoea alleviation as well as improving drinking water and sanitation simultaneously.

CONCLUSION:

This study found that better quality of source of drinking water and sanitation were associated with diarrhoea reduction among under-five (U5). Furthermore, higher proportion of improved sanitation in community reduces open defecation practice that leads to lower risk of diarrhoea. On the other hand, handwashing facility availability did not reduce diarrhoea. This reflects that the infrastructure availability at premises was not necessarily reduce diarrhoea if clean and healthy behaviour was not implemented. This study also suggested that the protective effect of piped water would be effective to prevent diarrhoea, particularly in poor situations. However, this suggestion was not always to be true due to poor condition of piped water in developing countries. Therefore, increasing piped water provisions as well as improving sanitation facilities, promoting clean and healthy behaviour, and preserving natural environment is necessary to alleviate diarrhoea in Indonesia.

KEYWORDS: diarrhoea, drinking water, sanitation, handwashing facility, environmental hygiene

The Investigation Of Pollutant Removal By Mineral Wool To The Water River Quality Status Of Cikapayang River, Indonesia

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ABSTRACT

On a laboratory scale, mineral wool has been used as a filter that could remove up to 95% of pollutants. However, to date, there was not single accessible study of the wide-scale use of mineral wool. As a river located in the central of Bandung City, Indonesia, the Cikapayang River has an important role in the ecosystem balance around the city. Therefore, this study aimed to evaluate the installation of mineral wool on the pollution index score in the Cikapayang River. This article is the first information about on-site proof of filter media in improving surface water quality in real conditions. In this case study, we use data monitoring from four stations flowing on Bandung City Hall's southwest side. Station I (6°54'37.5"S 107°36'37.8"E), Station II (6°54'39.2"S 107°36'37.7"E), Station III (6°54'41.3"S 107°36'37.5"E), and Station IV (6°54'43.8"S 107°36'37.3"E) were fitted with mineral wool with dimensions of 180x30x120 cm, 125x30x80 cm, 350x15x100 cm, and 325x15x100 cm respectively. In this case, WQI was calculated

using Storage and Retrieval (STORET), Pollution Index (PI), and Canadian Council of Ministers of the Environment WQI (CCME WQI). STORET and PI have been developed by the Indonesian Republic Environmental Ministry and detailed in Decree No. 115 in 2003. Meanwhile, the CCME WQI is a method that various researchers highly recommend because it was considered more sensitive. Data monitoring for two hundred and one days were grouped and analyzed according to wet vs. dry month and monitoring stations. Samples were taken using grab sampling before and after passing through the mineral wool and then brought to the laboratory for analysis. In addition, COD, TDS, TSS, TP, NO_{3-}, and NO_{2-} parameters were analyzed based on the Standard Methods for the Examination of Water and Wastewater (SMEWW), except pH, temperature, and DO that use a portable meter. The analysis of two of the three methods, STORET and CCME WQI, showed that the current quality of the Cikapayang River could no longer support its designation as class II surface water. The analysis showed that they were heavily to badly polluted, even during the rainy season. In the dry season that started from April to August, the PI score increased around 0.25-0.64 and the index score in STORET decreased from 3-6, which indicating that the pollution was getting worse. In addition, the analysis using CCME WQI showed that the pollution increased by 0.30-0,48. Like the results of laboratory tests, mineral wool could reduce physicochemical parameters with varying efficiency depending on the parameters and days when tested on a field scale. The amount of wastewater that entered the water body and the water volume in the two seasons that different from each other. Thus, it was considered to be the limitation for the removal efficiency, which was not as good as when tested in the laboratory. After adding mineral wool to each segment, the average pollution status decreased. The average IP index score becomes 4.65, -68 STORET, and 26.42 CCME WQI. Based on the results of the investigation as well as the advantages and disadvantages of each technique, the CCME WQI was considered the best for determining the quality dynamics because the amount of data and the difference score size of each measured data against the quality standard are considerable. Overall, mineral wool could improve water quality, characterized by changes in the pollution index score ranging from 30-65%.

KEYWORDS: organic materials, nutrients, mineral content, river, pollution index

Water supply improvement and payment for environmental services for lower-income coastal communities in Tegal Regency

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ABSTRACT. Adequate drinking water sources for households are one part of sustainable development goals, especially for lower-income coastal communities whose quality and quantity of water are vulnerably affected by climate change. This study aimed to determine the willingness to pay (WTP) to improve drinking water quality with piped water services. The second is to calculate the value of WTP for piped water installations by accommodating payment for environmental services for conservation in new clean water sources. This study used a survey with the contingent valuation method (CVM). Respondents are low-income communities on the coast of the Tegal regency, with a total of 150 people selected based on purposive random sampling. The results of this study were that the variables of income, expenditure for drinking water, home-ownership, PES value, and payment method are significant factors affecting willingness to pay for piped drinking water services. The average WTP for piped drinking water services is IDR 1,030,333.33. Meanwhile, the average PES value is IDR 4,733.33 monthly paid. Piped drinking water services can be implemented immediately with good cooperation from local governments through regional water companies to reach these communities by providing subsidies or grants that can increase willingness to improve their water supply.

BACKGROUND

One of the targets in the Sustainable Development Goals (SDGs) by the end of 2030 is access to safe and sustainable drinking water. Adequate and sustainable drinking water is a major needed community. This goal addresses reaching the

bottom 40% of people who have limited funding [1]. In terms of topology, people living in coastal areas are vulnerable to being affected by climate change with the occurrence of seawater intrusion and poor groundwater salinization [2, 3]. Scarcity of adequate drinking water becomes more common as an impact of climate change, particularly in urban communities in developing countries. To reduce it, required adaptation measures must be implemented, such as providing a steady supply of safe drinking water that meets both demand and supply. By estimating the household's willingness to pay to improve their water supply, this study has primarily concentrated on the demand side of adequate water [4].

Suradadi district is the only sub-district located on the coast of Tegal Regency which has not been connected to a piped clean water network. The piped drinking water network owned by the Local-owned Regional Water Supply Company, namely "Perumda Air Minum Tirta Ayu Kabupaten Tegal", has not yet reached this district. Another fact is that several villages in Suradadi district have limited groundwater resources and many water sources are brackish so that their drinking water needs depend on water tanker trucks selling clean water [5]. In addition, Suradadi is the fourth priority area for developing an urban drinking water supply system in Tegal Regency [6].

This study aimed to determine the willingness to pay (WTP) to improve drinking water quality from the lower-income communities in the coastal area. This estimation WTP measure when they willing to connect to improve their water source with piped water services from Regional-owned Water Supply Company, namely Perumda Air Minum Tirta Ayu Kabupaten Tegal. Understanding and measuring household demand for access to safe drinking water in underdeveloped areas is critical. Unfortunately, areas that lack proper water services, like Suradadi District, also face several socioe-conomic problems. The problems are including low income, access to safe drinking water, and a lack of education [7].

The second aim is to calculate the value of estimation WTP for piped water installations. This estimation also accommodating the value of payment for environmental services for conservation in new clean water sources. The conserve is such as activity reforesting around the source in mountain spring and another source organize by Perumda Air Minum Tirta Ayu or by regional government.

METHODOLOGY

Data Source

We conducted a survey using a CVM questionnaire to a total of 177 household respondents in the coastal area of Suradadi District, Tegal Regency in Central Java Province, Indonesia. We get the results of a sample of 177 household respondents who are targeted to be close to ten percent (10.00%) of the existing population. The number of households according to data from the Official Statistic Agency is 1,877 households in the Suradadi district in 2020.

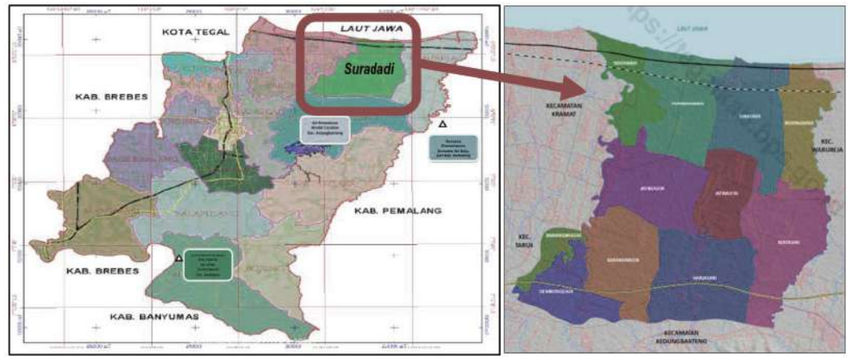

Figure 1. Map of Study: Suradadi District in Tegal Regency, Central Java Province, Indonesia

Due to the policy of the local government, namely the implementation of Community Activity Restrictions (Pemberlakuan Pembatasan Kegiatan Masyarakat/PPKM) since early 2021 to deal with the COVID-19 pandemic in Indonesia, we carried out this survey carefully. Consequently, this research was completed later than scheduled. This survey was conducted over a period of four months and one must accept that many of the targeted respondents did not want to be interviewed/surveyed.

We chose these households considering the characteristics of lower-income communities, namely recipients of government assistance such as the family of hope programs (Program Keluarga Harapan/ PKH), fishermen who received fishing gear grants, and several workers and socio-entrepreneurs. These characteristics are to support the criteria of lower-income communities.

CVM and Models

The approach used in this research is to use a non-market form of assessment with a direct method approach with survey techniques using the Contingent

Valuation Method / CVM. CVM is considered an appropriate method to assess the improvement of water quality or other services. This approach more used because it has an on-site use value but also a non-use value. There are several stages in compiling the application of CVM according to [8], namely:

Develop a Market Hypothesis

Formulating this market hypothesis can explain the existing service and drinking water tariffs from public perceptions and the latest PDAM performance data.

Break-downing Auction Values (bids)

The breakdown of the auction value was carried out through survey activities, including questionnaires and interviews, either face-to-face or telephone. Face-to-face interviews are considered as a way to get better results. The techniques that can reveal the value of this auction are as follows:

Bidding Games

By asking questions repeatedly as to what value is willing to be paid and the researcher as the questioner describes the increase or decrease in the auction value to get a fixed value

Payment Card

By asking the value of the range that you want to pay using a card whose value has been determined in advance by the researcher.

A referendum or discrete choice model

Giving a certain value to the respondent and giving yes or no approval from the predetermined value.

An open-ended question

The respondent is given the freedom to state the value that is ready to be paid for a project to be carried out.

Calculating the average WTP

From the calculation of the individual auction value obtained from the survey in the second step, the average (mean) and median (median) of all respondents.

$$\mathbf{AWTP} = \left(\frac{\sum_{i=1}^{n} \boldsymbol{WTPi}}{\boldsymbol{n}} \right) (1)$$

Where, AWTP= Average value of WTP

n = number of respondents

Estimating the bid curve

The individual WTP value as the dependent variable is regressed with other independent variables. These variables such as income, quality, accessibility, and other linear variables in the model.

Aggregating WTP values

As the final stage in the CVM method, it is necessary to convert the average data obtained in the third stage to the total value of the overall WTP. One of these aggregate values is by multiplying the average value by the number of sample respondents in the existing population.

$$\mathbf{TWTP} = \left(\sum_{i=1}^{n} \boldsymbol{AWTPi} \frac{\boldsymbol{ni}}{\boldsymbol{N}} \boldsymbol{P} \right) (2)$$

Where, TWTP= Aggregate/ Total value of WTP WTP

AWTP= Average WTP

n = respondents who willing to pay

N= number of samples

P = number of populations

After we estimated the WTP value from the survey that we conduct, we determining the factors that influenced the value of WTP. The determinant of WTP was estimated using the Ordinary Least Square (OLS) model from the survey results regressed on the independent variables. This model is used to identify variables or factors that can explain the value of WTP. The model can be written as follows:

$$\mathbf{WTP} = \alpha + \beta_1 \mathbf{AGE} + \beta_2 \mathbf{INC} + \beta_3 \mathbf{EXP} + \beta_4 \mathbf{EDU} + \beta_5 \mathbf{QUA} + \beta_6 \mathbf{HOS} + \beta_7 \mathbf{HSZ} + \beta_8 \mathbf{TAR} + \beta_9 \mathbf{PES} + \beta_{10} \mathbf{PMT} + \varepsilon_i (3)$$

The symbol "**α"** represents the constant or the intercept. The symbols "β_1" to "β_{10}" represent the estimated coefficient of factors or variables that we used to determine the WTP value. The last is ε_i that a random error term. The details of all ten variables, such as definition, unit of measurement, and expected sign of hypothesis are explained in Table 1.

Table 1. Variable Definition

Variables and definitions		Unit of Measurement	Expected Sign
WTP	value of willingness to pay to water supply improvement	IDR	
AGE	age of the respondent (house head)	year	±
INC	average monthly income	IDR	+
EXP	average monthly expenditure to purchase drinking water	IDR	+
EDU	years of schooling	year	+
QUA	quality of existing water	good/ bad (1/0)	-
HOS	home-ownership	self-owned/ rent (1/0)	+
HSZ	household/ family members	number of	+
TAR	perception of installation charges/ tariff	cheap/ expensive (1/0)	+
VPES	value of payment for environmental services	IDR	+
PMT	method of payment for installation charges	instalment/ cash (1/0)	+

The dependent variable is WTP, namely, the value of the respondent's willingness to pay for an improvement in drinking water to be used. This variable uses the value of willingness to pay for the installation fee of a new connection as a regional water company's customer. Why don't we use the monthly subscription rates for drinking water as in research [4] and [9]**?** Because we assume that the main obstacle to becoming a customer of a water supply company is related to the high cost of new installations. From the results of the initial survey related to the cost of new installations in the nearest sub-district, the initial installation fee is IDR 2,500,000 that approximately is exceed the income for many households.

Our independent variables use ten variables that we suspect may affect these low-income respondents. The respondent's age of the head of the household, length of education, home-ownership, and the number of family members are the social factors that we chose as in studies [4], [8], and [9]. Meanwhile, we use the average income, average monthly expenditure to buy water, the value of PES's willingness to pay, and payment methods as a measure of the respondents' economic factors. And the two remaining variables namely the quality of existing water and the perception of new installation fees, are supporting factors in terms of the existing drinking water service providers.

FINDINGS AND RESULTS

Characteristic of Respondent

From the initial question of the survey on the willingness to become a customer of piped clean water "Perumda Air Minum Tirta Ayu", only 150 from 177 respondents or there are 84.75% of respondents who wished to improve the quality of the existing water they had. We used several questions to mapping the characteristics or variables/factors, like social, demography, perception of water they used, and economic factors. The characteristics of 150 respondents who are willing to increase their clean water supply are categorized into socio-economic factors, which can be seen in Table 2 below:

Table 2. Characteristic of Respondents

Socio-economic Factors	***Respondent***	***Percentage***
Gender		
Male	147	98.00
Female	3	2.00
Age		
≤ 35 years old	7	4.67
> 35 – 45 years old	51	34.00
> 45 – 55 years old	79	52.67
> 55 years old	13	8.67
Household Size (Family Members)		
≤ 4 persons	115	76.67
> 4 persons	35	23.33
Home-ownership		
Self-Owned	143	95.33
Rent	7	4.67
Education		
No School	1	0.67
Primary School	63	42.00
Secondary School	72	48.00
High School	14	9.33
Occupation		
Fisherman	99	66.00
Self-employed	33	22.00
Day Labour	18	12.00

Socio-economic Factors	*Respondent*	*Percentage*
Monthly Income		
≤ IDR 1,000,000	2	1.33
> IDR 1,000,000 - 2,000,000	107	71.33
> IDR 2,000,000 - 3,000,000	36	24.00
> IDR 3,000,000	5	3.33
Monthly Expenditure to Buy Clean Water		
≤ IDR 50,000	7	4.67
> IDR 50,000 - 100,000	98	65.33
> IDR 100,000 - 150,000	29	19.33
> IDR 150,000 - 200,000	13	8.67
> IDR 200,000	3	2.00

The majority of respondents were male family heads (98.00%) with the most work are fishermen who live in coastal areas. The proportion of fisherman workers is about two-thirds of the total respondents (66.00%). The rest are self-employed and day laborers (34.00%). By age, more than half of them are aged 45 years and over (61.33%) with the most education at the elementary and junior high school levels (42.00% and 48.00%).

Based on economic factors used as a question in this survey, the average income of the respondents is mostly below IDR 2,000,000 (72.66%). This value indicates that their monthly income is also below the regency minimum wage standard of IDR 1,958,000. To meet their clean water needs, the majority of respondents have to spend more than IDR 50,000 per month (95.33%), although one respondent is not bought water because tend to boil their existing water than buy clean water. According to home-ownership variables, the survey shows that almost all respondent is owned by self their house with the percentage is 95.33%.

WTP and PES Estimation

As previously mentioned, not all respondents surveyed are willing to increase their source of clean water. Only 150 respondents from 190 household heads were willing to pay. To make it easier for respondents to determine the WTP value, we free the respondents to choose the minimum payment for the installation fee. The minimum payment we set for WTP is IDR 250,000 as the minimum payment to buy a water meter that we surveyed previously. Then we chose IDR 2,500,000 as the maximum payment as high as the installation fee in the nearest sub-district in Tegal. After we process the data in Table 3, we can show that the WTP for new connection installations obtained from the survey, the lowest value is IDR 250,000 and the highest value is IDR 2,500,000

as mentioned before. The average value of WTP is IDR 1,030,333. The average value of WTP is still considered reasonable because the average income is IDR 2,096,667 which shows that the average value of WTP is still lower than the average income of a month, or about 49.14%. In the payment method variable, almost all respondents want an installment payment method for several months. It's reasonable because the value of WTP is almost half of their income a month. It's also reasonable if we look at the average expenditure for buy clean water is average on IDR 94,030 which is 4,48% of average income for a month and then they choose to move to almost a half payment for their income, which is eleven times of their monthly clean water expense to this improvement.

Table 3. Descriptive Statistics of Variables (Respondent n=150)

Variable	Mean	Std. Dev.	Min	Max
WTP	1,030,333	586,163.1	250,000	2,500,000
QUA	0.12	0.32	0	1
AGE	47.69	6.97	32	69
INC	2,096,667	587,043.2	1,000,000	4,000,000
EDU	7.97	2.06	0	14
EXP	94,030	39,632.93	0	325,000
HOS	0.95	0.21	0	1
HSZ	4.05	1.28	2	13
TAR	.01	0.12	0	1
VPES	4,733	2.47	1,000	20,000
PMT	0.99	0.08	0	1

After we have the estimated WTP, we conduct aggregating the estimated WTP to the formulas below:

TWTP = () (4)

$$\text{TWTP} = (\sum_{i=1}^{n} AWTPi \frac{ni}{N} P) \quad (4)$$

$$\text{TWTP} = 1{,}030{,}333 \text{ x } \frac{150}{177} \text{ x } 1{,}877$$

TWTP = 1,638,928,001

As the result, the total WTP for Suradadi district for improvement to clean water source is IDR 1,638,928,001.

In line with this, we also investigated their willingness to help conserve water sources in the form of voluntary payments for environmental services. Of the 150 respondents that willingness to improve their water source, all of them are willing to pay for environmental services as a contribution to maintaining the

availability and sustainability of the new clean water source that they want to use. We also free the respondents to choose the minimum payment for the PES to make it easier for respondents to determine the WTP for PES. The minimum payment we set for WTP is IDR 1,000 as the minimum payment and then we chose IDR 20,000 as the maximum payment as high as 1% of the regency minimum wage standard of IDR 1,958,000 as mention above. The average WTP for PES is IDR 4,733, then the median value of WTP for PES is IDR 5,000. There is no difference between the two values above, that the value can be used to determine the cost of conservation that can be applied to their monthly water tariff.

Analysis of the Determinant Factors

We used OLS estimation to determining factors that significance influences WTP. Of the ten factors as the independent variables involved in the model, there are half have a statistically significant effect. These factors are INC (average monthly income), EXP (average monthly expenditure to buy drinking water), HOS (home-ownership), VPES (payment value for environmental services), and PMT (payment method for new installations). The results of the regression coefficients below show that the greater the monthly income of the family head, the greater the value of their willingness to increase their drinking water sources with sources that are well managed by PDAM. The condition of the positive direction of WTP also applies to the average value of monthly expenditures to buy drinking water and willingness to pay for environmental services. However, it is necessary to look at the results of research on PMT factors, where if they are given the flexibility of time to pay off the new installation costs, it will also increase the WTP value. By the significantly, EXP and VPES were the highest levels of significance at 1%. Meanwhile, the INC and PMT variables were statistically significant at 5% significance level. And the HOS variable has a statistically significant effect at the 10% level.

Table 4. Determinant of WTP by OLS Estimation

independent variables	coefficient	t-stat	p-value	
CONSTANT	*-495,955.10*	*0.77*	*0.440*	
QUA	*15,257.21*	*0.12*	*0.906*	
AGE	*-10,189.04*	*-1.50*	*0.137*	
INC	*0.22*	*2.56*	*0.012*	**
EDU	*6,508.60*	*0.25*	*0.801*	
EXP	*3.63*	*2.99*	*0.003*	***
HOS	*-445,638.70*	*-2.15*	*0.033*	*
HSZ	*6,442.06*	*0.19*	*0.850*	
TAR	*174,824.10*	*0.48*	*0.629*	
VPES	*71.21*	*4.03*	*0.000*	***
PMT	*1,225,475.00*	*2.25*	*0.026*	**

Notes: Number of observations = 150 respondents. R^2 = 0.3744. Adjusted R^2 = 0.3294. Mean VIF = 1.36. Signs (*), (**) and (***) are used to indicate the significance level of 10%, 5% and 1%.

We see that the WTP result with an R2 value of 0.3744 is quite good because it exceeds the reliable limit of a model used, which is 0.15 as in the study of Mitchell and Carson (1989) in [4]. With an R2 value of 0.3744, it can be concluded that 37.44% of the total WTP can be explained by the variables included in the model and the remaining 62.56% is explained by factors outside the model. Although the other variables such as QUA (Quality of Existing Water), AGE (Ages of Head-households), EDU (Years of Schooling), HSZ (Household Size), and TAR (Perception of Tariff) correlate WTP, the results of regression analysis were not statistically significant.

CONCLUSION

We assume that the value of WTP for improvement to piped drinking water services is reasonable and can be implemented immediately in the Suradadi district. Also, the PES value is cheap and acceptable for the application. Need some good cooperation from local governments through Perumda Air Minum Tirta Ayu to reach the blank spot or un-reached area and support for SDGs goals.

Providing subsidies or grants and installment methods maybe can increase willingness to connect from the households. Respondent's willingness to pay for environmental services also needs to be regulated and managed properly, related to the management of the funds collected and the implementation of conservation activities.

Last but not least, we call for additional studies to complete this result that incorporates more water source characteristics. The variables such as quantity, quality, and continuity of water supply and waterborne disease-related as the impact of health issues due to climate change.

ACKNOWLEDGMENT

We are grateful for the sincere answers from the respondents and authorized officials who have given research permits in limited conditions due to the COVID-19 pandemic during data collection in early 2021.

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Peranan Desain Produk dan Sign System pada Fasilitas Umum di Ruang Publik (Studi Kasus: Kran Air Siap Minum)

Dewi Isma Aryani

Universitas Kristen Maranatha

ABSTRACT

Fasilitas air siap minum di ruang umum (public space) bukanlah hal baru di Indonesia. Beberapa tahun lalu, sarana olahraga Institut Teknologi Bandung telah menyediakan fasilitas ini bagi para pengguna saraga. Sayangnya, kurangnya edukasi kepada pengguna serta rendahnya kesadaran masyarakat umum untuk menjaga dengan baik mengakibatkan ketidakberfungsian fasilitas air siap minum tidak dapat digunakan dan berhenti beroperasi. Fenomena ini diangkat untuk dikaji lebih mendalam menggunakan pendekatan metode kualitatif berupa survei dan keilmuan teori terkait, terutama dalam hal desain produk. Diharapkan melalui pembahasan ini dapat memberikan wawasan dan edukasi lebih baik lagi bagi masyarakat umum tentang pentingnya keberadaan fasilitas air siap minum di ruang umum.

Safely Managed On-Site Sanitation With Financial Flow Simulator (Esosview Tm) (Case Study: Tabanan Regency, Bali)

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ABSTRACT: About 46% of the world's population, around 3.6 billion people, are without safely managed sanitation services, and globally, 494 million people still practice open defecation. In Bali Province, although access to basic sanitation services is 95.01%, only 14.55% of the population have access to safely managed sanitation, and 4.42% still practice open defecation. This percentage includes septic tanks that are emptied at least once in the last five years. Open defecation and the high rate of unsafely-managed sanitation in Bali can potentially result in wastewater infiltration into drinking water sources, discharging enteric microorganisms andfecal-borne pathogens, such as *E.coli*. As centralized, city-scale domestic waste treatments are expensive and complex, on-site sanitation is the key strategy to achieve safely-managed sanitation that includes fecal sludge management in many Low- to Middle-Income Countries (LMICs) such as Indonesia. WASH services are considered sustainable if the five dimensions of sustainability factors (financial, institutional, environmental, technological, and social) are adequately addressed in the WASH program. This research focuses on financial flow modeling toachieve universal access to safely-managed sanitation using a financial simulator, eSOSView™, in Tabanan Regency, Bali. The aims of this paper are: (1) to analyze existing Faecal Sludge Management (FSM) and financial model applied in the study area; (2) to develop alternative

financial models and analyze them using eSOSView™; and (3) to choose a financial model using Multi-Criteria Analysis (MCA) and its application in the study area. The results are useful to build recommendations for achieving 100% safely managed on-site sanitation in Tabanan Regency. A Real Demand Survey (RDS) of households and semi-structured interviews with the private and government sectors were conducted to collect data imputed into the model. One hundred households selected by cluster random sampling method participated in the RDS. Stakeholders from the Bali Province PALD Technical Implementation Unit (UPT), and the private party that provide Emptying & Transport (E&T) services were interviewed. This researchresulted in five financial models. To choose the most suitable financial model for Tabanan Regency, Multi-Criteria Analysis (MCA) was employed. The MCA considered five aspects: financial feasibility (50%), public acceptance (15%), stakeholder capability (15%), compliance with the latest regulations and public policies (10%), and ease of implementing business models (10%). Out of five financial models, Model 3 was chosen as the most suitable business model to achieve universal access to safely-managed sanitation in Tabanan Regency, Bali. In Model 3, households need to pay a certain amount for the emptying fee and sanitation tax. UPTD as the city's fecal sludge management operator receives discharge fees from the clients who dispose of their sludge to be treated at the fecal sludge treatment plant and budget support from thegovernment authority (the Environmental and Forestry Service/DLHK). End-use products (fertilizers) from the fecal sludge treatment plant can be sold at pre-agreed prices to industries that need them. In the existing model, the fertilizers produced from the fecal sludge treatment plant (approximately 10 tons/month) are not for sale; they are used for the city parks, Tabanan Regency government offices, and Sembung Gede landfill, for free. In Model 3, we took the example of Semarang City. The base price per kg of fertilizers produced in 2014 was IDR 307/kg(including 5% profit). Considering an average annual inflation rate of 5%, fertilizers' base price per kg can increase to IDR 489/kg in 2022. The potential annual revenue from fertilizer sales of 10 tons per month is IDR 58,680,000. Additionally, UPTD can set the minimum purchase amount and enter into business cooperation agreements with agro-companies to sustain the business model. eSOSView™ is an effective tool to assist local governments in performing financial model analysis with a simple and easy to understand user-interface. It helps them to design strategies and decision-making related to financial aspects in the FSM by providing comprehensive financial considerations. However, a deep understanding of the formulas and terminology used; and complete data are needed to fill in the eSOSView™ to get results with a minimal error rate. Moreover, not only the Tabanan Regency area but also this analysis can be applied to other areas with the note that the criteria chosen for the MCA are subjective depending on the characteristics of the area and the considerations taken by the researcher so that for other researchers the results will be different. Based on the results of this study, the Government of Tabanan can achieve 100% safely managed on-site sanitation by applying emptying fees and sanitation taxes for households, discharge fees for private parties who dispose of the fecal sludge in FSTP, purchase prices for agro-companies who buy the fertilizer, and budget support from the DLHK. These aspects will be the sources of revenues in Model 3 in eSOSView™.

KEYWORDS: *eSOSView™, fecal sludge management, financial flow, Indonesia, safely-managed sanitation*

INTRODUCTION

About 46% of the world's population, which is around 3.6 billion people, do not have safely managed sanitation services, and globally, 494 million people still practice open defecation (WHO, 2021). In Bali Province, although access to basic sanitation services is 95.01%, only 14.55% of the population have access to safely managed sanitation, and 4.42% still practice open defecation. Due to open defecation and the lack of safely managed sanitation services,Nastiti et al. (2013) stated that many sources of clean water are contaminated with enteric microorganisms, an example of which is the presence of *E. coli* in drinking water due to wastewater infiltration. However, one of the greatest challenges is that domestic wastewater management cannot only rely on sewerage as a wastewater channel to the Wastewater Treatment Plant (WWTP) or centralized treatment. Based on a study by the World Bank and Australian Aid in 2013 (East Asia Pacific Region Urban Sanitation Review: Indonesia Country Study), it is stated that a key issue in many regions in Indonesia in developing a centralized sewage treatment system is physical characteristicsso that a pumping station and pipeconstruction needed are complex. This of course requires a relatively large cost. Thus, safely managed sanitation management is the most realistic effort in improving fecal sludgemanagement in many Low to Middle-Income Countries (LMICs) such as Indonesia.

A key aspect of achieving safely managed sanitation is financial sustainability. WASH services are believed to be sustainable in the long term if these five aspects (financial, institutional, environmental, technical, and social (FIETS)) or sustainability factors are handled properly in the WASH program (Daniel et al., 2021). In recent years, there has been an increasing interest in financial modeling to achieve safely managed sanitation by using a financial simulator called eSOSView™ (Mohideen, et al., 2022; Furlong, et al., 2020; Shrestha, 2018).

Although extensive research has been carried out on improving financial models using eSOSView™, no single study exists that investigates financial models to achieve 100% access to safely managed sanitation. This research focuses on financial flow modeling to achieve universal access to safely-managed sanitation using a financialsimulator, eSOSView™, in Tabanan Regency,Bali. The importance and originality of this study are that it explores the gap between the current financial model and the ideal financial model to achieve 100% access to safely managed sanitation. There are threeprimary aims of this study: (1) to analyze current Faecal Sludge Management (FSM) and the financial model in the study area; (2) to develop alternative financial models using eSOSView™; and (3) to choose a financial model using Multi-Criteria Analysis (MCA) and its application in the study area.

METHOD

The positivist paradigm underpins this study and the quantitative approach was applied in this study.

Primary data

A Real Demand Survey (RDS) of households and semi-structured interviews with the private and government sectors were conducted to collect the primary data. One hundred households selected by cluster random sampling method participated in the RDS with questionnaires with the Likert scale as the instrument used to collect primary data. Purposive sampling with thecriterion-i strategy was used to recruit participants from stakeholders. Knowledge and experience are the primary criteria for respondents in this study. Stakeholders from the Environmental and Forestry Service (DLHK) of Tabanan Regency represented by the Bali Province PALD Technical Implementation Unit (UPTD), and private parties that provide Emptying & Transport (E&T) services were interviewed. Open-ended questions are used in the interviews. Padjadjaran University's ResearchEthics Committee approved the study procedures (Ethical Exemption Number662/UN6.KEP/EC/2022).

Secondary data

A literature review was conducted from relevant stakeholders, in this case, the local government of Tabanan Regency, for secondary data collection. The Tabanan Regency Documents in Figures 2021, the Tabanan Regency Sanitation Strategy (SSK) document 2021-2026, and related regulations, namely the Regency Regent's Regulation Tabanan No. 30 of 2016 concerning a review of fees for providing and/or desludging services, were studied as secondary data in this study.

Data analysis

The primary and secondary data are analyzed using eSOSView™, which is a simulator to be able to model financial flows with a scenario of fulfilling 100% safely managed sanitation in the study area. There are five financial models based on Strande, L. (2014) that are analyzed using eSOSView™. Theoutput of the analysis is financial indicators for each financial model. Multi-Criteria Analysis (MCA) was used to choose the idealfinancial model for Tabanan Regency. The MCA considered five aspects: financial feasibility (50%), public acceptance (15%), stakeholder capability (15%), compliancewith the latest regulations and public policies (10%), and ease of implementing businessmodels (10%).

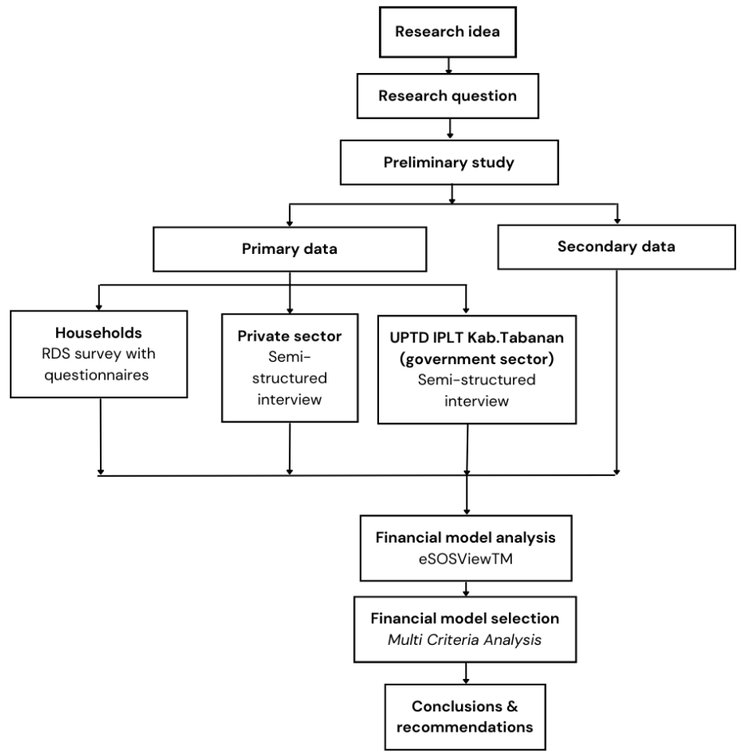

Figure 1 Research methodology

RESULTS

Existing Financial Model

The operator of Faecal Sludge Treatment Plant (FSTP), UPTD, makes revenue from emptying fees from households and disposal fees paid by private desludging services. As a result, the UPTD's desludging services and faecal sludge treatment are financially dependent on these costs, and this excludes

budget allocation from DLHK. Fertilizer derived from the sludge treatment process with SDB is not sold but is distributed toresidents in need and used for landscaping managed by the local government. The current financial model used in financial analysis is identified as **Model 6.**

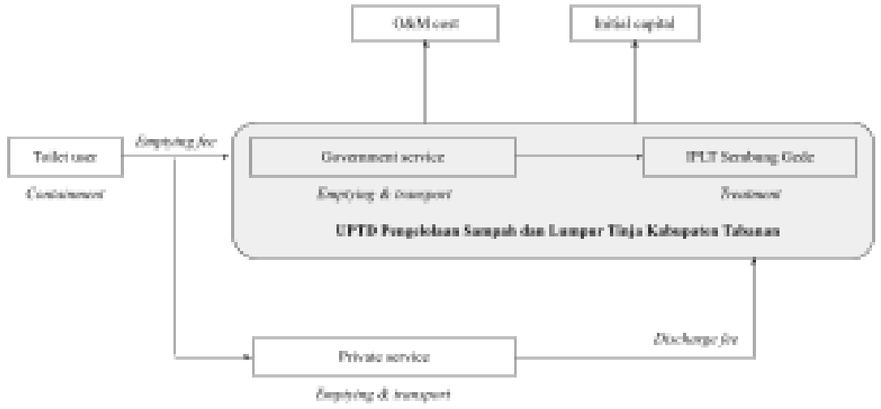

Figure 2. Existing financial model (Model 6)

Financial Model Analysis UsingeSOSView™

There are five sheets in eSOSView™ including superstructure, containment, emptying, transport, and treatment. Eachsheet needs to be filled in with each dataderived from primary data, as well as secondary data.

The type of superstructure used by the people of Tabanan Regency based on RDS is a pour flush toilet (61.6%) and cistern flush toilet (38.4%) with the containment using a septic tank (97,7%). Based on the Tabanan Regency's Sanitation Strategy (SSK) document in 2021-2026, the percentage ofaccess to safely managed sanitation has only reached 18.73% until 2019, while it is64.47% for access to basic sanitation; 13.42% for access to shared sanitation; 1.07% unimproved sanitation; and 2.53% open defecation.

	Model 1	Model 2	Model 3	Model 4	Model 5
Households	92,326				
CAPEX (IDR)	986,410,98,000				
OPEX (IDR)	1,134,330,966,027		1,145,460,403,697		
***Net profit/loss* (IDR)**	-1,249,412,247,493		-1,260,541,685,163		

Table 1. Financial indicators (Superstructure)

The vehicles used by the UPTD to perform desludging services are two units of conventional vacuum trucks with a capacity of 4 m³ each. One desludging truck can makea maximum of two trips in a single day, and up to 27 service trips can be made in a single month, according to interviews with the UPTD.

Table 2. Financial indicators (E & T)

	Model 1	Model 2	Model 3	Model 4	Model 5
FS discharge (m3/day)	16				
Quantity of trucks	2				
CAPEX (IDR)	**803,400,000**	**2,803,400,000**	**803,400,000**	**803,400,000**	**803,400,000**
OPEX (IDR)	**1,549,063,014**	**223,380,762**	**1,549,063,014**	**1,556,856,670**	**1,556,856,670**
Revenue (IDR)	**8,755,755,829**	**10,294,861,081**	**8,755,755,829**	**8,755,755,829**	**10,630,463,218**
EBITDA (IDR)	7,206,692,815	10,071,480,319	7,206,692,815	7,198,899,159	9,073,606,548
Depreciation (IDR)	80,340,000	186,893,333	80,340,000	80,340,000	80,340,000
EBIT (IDR)	7,126,352,815	9,884,586,986	7,126,352,815	7,118,559,159	8,993,266,548
Financing costs (IDR)	40,170,000	140,170,000	40,170,000	40,170,000	40,170,000
EBT (IDR)	7,086,182,815	9,744,416,986	7,086,182,815	7,078,389,159	8,953,096,548
CIT%	22.00%	22.00%	22.00%	22.00%	22.00%
CIT (IDR)	1,558,960,219	2,143,771,737	1,558,960,219	1,557,245,615	1,969,681,241
Net Profit/loss (IDR)	**5,527,222,596**	**7,600,645,249**	**5,527,222,596**	**5,521,143,544**	**6,983,415,308**
Payback in month	1.34	3.36	1.34	1.34	1.06
Contribution Margin per daily user per year	1.04	1.45	1.04	1.04	1.31
BEP in # users per day	5146.24	8566.32	5146.24	5151.81	4087.39
ROI	6.88	2.71	6.88	6.87	8.69

A discharge of 27 m3/day of sludge is the maximum amount that the current FSTP can take in. The types of treatment units in FSTP are settlers, waste stabilization ponds, and unplanted drying beds. The end product (compost) produced is as much as 10 tons/month

Table 3. Financial indicators (Treatment)

	Model 1	Model 2	Model 3	Model 4	Model 5
FSTP capacity (m3/day)	27				
CAPEX (IDR)	**2,000,000,000**	-	**2,000,000,000**	**2,000,000,000**	**2,000,000,000**
OPEX (IDR)	**154,743,000**	-	**154,743,000**	**154,743,000**	**2,029,450,389**
Revenue (IDR)	**1,597,785,252**	-	**12,727,222,922**	**11,254,591,326**	**11,254,591,326**
EBITDA (IDR)	1,443,042,252	-	12,572,479,922	11,099,848,326	9,225,140,937
Depreciation (IDR)	100,000,000	-	100,000,000	100,000,000	100,000,000
EBIT (IDR)	1,343,042,252	-	12,472,479,922	10,999,848,326	9,125,140,937
Financing costs (IDR)	100,000,000	-	100,000,000	100,000,000	100,000,000
EBT (IDR)	1,243,042,252	-	12,372,479,922	10,899,848,326	9,025,140,937
CIT%	22.00%	-	22.00%	22.00%	22.00%
CIT (IDR)	273,469,295	-	2,721,945,583	2,397,966,632	1,985,531,006
Net Profit/loss (IDR)	**969,572,956**	-	**9,650,534,339**	**8,501,881,694**	**7,039,609,931**
Payback in month	16.63	-	1.91	2.16	2.60
Contribution Margin per daily user per year	0.21	-	1.82	1.60	1.33
BEP in # users per day	31990.05	-	3671.75	4158.89	5004.04
ROI	0.48	-	4.83	4.25	3.52

4.3 Result of Multi-Criteria Analysis (MCA)

Table 4. MCA Final Results

No	Criteria	Sub-criteria	Weight	Value					Score				
				1	2	3	4	5	1	2	3	4	5
1	Financial feasibility	Emptying-transport	25%	73	100	73	72.6	92	18.25	25	18.25	18.15	23
		Treatment-*reuse*	25%	10	0	100	88	73	2,5	0	25	22	18.25
2	Public acceptance	-	15%	100	100	70	70	70	15	15	10.5	10.5	10.5
3	Government capability	-	15%	100	100	80	80	80	15	15	12	12	12
4	Compliance with current regulations and policies	Emptying-transport	5%	100	100	90	80	70	5	5	4.5	4	3.5
		Treatment-*reuse*	5%	90	90	90	90	90	4.5	4.5	4.5	4.5	4.5
5	Ease of implementation	Emptying-transport	5%	90	100	80	80	80	4.5	5	4	4	4
		Treatment-*reuse*	5%	90	90	90	90	90	4.5	4.5	4.5	4.5	4.5
Total			100%	653	680	673	650.6	645	**69.25**	**74**	**83.25**	**79.65**	**80.**

In **Table 4** it is known that the highest score is obtained by model 3, while the lowest score is obtained by model 1. It can be concluded that model 3 is the financial model chosen in this study as the most suitable financial model to achieve the maximum safely managed sanitation target (100%) in Tabanan Regency based on the selected criteria and sub-criteria.

DISCUSSION

In order to be able to implement model 3 in the study areas, there are several aspects that need to be considered.

Financial

Regarding the value of tax sanitation, it is known that if applying the same value to every household in Tabanan Regency, tax sanitation in the amount of IDR 120,545/HH/year is required. By using cross-subsidies, the value of the sanitation tax can be calculatedbased on economic status and made enforceable.

According to the Tabanan Regency Sanitation Strategy for 2021–2026, budget allocation can be requested from APBN, DAK, APBD, and APBDes to fill the funding gap for theTabanan Regency sanitation sector.

Public acceptance

The 1,000 toilet program from the Indonesian National Armed Forces (TNI) is supporting the achievement of the goal to increase access to sanitation in order to make it safely managed in Tabanan Regency. It is also possible to direct the Kunti Bhakti (LSM) operating in theTabanan Regency region to aid in the promotion and socialization of safely managed sanitation initiatives. Local traditional leaders are another group that can get involved in public acceptance initiatives. By including traditional leaders in public acceptance initiatives, they will be able to explain the implementation of the sanitation tax and fertilizer salesto the public in a thorough andunderstandable manner using a local cultural or customary approach.

Government capacity

In order to manage sanitation taxes and the proceeds from the sale of fertilizer, model 3 calls for increasing the government's capacity in the relevant institutions. UPTD Management of Waste and FecalSludge receives funds from the sanitation tax, which is administered by the Tabanan Regency Regional Tax and Retribution Service UPTD(PPRD) under the direction of the Bali Province Regional RevenueAgency (BPD). In addition, managingthe financial transfer of fertilizer salesfrom the end-use industry is another duty assigned to the UPTD of Waste and Sludge Management.

Regulations and policies

Based on the current laws and policies, it is evident that a legal framework is necessary to support theimplementation of the sanitation tax, from household collection to the Tabanan Regency Regional Tax and Retribution Service UPTD (PPRD) to regulations for Bali ProvinceRegional Revenue Agency (BPD) of the

sanitation tax in Tabanan Regency. Local traditional leaders can also support the implementation of this sanitation tax by using awig-awigor perarem in their respective *banjars* to raise community willingness to pay and gather support for a fair sanitationtax.

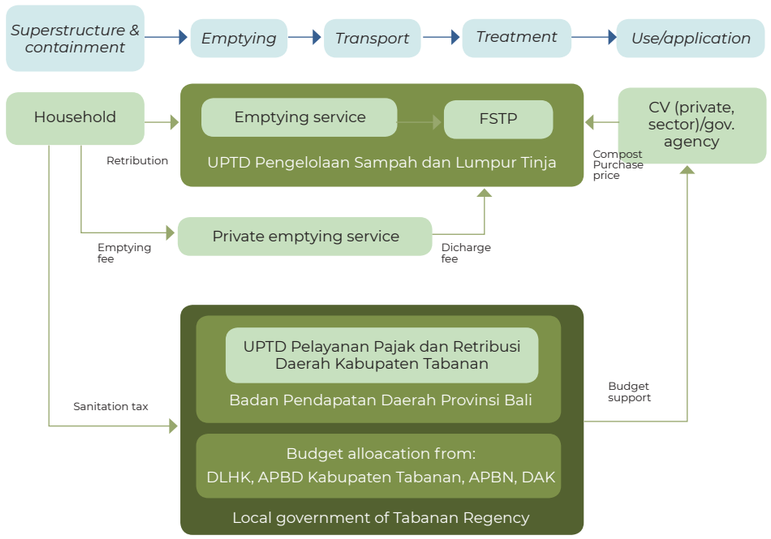

Figure 3. Implementation of Model 3 inTabanan Regency

CONCLUSION

Until 2019, there was around 2% access to off-site sanitation, 1% safelymanaged sanitation, 17% basic sanitation, 78%unimproved sanitation, and 2% open defecation.

Analysis using eSOSViewTM givesthe following results:

Superstructure-containment: Models 1 and 2 have similarOPEX and net loss values thatare lower than models 3, 4,and 5.

Emptying-transport: Model 2 has the highest net profit value due to the integration of the emptying-transport-treatment services. Model 5 also has a sizable net profit value due to the fact that it does not solely rely on one funding source.

Treatment: Model 3 has thehighest net profit, while model 1 has the lowest net profit because model 3 relies onmultiple direct revenue sources.

In this study, Model 3 is been determined to be the most effective financial model for achieving the overall goal of safely managed sanitation (100%) in Tabanan Regency.

WASH Access and RTI Symptoms Across Life Stage among Indonesian Ever-Married Women

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INTRODUCTION

Reproductive tract infections (RTIs) were one of the health concerns for women of reproductive age. RTIs were communicable diseases that included sexual transmitted infections (STIs), endogenous infections caused by organism overgrowth in the genital tract, and iatrogenic infections caused by medical procedures such as unsafe abortion and insufficient family planning services[1]including preterm births, pelvic inflammatory disease, increased susceptibility to HIV infection, and other chronic health problems. A number of potential microbial pathogens, singly and in combinations, have been implicated in the disease process. The list of possible agents continues to expand and includes members of a number of genera, including Gardnerella, Atopobium, Prevotella, Peptostreptococcus, Mobiluncus, Sneathia, Leptotrichia, Mycoplasma, and BV-associated bacterium 1 (BVAB1. RTI symptoms, such as abnormal vaginal discharge, could thus be caused by either a sexual or a hygiene-related disease, or both. Furthermore, RTIs were more common during certain stages of a woman's reproductive life-cycle, such as menstruation[2,3], union[4], pregnancy[5–7], and delivery[6,7].

Previous studies found that RTIs were common in developing countries with poor sanitation coverage[8–10]the relationship between menstrual hygiene management (MHM. On the contrary, in 2021, the percentage of Indonesian households with improved sanitation was approximately 80.29 percent[11]. Furthermore, in 2019, about 84.91 percent of Indonesian households with the 40 percent lowest expenditure had access to clean drinking water[12].

Due to their reproductive cycles in their life stage, women required access to clean water, sanitation, and hygiene (WASH) practices[8–10,13]the relationship between menstrual hygiene management (MHM. Aside from the high sanitation and

clean water coverage in Indonesia, it was necessary to examine the impact of WASH practice on RTI symptoms at various life stage. The purpose of this study was to see how the association between WASH practices and self-reported RTI symptoms varied across life stage among Indonesian ever married women.

METHODS

This study used data from the 2017 Indonesian Demographic and Health Survey (IDHS). The unit of analysis was ever-married women between the ages of 15 and 49. Sexually transmitted infections (STIs) or symptoms were the outcome variable. The prevalence of RTI was determined among women who had a STI, or abnormal genital discharge, or a genital sore or ulcer, or all in the 12 months preceding the survey[14].

Individual characteristics included education level (primary, secondary, and higher) and life stage (pregnant, married/living together, widowed/divorced). Additionally, drinking water (improved water, bottled and refilled water, or unimproved water), time to get drinking water (< 30 minutes, ≥ 30 minutes), nondrinking water (improved water, unimproved water), type of toilet facility (improved toilet, unimproved toilet), and presence of water and sanitizer at the hand washing place (water and soap, water and sanitizer other than soap, water only, or other) were considered.

Descriptive statistics were presented using frequency and weighted proportion[14]. The chi-squared p value was used to determine the relationship between having RTIs or symptoms in each factor. The logistic regression method was used to determine the relationship between women's characteristics and the risk of having RTIs or other symptoms. All processes were carried out with complex sample weighting using STATA version 17.0.

RESULTS

Chi-squared analysis showed that the correlation between WASH practice and each life stage was negligible (table 2). Multivariate logistic regression (table 3) revealed that women who were married/living together or widowed/divorced were less likely than pregnant women to experience RTIs or symptoms (AOR married=0.68; AOR widowed/divorced=0.58). Women with a higher education had a lower risk of having RTIs or symptoms (AOR=0.77) than women with a primary education. Women who used improved nondrinking water had a lower risk of RTIs or symptoms than those with unimproved one (AOR=0.8). Furthermore, women group who used water only or others in handwashing facilities were more likely to have RTIs than women who used soap and water (AOR=1.19). Women who used bottled and refilled water more likely to have RTIs than women used unimproved drinking water (AOR=1.54). Despite a weak significant correlation and a predictable pattern, women who use improved toilets have a lower risk of RTIs than women who use unimproved toilets (AOR=0.9).

DISCUSSION

Bacterial vaginosis was an endogenous infection caused by an overgrowth of normal vaginal bacteria[15]. Clinically, bacterial vaginosis manifested as abnormal vaginal discharge[15]. Findings showed that access to clean water and sanitation is critical for ever-married women of reproductive age in Indonesia. Abnormal vaginal discharge was less common in women who had daily access to clean water for vaginal and anal cleansing. Hand-washing with soap and water was also required to maintain hygiene behaviors. Women who had access to bottled and refilled water were more likely to experience abnormal vaginal discharge. In some parts of Indonesia, contaminated bottled and refilled water was observed[16]. Abnormal vaginal discharge was reduced in women who had access to better toilet facilities[17]helminth at point of foot contact, and number of flies. Additionally, samples were collected from comparable surfaces in the household, and a questionnaire on management and use, combined with a visual inspection of the latrine's design was conducted. In total, 341 latrines were sampled. The MDG classifications \"improved\" vs \"unimproved\" did not describe the observed differences in E. coli concentrations. Disaggregating the data into the JMP sanitation ladder, on average \"shared\" facilities were the least contaminated: 9.2 vs 17.7 (\"improved\", although the significance was weak. Thus, a lack of access to improved water supply, sanitation, and hygiene practices resulted in RTI symptoms..

The findings revealed that WASH practice did not differ between women's life stages. However, after adjusting with WASH practice and educational attainment, life stages were associated with RTI symptoms. Thus, there is an association between WASH practices and RTI symptoms across all life stages. Pregnant women were the most vulnerable to RTI symptoms. Widowed or divorced women were the least likely to experience RTI symptoms. It was assumed that widowed/divorced women did not engage in sexual activity, so they were less likely to develop STIs that manifested as abnormal vaginal discharge. Sexual contact could spread the bacteria among individuals, eventually disrupting the natural balance of bacterial flora in the vagina[15].

Women with a higher level of education were the least likely to experience RTI

symptoms. As a result, this finding recognized the importance of education in lowering the risk of self-reported RTI symptoms[18,19].

CONCLUSION

Across the reproductive life cycle, WASH practice was associated with RTI symptoms. Pregnant women were the most likely to experience abnormal vaginal discharge due to hormonal imbalance. Education for women was required to reduce the risk of RTI symptoms.

KEYWORDS: RTI, life stage, hygiene practice, WASH

APPENDIX

Table 1. Respondent characteristics and prevalence of RTI symptoms

Characteristics	All women		Women reported had RTI symptoms (%)		
	n	%	No	Yes	*p*
Drinking water					
Improved water	20,204	53.1	86.53	13.47	0.003
Other improved water	8,503	22.35	84.21	15.79	
Unimproved water	9,339	24.55	87.91	12.09	
Time to get drinking water					
On premises or <30 minutes	37,279	97.99	86.39	13.61	0.016
>= 30 minutes or other	766	2.01	84.58	15.42	
Nondrinking water					
Improved water	12,792	33.62	86.04	13.96	0.195
Unimproved water	25,254	66.38	86.51	13.49	
Type of toilet facility					
Improved toilet	32,066	84.28	86.59	13.41	0.001
Unimproved toliet	5,979	15.72	85.09	14.91	
Presence of water and sanitizer at hand washing place					
Water and soap	33,770	88.76	86.54	13.46	0.014
Water and sanitizer other than soap	1,597	4.2	85.75	14.25	
Water only or others	2,678	7.04	84.37	15.63	
Education level					
Primary or less	12,985	34.81	86.51	13.49	0.000
Secondary	19,687	52.78	85.27	14.73	
Higher	4,629	12.41	89.8	10.2	
Life stage					
Pregnant	1,927	5.06	81.29	18.71	0.000
Married/living together	33,759	88.73	86.5	13.5	
Widow/divorce	2,359	6.2	88.42	11.58	
Total	38,045	100.00	86.35	13.65	

Table 2. Percentage of wash factors by life stage among ever married women aged 15-49

Characteristics	Pregnant (n=1,927)			Married/Living together (n=33,579)			Widowed/Divorced (n=2,359)		
	RTI symptoms (%)			RTI symptoms (%)			RTI symptoms (%)		
	No	Yes	*p*	No	Yes	*p*	No	Yes	*p*
Drinking water									
Improved water	81.80	18.20	0.718	86.68	13.32	0.006	88.00	12.00	0.636
Other improved water	78.69	21.31		84.34	15.66		87.52	12.48	
Unimproved water	82.89	17.11		88.05	11.95		90.20	9.80	
Time to get drinking water									
On premises or <30 minutes	81.39	18.61	0.503	86.52	13.48	0.031	88.63	11.37	0.438
>= 30 minutes or other	76.12	23.88		85.42	14.58		79.98	20.02	
Nondrinking water									
Improved water	81.27	18.73	0.63	86.16	13.84	0.19	88.72	11.28	0.997
Unimproved water	81.30	18.70		86.67	13.33		88.27	11.73	
Type of toilet facility									
Improved toilet	81.20	18.80	0.149	86.77	13.23	0.001	88.46	11.54	0.895
Unimproved toliet	81.77	18.23		85.03	14.97		88.23	11.77	
Presence of water and sanitizer at hand washing place									
Water and soap	81.37	18.63	0.091	86.72	13.28	0.002	88.19	11.81	0.184
Water and sanitizer other than soap	84.05	15.95		85.56	14.44		90.55	9.45	
Water only or others	78.75	21.25		84.28	15.72		90.41	9.59	

Table 3. Logistic regression model for factors associated with had STIs or symptom among ever married women aged 15-49

Characteristics	AOR	95% CI	*p*
Dinking water			
Improved water	1.01	(0.89-1.15)	0.835
Other improved water	1.54	(1.33-1.77)	0.000
Unimproved water	1.00		
Time to get drinking water			
<30 minute	0.87	(0.67-1.13)	0.304
>= 30 minute or other	1.00		
Non drinking water			
Improved water	0.80	(0.67-0.95)	0.012
Unimproved water	1.00		
Type of toilet facility			
Improved toilet	0.90	(0.81-1.02)	0.092
Unimproved toliet	1.00		
Presence of water and sanitizer at hand washing place			
Water only or others	1.19	(1.03-1.37)	0.017
Water and sanitizer other than soap	1.07	(0.89-1.29)	0.461
Water and soap	1.00		
Education level			
Higher	0.77	(0.67-0.89)	0.000
Secondary	1.13	(1.03-1.23)	0.012
Primary	1.00		
Life stage			
Married/living together	0.68	(0.58-0.79)	0.000
Widow/divorce	0.58	(0.47-0.73)	0.000
Pregnant	1.00		

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Water, sanitation and hygiene (WASH) and Infection Prevention and Control in COVID-19 referral hospitals in Indonesia: Evidence from Indonesia

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INTRODUCTION

Infection prevention and control (IPC) is empirically proven to have the ability to support the implementation of health system through the improvement of quality of healthcare services. Captivating evidence found that nearly 70% healthcare-acquired infections (HAIs) can be prevented by proper IPC interventions. In regard to the role of water, sanitation and hygiene (WASH) in the implementation of cost-effective the IPC interventions, integration and alignment of WASH has been highlighted to be appropriate strategies in the context of broader efforts to overcome antimicrobial resistance (AMR), health emergencies and inadequate quality of healthcare.

However, a recent global assessment of IPC in 2021-2022 found that only four out of 106 assessed countries (3.8%) had all minimum requirements for IPC in place at the national level. As such, adequate WASH services in healthcare settings a prerequisite of quality of care and is needed to be addressed as it has not been studied yet in Indonesia. This study aimed to determine the existing conditions of WASH services and assess the readiness of such services during theCOVID-19 pandemic. The findings can be used to inform policy making in COVID-19 management and other upcoming diseases' pandemic.

METHOD:

An online survey of WASH conditions and Infection Prevention and Control (IPC)'s facilities using core questions of WHO/UNICEF Joint Monitoring Program 2018 and WHO Guidelines on Core Components of IPC Programmes at the National and Acute Healthcare Facility Level (2016) was conducted in 106 (80.3%) Indonesian COVID-19 referral hospitals during the period 1-18 May 2020. Relevant indicators of five elements of WASH, namely water, sanitation, hygiene, waste management and environmental cleaning were assessed and were categorized into WASH ladders for healthcare facilities. Moreover, the 2018 WHO IPC assessment framework at the facility level was also used to determine the availability and condition of WASH and other facilities related to hygienic environment.

RESULTS

The highest proportion of referral hospitals were owned by local governments (74.5%) and the highest proportion of hospitals' class was B class (54.7%). No hospitals were found to meet all the five basic WASH indicators as the highest ladder, either before and during pandemic. The WASH elements which comply with basic ladder with the proportions >95% were water, hygiene and waste management. In contrast, the proportions of basic compliance of sanitation and environmental cleaning elements were lower, which were 60.4% and 76.4%, respectively. Overall, there were no significant differences between the proportions of compliance of all elements before and during pandemic.

Concerning the conditions of the IPC facilities, there were four levels including inadequate, basic, intermediate and advanced. The results showed that all hospitals were in basic, intermediate and advanced levels. The ideal level for COVID-19 referral hospitals is advanced level, where all the IPC core components are fully implemented. However, there were only two provinces (West Sulawesi and Maluku) having hospitals with basic level. Moreover, in terms of the availability of isolation rooms, mechanical ventilations and energy, there were 18 out of 33 provinces which their all hospitals complied with the advanced level and there were also 3 provinces which its hospitals only complied with intermediate level.

DISCUSSION/IMPLICATION

Healthcare facilities including COVID-19 referral hospitals are facilities providing healthcare services for highly infectious disease patients are prone places in spreading healthcare-acquired infections (HAIs). As such, the hospitals must be equipped with infrastructures complied with a standardized built environment accommodating IPC core components including WASH facilities. Failure to meet the standards will be harmful to patients and hospital community. The findings of the study revealed that WASH services in many hospitals were lacking. Also, inequality exists among hospitals classes, ownership and location. Global indicators have not been implemented in national surveys, resulting in incompatible data comparison.

The findings of the study can be utilized by relevant stakeholders to revise the existing policies on hospital's environmental health and IPC programs implementation. Applied research and innovation to improve WASH services and IPC programs particularly in infectious diseases referral hospitals are needed as the upcoming disease pandemic can be more severe and complex. Furthermore, integration of WASH and IPC programs would be more promising in addressing HAIs and AMR as the two programs have been proven to be cost effective.

CONCLUSION

Indonesian healthcare facilities have been facing challenges in providing high quality of care through the implementation of IPC programs. Appropriate policies and regulations are needed to improve the conditions of COVID-19 referral hospitals as they can be useful for referral hospitals for other emerging infectious diseases.

Improving Community-Based Waste Management Through a User-Friendly Application

BACKGROUND

The rapid development of the world population has finally led to a new problem, including the increase in household waste generation. Waste management in most of Indonesian cities is stilla major problem in environmental management. Some issues include the lack of transport trucks, waste treatment facilities, community awareness and education, over-capacity landfills was should be faced by the government. Undeniably, the community needs to be involved in improving waste management. In this research, a user-friendly waste management applicationwas developed to help implement community-based waste management.

METHODOLOGY

This research was conducted through 2 stages, i.e. interviews and application development. Interviews were conducted with village officials, waste operators and the community to find out information regarding the existing waste management condition and application features they might be expected. Furthermore, a user-friendly Android-based application was developed to help manage waste community-based independently. In the next stage, a survey was conducted on users regarding their willingness to implement the applications offered. The data needed include the current waste management conditions, technical facilities and infrastructure for the waste management system, the number of houses serviced and workers, and the facilities available.

RESULTS

The waste management system at Geulanggang Baro village, Bireuen residence, Aceh Province, Indonesia was demonstrated community-based waste management potential to improve. It was managed independently by volunteers coordinating with local village officials and consisted of one driver and one collector. The integrated waste management in this villagewas started in 2019, with only 24% of the total village population involved. Moreover, to support waste management activities, there are some facilities provided, such as a pick-up car,shovels, and other Personal Protection Equipment (PPE); masks

and gloves. Waste collection is done twice a week, on Wednesday and Sunday nights. After going through interviews related to user needs, the application is developed as simply as possible to support users with different interests. The intended users include waste operators, village officials and the community. This application has features such as History, Selling Waste, Notifications and Educational Articles. The Selling Waste feature and Notifications are the requested features by the users. The Selling Waste is designed to make it easy for the public to find out the potential waste that can be received from selling inorganic waste to operators. Operators and village officials also benefit from this feature to increase income for waste management. Furthermore, the Notification feature was created to remind the public when to pay monthly waste retribution.

DISCUSSION

Previously, the village community did not have waste transportation facilities. Therefore, the people are forced to manage their waste by burying, burning and dumping it on empty land. By 2022, residents participating in waste management was increased to 38%. The total number of houses is 300 and 360 families in the Geulanggang Baro village. The number of residents who pay retribution waste for 2019-2022 is increasing from 72 people become 115 people. They pay retribution Rp 20.000 per month. Currently, Geulanggang Baro village does not havea temporary bin. It made difficulties to transfer waste. However, after the waste was collected, the car was parked around an open field. The next day, the trash was transported by a garbagetruck belonging to the environmental services, Bireuen regency to the Beururu landfill.

CONCLUSIONS

In conclusions, the problem are faced by the community including facilities, services and management. Through this application, it is hoped that waste management in the village of Geulanggang Baro, Bireuen regency can run more efficient and profitably for the users and operator as well

Hak Atas Air Dalam Perspektif Hukum Hak Asasi Manusia: Konsep Ius Constituendum dan Kaitannya Terhadap Sustainable Development Goals

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Water has always been an important part of human life. In the last few decades, water polemics have increased and the main problem is due to the absence of effective water management and water security (water protection) instruments. The lack of access to clean water always occurs and at its worst, also has a serious impact on human rights aspects and is a major obstacle to sustainable development. As an archipelago surrounded by waters, Indonesia has a unique legal framework in governing water management. Constitutionally, it is stated that the earth, water, and the wealth contained therein are controlled by the state and used as much as possible for the prosperity of the people. In the international scope, the water sector is characterized by a very complex and problematic situation.

The operation of water services, the legal framework and water conditions are key issues for this problem, which are not only regional, but exists in most developing countries. The right of every human being to safe drinking water and basic sanitation must be recognized and realized. This research aims at analysing the right to water from the concept of Ius Constituendum and its relationship with the sustainable development goals. This research will employ a normative method, where it seeks to analyse the existing legal framework as well as literature resource. The result of this research found that the governance of water management in Indonesia; while it is consistent with the Constitution, there are still a lack of implementation in terms of ensuring the access to clean and sanitized water. This also reflects the Country's position that is far from the targeted Sustainable Development Goals.

Sustainability Status Analysis of Women's Participation in the IUWASH Plus Program in Malang Regency

Aptu Andy Kurniawan

Dinas PU Sumber Daya AIr Kabupaten Malang

INTRODUCTION

A five-year project to accelerate the achievement of Indonesia's development goals of increasing access to safe drinking water and sanitation, and hygiene behavior (WASH) in vulnerable urban areas and strengthening WASH services and climate-resilient water resources management (PSDA). Partnering with the Government of Indonesia, USAID IUWASH Tangguh supports Indonesia's efforts to achieve the Sustainable Development Goals (SDGs) targets of ensuring access to water and sanitation for all (Goal 6) and creating cities and settlements that are inclusive,safe, resilient, and sustainable (Goal 11) .

Using an Integrated Resilient IUWASH Systems (IRIS) approach—which aligns actions and incentives between upstream and downstream actors, working with key stakeholders through partnerships that streamline key enabling environments and enabling factors, such as finance and data—the team USAID IUWASH Tangguh will provide technical assistance to the Government of Indonesia, the private sector, and community stakeholders to achieve four objectives:

1. Strengthening Governance and Financing of the WASH Sector and Management of Water Resources (PSDA);
2. Improving access to safe, climate-resilient, and inclusive drinking water and sanitation servicesfor the poor;
3. Improvement of PSDA to Support Resilient Drinking Water Services; And
4. Increasing Behavior Adoption and Increasing Women's Participation and Leadership Role Contributing to Increasing WASH and PSDA.

At a local level in many societies, women play a central role in providing water supply and sanitation. They have primary responsibility for the management of household water supply, sanitation and health (Iuwash, 2019). Generally

women are most vulnerable to poverty and have fewer chances to improve the economic conditions affecting their access to natural resources.

Women are more vulnerable to water-related diseases since they are more exposed as water carriers and their important role in carrying out domestic chores (preparing food, cleaning toilets, washing clothes, etc.). Cultural biases affecting the installation and operation of sanitation services (see box 2). Women lose a lot of time fetching water, which has a negative impact on their personal and family life and economic status

This study examines the status and sustainability of women's participation in the IUWASH Plus program in Malang Regency. This research is expected to be a reference for increasing women's participation in the iuwash plus program in Malang regency are more prosperous by managing sensitive attributes that affect the dimensions of women's participation.

METHODOLOGY

Location and Time

The activity location is the location especially community activities relation to the main actors involved in the IUWASH Plus program in Malang Regency.

Data Types and Sources

Types of data collected in this research is primary data including:

Data on Individual and Family Characteristics (age, education level, level main and side income health, status of respondents related to water and sanitation both the main job and side, and thesocial status of the respondent in society

Family (age, education level, main income level and side, health, status of respondents relatedto water and sanitation both jobs main and side, and status respondent's social status in society Role of women at the household level. Most of the care of under-fives is done by the mother, who is also responsible for food preparation and serving and for cleaning the home, even if other household members, especially girls, often help out. Because of the need to multi-task, such as a baby needing cleaning in the middle of food preparation, it may be hardest for the mother to maintain good hygiene. On the other hand, mothers appear to be more aware of the need for cleanliness. An adult female usually cleaned the toilet and 34% stating that this function was carried out by a male adult. This indicates a gender bias in perceptions of division of labor around toilet cleaning suggesting that survey results need to be interpreted with care. (S.Aloua, 2016)

Data Collection Method

This study uses a survey method. The data collected is in the form of primary and secondary data. The primary data collection method was conducted through structured interviews with respondents using a closed questionnaire. Respondents were assigned randomly as many as 30 people at each research location.

Data Analysis Method:

This study's method of analysis uses leverage analysis, which is carried out using the Multi- Dimensional Scaling (MDS) approach. This approach is modified from the RAPFISH (Rapid Assessment Techniques for Fisheries) program developed by the Fisheries Center, University of British Columbia (Kavanagh, 2001 in Fauzi and Anna, 2002). The MDS method is a multivariatestatistical analysis technique using SPSS software, which transforms each dimension and multidimensionally the sustainability of women's participation in the sustainability of the IUWASH plus program in Malang Regency. RAPFISH ordination approach with the MDS method in this study was carried out through several stages. First, determination of attributes thatinclude three dimension, namely the characteristic dimension individual, family characteristics, and role of women household.

Second, the assessment of each attribute in ordinal scale (scoring) based on criteria sustainability in every dimension. Third, assess role sustainability index and status and women in water and sanitation studied multidimensionally as well as in every dimension. Fourth, sensitivity analysis (leverage analysis) to determine a sensitive variable affect sustainability. Fifth,Monte Carlo analysis to take into account uncertainty aspect.The MDS approach in RAPFISH provide stable results (Pitcher and Preikshot, 2001) were compared with multiple variable analysis method others(eg factor analysis). Whole data of the attributes considered in this study were analyzed multidimensional to determine the point reflecting a sustainability position women's participationin development fishing business. In MDS analysis with use the computer, all at once

Leverage analysis is carried out, analysis Monte Carlo, determining the value of Stress, and the coefficient of determination (R2) is a program package with MDS program. First, Leverage analysis used to determine sensitive attributes, or interventions that can be done on the attribute sensitive to increase status continuing women's participation in IUWASH plus program. AnalysisLeverage can determine the factors or the most influential attribute relative to other specified attributes by the largest index. The bigger the index Leverage then that attribute the most sensitive than other attributes. Sensitive attribute

determination is done results in priority order Leverage analysis by looking at the shape Root Mean Square (RMS) changes ordinate on the X axis. The greater the value The change in RMS, the bigger it is the role of these attributes in the improvement sustainability status of women's participation in IUWASH plus program in Malang Regency.

Monte Carlo analysis is used for suspect the effect of errors in the process analysis carried out, atintervals 95 percent confidence. Analysis results expressed in the form of an index value Monte Carlo which is further distinguished with the results of MDS analysis.

Attributes considered influence the level sustainability in every dimension on this research include:

Individual Characteristics, the attributes are : hygiene knowledge, wife's activity, wife'sincome, wife's education, wife's social status , health sanitation knowledge, understanding clean water, wife's health behaviour and wife's age

Characteristics of the Family, the attributes are: children behaviour, number of children, husband's social status, husband's income, husband's education and husband's age.

Role of women at the household level., the attributes are : responsible food preparation, taking care kids, household activity, preparation pure water for drinking, preparation clean water for taing a bath, understanding IUWASH plus knowledge

RESULT AND DISCUSSION

Dimensions Of Individual Characteristic

Based on classification of characteristic dimension conditions individuals in all research locations category or status is quite sustainable Based on the results of the Leverage analysis, three attributes are obtained that are sensitive to the sustainability index value on the individual characteristic dimension. (1) understanding clean water, (2) health behaviour, and (3) social status (Figure 1).

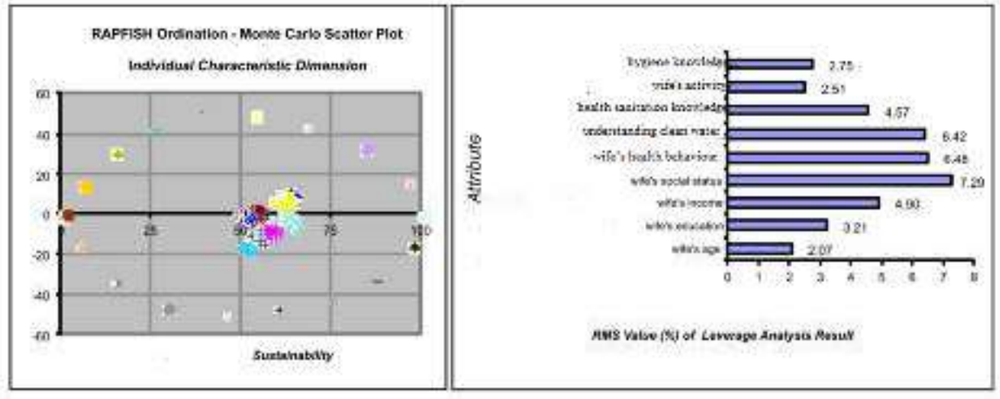


Figure 1. Sustainability index Value and Sensitive Atributes Impact on Sustainability Of Indivudual Characteristic's Dimension

Recommended policy options is coaching and motivating health sanitation nowledge so it can continue to grow well through government, non-governmental organizations,as well as other related institutions.

Dimensions of Family Characteristics

From the results of Leverage analysis, obtained two attributes that are sensitive to value characteristic dimension sustainability index family (Figure 2). (1) husband's social status and (2) husband's income. Based on research results average social status as members of ordinary societyand the average income level of family per month belongs to the category low income. The second appearance attribute can be interpreted that status and Husband's income has an effect on women'sparticipation in development IUWASH program. So that these two attributes become a factor which can be considered in policy options.

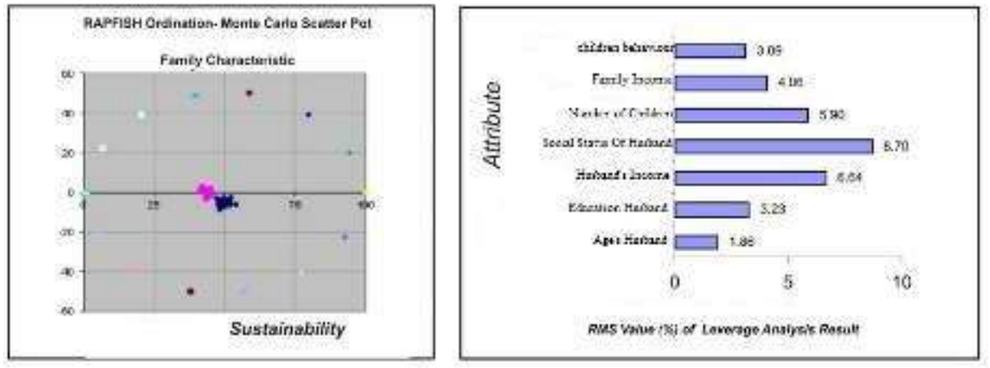
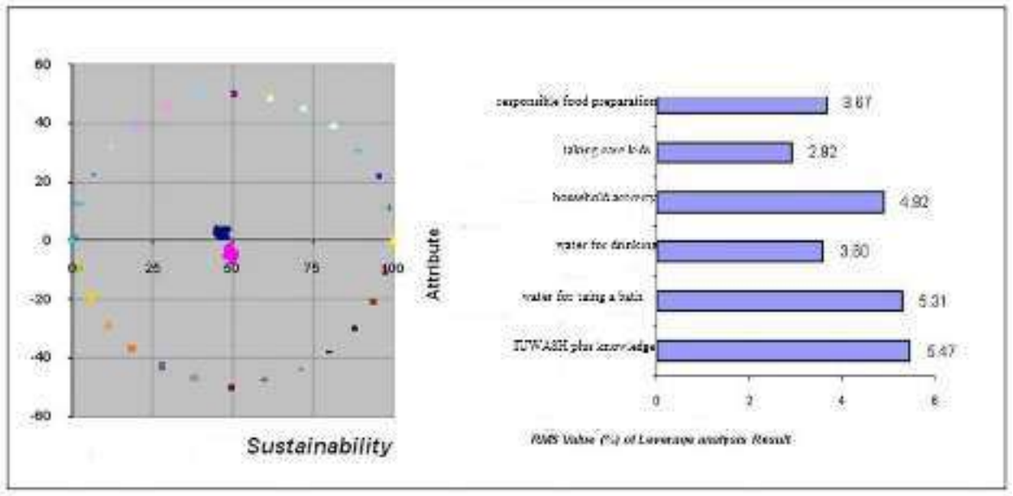


Figure 2: Sustainability index Value and Sensitive Atributes Impact on Sustainability Of Family Characteristic's Dimension

Policy options what is suggested is to give economy's activity development so women are not depending on the husban's income, which in the end can improve household income

Dimension of Role Women at the household level.

Based on the results of leverage analysis in figure 3, the sensitive attribute affect women's role at the household are IUWASH plus knowledge and preparing water for taing a bath. The research results show prepare water for drining difficult to develop, this is due due to lack of knowledge.



Alternative solutions need support government institutions, as well non-governmental organization to give WASH training continuesly.

CONCLUSION

The participation of women in the sustainability of the IUWASH Plush program in the Malang district is extensive. But often gets obstacles both from himself and from outside himself.Constraints that come from himself include a lack of motivation to understand sanitation, minimalknowledge about the importance of clean water for sanitation, low education, and a lack of skills.In all locations, the capacity possessed by women is sufficient to carry out the sustainability of the iuwash plus program covering three dimensions; 1) the dimensions of individual characteristics, 2) the dimensions of family characteristics, 3) Role women at household level

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Understanding household self-supply use and management in urban Indonesia

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BACKGROUND/KNOWLEDGE GAP, PROBLEM STATEMENT, OBJECTIVE

In urban Indonesia, 40 million people rely on groundwater self-supply, however the role of self-supply in securing household water provision remains unexplored. Household self-supply refers to an on-premises water supply relying on groundwater or rainwater, that is privately owned, financed and managed by individual households. Understanding the reliance of households on self-supply and its associated management is crucial to developing appropriate strategies to ensure safe and reliable drinking water services for households in urban Indonesia. The study sought to understand (i) the use and non-use of self-supply water services and alternative water choices and (ii) how self-supply is managed by individual households, including intra-household gender dynamics.

METHODOLOGY

This study used a mixed-methods approach to understand the use and management of household self-supply in the Indonesian cities of Bekasi and Metro, where a high proportion of households rely on private wells for water supply. Data for the quantitative approach were collected from 300 randomly selected households in both Bekasi (February-March 2020) and Metro (October-November 2020). The quantitative approach included a household survey that covered a range of themes about the household, water sources used and perceptions of water service attributes. Following descriptive analysis of the

household survey, 24 in-depth interviews were carried out by phone from 12 purposively selected households in Bekasi (December 2020) and Metro (August 2021 and November 2021-January 2022), respectively. The in-depth interviews covered themes on water choice, perception, management and decision-making.

RESULTS

Self-supply was the preferred drinking water source because of its perceived safety, taste and appearance at both study sites. The most important attributes influencing choice of domestic water source were appearance, reliability and safety in Bekasi, and safety followed by convenience and reliability in Metro. Coping strategies to overcome quality and availability problems of self-supply included water treatment, switching from dug wells to deeper boreholes and the use of multiple water sources. All households reported boiling self-supplied water, however, the labor involved was tiring for some households, leading them to resort to alternative water sources. Reasons for non-use of alternative water sources such as refill water and public piped systems included a lack of trust in water quality and perceived poor taste. Regarding self-supply management, responsibilities and decision-making varied across households, but cooperation between men and women concerning workload was common. In both study sites women were mostly responsible for household water management, and men were mostly responsible for maintenance and repairs, cleanliness of the water source and financing.

DISCUSSION/POLICY IMPLICATIONS

To support and regulate self-supply towards a safely managed water service, strategies for improvements should be considered not only at the source, but also at point-of-use, including promotion of safe household water treatment and management. Although self-supply was the main source of water at these study sites, alternative water sources such as refill water and public piped systems played an important role in supplementing inadequate supplies, and hence their safety and reliability should also be considered when establishing support strategies.

CONCLUSION

This study provided important insights into the use and management of self-supply in urban Indonesia. An improved understanding of how and why urban households self-supply their water is crucial for accelerating progress towards Sustainable Development Goal 6.1 in Indonesia. A mixed-methods approach was used, which allowed for more comprehensive findings and provided both broader and deeper insights into the use and management of self-supply than a purely quantitative or qualitative approach. This study found that households in Bekasi and Metro generally preferred groundwater self-supply water, but still used alternative water sources to supplement inadequate supply. Some considerations to support and regulate self-supply towards a safely managed water service can be concluded from this study: (i) self-supply use was connected with water boiling, which increased water quality at the point-of-use but came with an additional workload for household members and the potential use of fuel which is harmful to health; (ii) in response to groundwater availability issues, households that could afford it often switched from shallow dug wells to deeper wells with a motorized pump; (iii) there was little trust in quality of alternative water sources such as refill water and public piped systems; (iv) gendered intra-household dynamics varied across households, but showed cooperation between women and men and certain clearly defined roles in terms of responsibilities and decision-making.

Constraints and Challenges of Inclusive WASH Development to Achieve Access to Sanitation and Safe Drinking Water in the Urban Slum Area of Padang City: Community Perspective

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INTRODUCTION

Water and sanitation are basic human rights. Universal access to safe and equitable drinking water and sanitation is also emphasized in SDG point 6, which is expected to be achieved in 2030[1]. However, until now, there has been limited access to safe drinking water and sanitation in Indonesia. According to Bappenas (2022) data on trends in access to sanitation and drinking water, until 2021, only 7.25% of Indonesian households have access to safe sanitation, and only 11.8% have access to safe drinking water[2]. Under these conditions, and in order to meet the SDG target, efforts to develop inclusive water and sanitation facilities (WASH inclusive) involving community groups are undoubtedly required[3]. Padang city water Mata Air Village is located in South Padang District, Padang City, which is based on the Slum Decree of the Mayor of Padang City No. 163 of 2014 concerning the Location of Housing and Slum Environments in Padang City. It is one of the slum neighborhood areas in Padang City that needs a livable development plan so as to create a better urban area[4].

The most important environmental issue in this urban village is the low level of access to proper sanitation and drinking water, including the fact that there are still many households that do not have healthy latrines, resulting in fecal contamination of drinking water and clean water[5]. Based on an initial survey conducted from 15 neighborhood associations and 55 neighborhood

associations in Mata Air Village, there are 17 RWs spread across 10 RTs that do not yet have healthy latrines, so liquid waste (feces) goes directly into rivers or ditches around settlements. This certainly has an impact on groundwater pollution due to fecal contamination; this is evidenced by the physical condition and microbiological quality of the water sources for the surrounding community, the majority of which use drilled or dug wells that are already in a polluted condition based on Minister of Health regulations 32 of 2017, with a description of the physical condition in color, turbidity, and smell, and the results of laboratory tests conducted at several points of drinking water or clean water sources showed coliform and Eschericia Coli (E. coli) contamination of around 1,100 CFU/100ml[6],

As a result of this condition, the community was forced to replace its source of drinking water with bottled water. repeated, but the condition is still a problem because laboratory tests conducted in several household locations found contamination of refill drinking water with Coliform and E. coli around 1.100 CFU/100ml and160 CFU/100ml[7]. Apart from the participation of the community and related parties, which is still low in creating inclusive WASH development to achieve access to sanitation and safe drinking water[8]. Based on this, this study aims to analyze the constraints and challenges in the development of inclusive WASH to achieve access to sanitation and safe drinking water in urban slum areas, especially the Mata Air Village, from a community perspective.

METHODOLOGY

Data collection in this study was carried out using qualitative techniques using in-depth interviews with the community. Data collection was carried out in urban village Mata Air, especially in RW 11 and RT 02. This location was chosen because of the condition of the residential environment, which has a high risk of environmental pollution and health based on the results of brainstorming with the head of the urban village, the head of the Rawang Health Center, the Environmental Health Program Holders, and River Care Communities in Mata Air Village, Padang City. This study focuses on an approach to the community so that the selected respondents are the entire community in RW 11 RT 02, totaling 34 heads of family all of whom do not have access to healthy latrines and contaminated water sources. The data were then analyzed using transcription, coding, and categorization techniques to interpret the results.

RESULTS

Based on the participation of all respondents during data collection, various obstacles and challenges were encountered in the development of inclusive

WASH for achieving the target of safe sanitation and drinking water facilities in Mata Air Village, as illustrated in **Figure 1.**

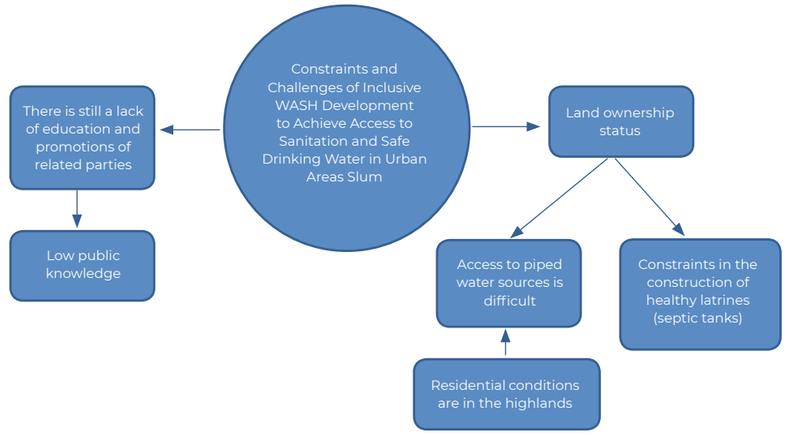

Figure 1 shows that there are internal and external obstacles and challenges that need to be made by various parties to overcome this. Internal constraints and challenges stem from within the community itself, namely, the low knowledge of the community, including regarding access to safe sanitation, especially the provision of healthy latrines, the risk of environmental and health pollution, and the provision and management of water sources for safe drinking water facilities. This is, of course, influenced by a lack of health education and promotion by community stakeholders. Then, there are external constraints with much bigger implications, namely the community's difficulties in building settlements, especially in the case of building healthy latrines for the construction of septic tanks due to the ownership status of leased land. This also makes it difficult for piped access and the construction of a proper water source because the land was not previously designated for residential areas and did not receive a development permit from the land owner. The difficulty of accessing the pipeline is also due to the condition of the settlements in the Highlands, which prevent water from flowing into the area.

DISCUSSION

Constraints and challenges of inclusive WASH development to achieve access to sanitation and safe drinking water in the urban slum area of Padang City:

Internal

Internal constraints and challenges, namely the low level of public knowledge. According to Notoatmodjo, knowledge is the result of knowing, which occurs after someone senses an object. Sensing occurs through the five senses. Namely,

the senses of hearing, sight, smell, feeling, and touch. Some human knowledge is obtained through the eyes and ears[9]. Lack of public knowledge regarding access to safe sanitation, especially the provision of healthy latrines, the risks of environmental and health pollution, and the provision and management of water sources for safe drinking water facilities.

According to Notoatmojo, there are six factors that greatly affect a person's level of knowledge: age, experience, occupation, socio-culture, environment, and education[10]. Less will hinder the development of one's attitude towards newly introduced values[11,12]. The environment influences the process of entering knowledge into individuals who are in that environment. This happens because of the mutual interaction that will be responded to as knowledge by each individual. Experience as a source of knowledge is a way to obtain the truth of knowledge by repeating the knowledge obtained in solving problems encountered in the past[14,15].

Based on the results of observations and sharing with the community and related parties, the lack of public knowledge is also affected by a lack of health promotion, education, and outreach to the community. so that people's knowledge about accessing safe sanitation is very low or minimal. Health promotion itself, according to the WHO, is a process that strives for individuals and the community to increase their ability to control health factors so that they can improve their health status[16]. For this reason, health promotion is very necessary for increasing public knowledge.

External

The community has difficulty carrying out settlement construction, especially in terms of building healthy latrines for building septic tanks, because of the ownership status of leased land. Republic of Indonesia Law No. 1 of 2011 concerning Housing and Settlement Areas states that the implementation of housing and residential areas includes planning, development, utilization, and control activities, including institutional development, funding, and financing systems, as well as a coordinated and integrated community role. All of the aforementioned aspects involve cross-sectoral, interdisciplinary, scientific, numerous institutions, agencies, and the community in order for the implementation process to be consistent with the goals and benefits of housing and residential area management[17,18]

The complexity of housing and settlement development issues is increasingly diverse, marked, among others, by the existence of slum areas in urban and rural areas, the large number of housing and residential areas damaged or destroyed by disasters, and the increasing rate of demand for housing and settlement land. Some of the causes of these problems are due to the low competence of human resources regarding housing and settlement management, weak community capacity in environmental management, a lack of comprehensive stakeholder understanding of housing and settlement areas, and weak joint action and/or cross-sectoral integration in the field of housing and settlement management. settlements according to the mandate of the law[19]

Land ownership status is an external factor that is the main cause of the difficulty in building settlements that provide access to safe sanitation. As a result of land ownership, it is difficult for the community to build settlements with access to safe sanitation, namely access to piped water sources; this is also because the settlements are located in highland areas. Then, the construction of healthy latrines (septic tanks) was hampered[20]. Healthy latrines are effective fecal disposal facilities to break the chain of disease transmission. Healthy latrines must be built, owned, and used by the family in a position (inside or outside the house) that is easily accessible to the occupants of the house[21].

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Improving Readability of Communication Materials in Creating Demand for Safely Managed Sanitation in Indonesia

Putri Sortaria

SNV Netherlands Development Organisation Indonesia

LATAR BELAKANG

Pemanfaatan materi komunikasi, informasi, dan edukasi (KIE) yang mudah dipahami masyarakat adalah tahap yang penting dalam upaya menciptakan kebutuhan sanitasi aman di Indonesia. Sayangnya, sebagian besar materi KIE yang beredar didasari perencanaan yang terbatas, tidak didahului dengan riset formatif, dan tidak melalui uji coba di tingkat penerima pesan. Idealnya, uij keterbacaan materi KIE perlu dilaksanakan dengan tujuan menciptakan materi yang dapat dibaca dan dimengerti dengan mudah, sesuai dengan konteks sosial budaya setempat, serta diterima oleh masyarakat.

METODOLOGI DAN HASIL

SNV Indonesia saat ini tengah melaksanakan program WASH SDG di Kota Tasikmalaya, Bandar Lampung, dan Metro, yang salah satu komponennya adalah Komunikasi Perubahan Perilaku (KPP). Sebagai bagian dari komponen ini, di tahun 2022 SNV melaksanakan uji keterbacaan kepada pengguna materi KIE seperti sanitarian dan kader kesehatan, serta kepada penerima pesan yaitu masyarakat, termasuk penyandang disabilitas.

Uji keterbacaan dilakukan untuk 10 (sepuluh) materi tertulis dan 1 (satu) video dengan metode diskusi kelompok terfokus yang terdiri dari 5 (lima) hingga 8 (delapan) peserta. Skala Likert digunakan sebagai alat untuk mengukur persepsi masyarakat terhadap setiap materi KIE yang diujicobakan. Aspek yang masuk ke dalam penilaian antara lain: ketertarikan, kelengkapan informasi, penerimaan masyarakat, kesesuaian dengan konteks penerima, ajakan untuk beraksi, aksesibilitas materi, dan saluran penyampaian informasi yang dirujuk oleh masyarakat penerima.

Uji coba KIE dilakukan salah satunya agar para promotor perilaku kesehatan

termasuk sanitasi aman paham pentingnya penggunaan materi KIE yang baik untuk memastikan pesan kunci dapat tersampaikan dan terjadi perubahan perilaku. Untuk mendukung hal tersebut, hasil uji coba menunjukkan bahwa masyarakat lebih tertarik pada materi KIE yang memiliki banyak gambar berwarna-warni daripada teks yang mengandung banyak informasi. Kemudian, ketersediaan nomor yang bisa dihubungi saat dibutuhkan, seperti tukang tangki septik atau sedot WC, sangat penting dicantumkan agar masyarakat dapat langsung beraksi terhadap pesan yang disampaikan. Selain itu, kita dapat mengombinasikan format audio dan visual untuk meningkatkan aksesibilitas dan menyesuaikan dengan kebutuhan masyarakat yang beragam.

Selain itu, penyebaran informasi dengan materi KIE juga dapat disebarkan melalui berbagai kanal atau saluran informasi yang sesuai, tidak hanya dengan sosialisasi tatap muka langsung, tapi juga dapat melalui papan informasi cetak di lokasi tertentu dan juga sosial media.

DISKUSI DAN REKOMENDASI

Dalam melakukan uji keterbacaan KIE, sangat baik apabila melibatkan serta para pelaku promosi kesehatan dan kader mulai dari perencanaan hingga pelaksanaan. Hal ini dapat menghasilkan materi KIE yang tepat sasaran berdasarkan motivator yang sesuai di lokasi target, dan juga dapat disesuaikan dengan konteks masyarakat agar penerimaan baik oleh masyarakat. Dengan demikian potensi untuk pesan perubahan diterima masyarakat lebih tinggi dan potensi terjadinya perubahan perilaku di masyarakat juga lebih tinggi.

Kemudian, dengan melibatkan kelompok rentan dalam uji keterbacaan serta mendapatkan langsung masukan dan persepsi dari apa yang benar-benar dibutuhkan oleh mereka, maka pesan perubahan yang dikembangkan dapat diterima oleh kelompok rentan.

KESIMPULAN

Temuan dari uji keterbacaan di atas penting untuk dipertimbangkan oleh promotor, baik sanitarian, kader, maupun penyampai pesan lainnya supaya masyarakat dapat tertarik, memahami, serta menerjemahkan pesan menjadi aksi.

Tidak hanya itu, pemahaman akan konteks sosial budaya masyarakat setempat juga krusial perannya terhadap penerimaan pesan dan aksi perubahan perilaku oleh masyarakat penerima menuju sanitasi aman

Collaborative Effort on Develop and Implement Behaviour Change Communication Strategy in Indonesia

Putri Sortaria

SNV Netherlands Development Organisation Indonesia

LATAR BELAKANG

Dalam penciptaan kebutuhan masyarakat akan sanitasi aman, SNV memahami pentingnya institusionalisasi dalam proses Komunikasi Perubahan Perilaku (KPP). Melalui program WASH SDG, SNV menekankan bahwa pencapaian sanitasi aman dan proses perubahan perilaku bukan hanya tanggung jawab sektor kesehatan, melainkan multi-sektor. Oleh karenanya, institusionalisasi di dalam lembaga pengampu serta kolaborasi multi-pihak di tingkat kota esensial untuk prioritisasi perencanaan dan penganggaran penciptaan kebutuhan, yang tujuan akhirnya diterjemahkan menjadi peningkatan akses sanitasi.

Pemerintah Indonesia telah berkomitmen untuk mencapai akses sanitasi layak sebesar 90%, termasuk 15% sanitasi aman di tahun 2024[1]. Di Kota Bandar Lampung dan Metro, akses sanitasi aman saat ini adalah 0%[2] dan 6%[3] secara berurutan. Angka ini menunjukkan kesenjangan yang tinggi antara akses saat ini dengan target kedua kota untuk mencapai 12% sanitasi aman di tahun 2026. Walaupun kedua kota tersebut sudah berupaya meningkatkan kesadaran masyarakat dengan target perilaku yang beragam (misal: kebutuhan sanitasi dan perilaku cuci tangan pakai sabun), tetapi belum ada strategi KPP perkotaan yang terstruktur, berbasis bukti, dan berfokus pada tujuan akhir [4]. Hal tersebut menyebabkan kegiatan perubahan perilaku hanya berpusat pada terlaksananya kegiatan tanpa melihat hasil jangka panjang dan dampaknya terhadap masyarakat. Selain itu, keberlanjutan dari pelaksanaan dan pengarusutamaan di insitusi pengampu, serta terbatasnya pemantauan dan evaluasi yang konsisten masih menjadi tantangan.

METODOLOGI DAN HASIL

Di tahun 2021, SNV memfasilitasi pembentukan Kelompok Kerja (Pokja) KPP di tingkat kota yang melibatkan seluruh institusi kunci dalam mewujudkan akses sanitasi aman, antara lain Badan Perencanaan Daerah (Bappeda), Dinas

Kesehatan, Dinas Lingkungan Hidup, Dinas Pekerjaan Umum dan Perumahan Rakyat, Dinas Sosial, Dinas Pemberdayaan Perempuan dan Perlindungan Anak. Kolaborasi dan partisipasi aktif dari semua anggota Pokja KPP berhasil merumuskan tonggak-tonggak capaian kunci untuk mencapai target dan indikator sanitasi aman.

Dalam masa fasilitasi dan pendampingan, SNV memberikan peningkatan pengetahuan dan keahlian mengenai topik sanitasi dan kebersihan di tingkat perkotaan. Tujuan dari peningkatan kapasitas tersebut adalah agar masing-masing dinas yang terkait paham akan peran dan tanggung jawabnya atas pemenuhan Standar Pelayanan Minimum (SPM) untuk memenuhi hak masyarakat kota akan akses sanitasi.

Hasil dari pendampingan dan peningkatan kapasitas adalah adanya pengembangan strategi KPP tingkat kota yang berisi rencana kerja semua institusi untuk menciptakan kebutuhan sanitasi aman sesuai dengan tugas dan fungsinya masing-masing. Setelah strategi KPP disosialisasikan ke seluruh dinas terkait, kemudian SNV memberikan pelatihan peningkatan keahlian KPP Bersama dengan pokja KPP kepada masyarakat, kader kesehatan, dan tokoh masyarakat.

Bersamaan dengan pengembangan dan sosialisasi strategi KPP, kami juga melakukan implementasi di tingkat kelurahan di Kota Bandar Lampung dan Kota Metro. Di Kota Bandar Lampung melalui kegiatan Kampung Hijau kami berusahan menarik perhatian masyarakat tentang isu sanitasi aman dan kebersihan tangan melalui kebersihan lingkungan, karena isu kebersihan lingkungan terutama manajemen persampahan merupakan isu yang masih marak terjadi. Bersama dengan kader kesehatan dan kelompok pemuda, di lokasi Kampung Hijau di Kota Bandar Lampung membuat kegiatan “Sedekah Sampah” yang merupakan upaya mengumpulkan sampah potensi daur ulang ke bank sampah, dan pendapatan yang dihasilkan dikumpulkan untuk perbaikan tangki septik standar atau penyedotan tinja.

Di Kota Metro melalui inisiasi Bappeda Kota dan kelompok wanita PKK (Pemberdayaan dan Kesejahteraan Keluarga), dilakukan mekanisme arisan sedot tinja (ARSETI) yang mana kelompok perempuan di tingkat kelurahan mengumpulkan uang dan arisan untuk sedot tinja. Hingga saat ini di Kota Metro sudah terbentuk kelompok ARSETI yang sedang melakukan putaran arisan untuk sedot tinja.

DISKUSI DAN REKOMENDASI

Komunikasi Perubahan Perilaku (KPP) merupakah bagian yang tidak terpisahkan dari upaya pemenuhan akses sanitasi aman. Selain itu, KPP juga bukan hanya tanggung jawab dari Dinas Kesehatan untuk promosi kesehatan, tetapi memerlukan kolaborasi dari berbagai dinas dan pihak terkait. Maka dari itu perlu adanya kolaborasi multi-pihak agar bisa tercapai tujuan akhir peningkatan akses sanitasi aman yang berkelanjutan.

Kemudian, untuk memperkuat tata kelola tersebut bahwa dengan adanya komitmen dan pengesahan pembentukan kelompok multi-pihak menjadi penting. Dengan begitu setiap pihak yang terlibat dapat memahami dengan jelas peran dan tanggung jawabnya untuk pelaksanaan KPP sanitasi aman sesuai dengan tugas pokok dan fungsinya.

KESIMPULAN

Pembentukan Pokja KPP ini diharapkan dapat memperkuat kolaborasi multi-pihak dalam pencapaian target sanitasi aman kota. Bukan hanya kolaborasi, pembentukan kelompok kerja ini turut mendorong keterwakilan yang setara dari berbagai institusi pemerintahan. Tujuan akhirnya, kami berharap dapat mendorong keterbukaan dan akuntabilitas pemerintah kota dalam sinkronisasi strategi KPP ke dalam upaya yang lebih besar dalam mempercepat pencapaian akses dan layanan sanitasi aman yang berketahanan iklim dan inklusif.

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Management Information System (MIS): Accelerating Access to Safely Managed Sanitation in Pinrang, South Sulawesi

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BACKGROUND

Indonesia has achieving 81 % on Open Defecation Free (ODF) by 2022 and continuously improving the sanitation services by accelerating access to safely managed sanitation to achieve the SDGs targets. More than 97% of districts in Indonesia rely on the on-site sanitation, which needs chain service from septic tanks to domestic waste-water treatment plants (DWWTP). There are 16 DWWTPs out of 24 districts in South Sulawesi, although only 13 are operational (2 units overload, 8 units operate on unscheduled desludging, and 3 units are not optimally operated). This condition is consequence on the reducing of the idle capacity of existing DWWTP. Therefore, better support for vulnerable households, improve performance of sanitation service including the consumer database improvement isnecessary. Data is a valuable asset that requires to be updated on a regular basis. However, gathering data is often time-consuming and resource intensive. When data is out of date, the risks of inadequate or poor planning and decision-making escalate.

Pinrang district is one of the most advanced sanitations in addition to Makassar city for the DWWTP operation in South Sulawesi. Pinrang has received awards for successfully implementing Community Based Total Sanitation (Sanitasi Total Berbasis Masyarakat - STBM) in 2019 and 2020, as well as for achieving Open Defecation Free (ODF) status by 2019. Furthermore, the Pinrang district government has announced the implementation of safe sanitation through Bupati Decree Number 7/2018on scheduled desludging program. The primary mandate is to obligate the civil servant to participate in the scheduled desludging services as the customer. In accordance with these directives, the DWWTP continues to improve service performance, including optimizing the operation of infrastructure facilities.

METHODS

Intending to accelerate the scheduled desludging program's implementation, DWWTP Pinrangwith the support of UNICEF through BaKTI Foundation has actively participated on several program. Horizontal learning with Sidoarjo district and Makassar city has triggered the improvement of data management as well as the capacity development of the operator. Preparing potential customers' data forthe scheduled desludging program through a septic tank survey in 2021. Also collaborating with the District Health Office and University on safe sanitation inspections and septic tank surveys by sanitariansand the local students in 2022. The septic tank survey collected data from 700 households who are potential consumers of scheduled and unscheduled desludging services.

RESULTS AND DISCUSSION

In order to improve the quality of customer database management and service management, DWWTP Pinrang requires the support of the Management Information System (MIS) platform. This MIS will eventually serve as a foundation for a variety of web applications that manage customer databases and domestic wastewater services. In 2022, DWWTP Pinrang initiated the development of the Management Information System Domestic Wastewater Treatment Plant (MIS DWWTP), as an initial step toward supporting the MIS platform. This initiative was supported by UNICEF in collaboration withYayasan BaKTI. The main purpose of the MIS is to support the implementation of a scheduled sludge service program through the development an android-based database application that will be used by DWWTP in implementing a more advanced local domestic wastewater management system. The application was developed in two versions: a web-based version, which are utilized by domestic wastewater decision makers for purpose of monitoring, planning and managing data. While the androidversion to be used by DWWTP operator team in the field for information collection of the customer detail data that including name, image, and address, so they could capture more household's data quickly.

The main beneficial outcome of this MIS is to accelerate the access of safely managed sanitation in Pinrang District. Moreover, several beneficial outcomes that help the DWWTP directly in the daily operation are consist of; the DWWTP data team or officer is able to become the operator to manage the implementation of the Scheduled Sludging Service prospective customer survey, which is carried out based on the DWWTP MIS application. The operators could also act as enumerators for the customer survey on the field. Additionally, the decision maker, the board of leaders, and the related stakeholders are able to use the MIS DWWTP application in planning and monitoring the implementation of domesticwastewater management, and also get a new perspective on how to measure the progress of safely managed sanitation through the updated data that has been stored on the website.

Data from the Statistical Bureau show that Pinrang has 119,956 households as of 2021, and only 3% of households have been desludging. Along with the improvement of the customer database through the MIS, there are now 8,332 households that have been registered. In 2023, those numbers will represent potential customers which will continuously to grow. As long as the Pinrang district government keep consistent on three main the criteria of safely managed sanitation, which maintain ODF status that include of society has been used the improve sanitation facilities, the usage of SNI-standard septic tanks (the excreta produced stored temporarily and transported to treatment off-site) and the safely managed acrossthe entire sanitation service chain. Accordingly, the percentage of safely managed sanitation will potentially increase by more than 7% within 2 years.

CONCLUSION AND RECOMMENDATION

By utilizing the customer data base that has been store and continuously updated in the DWWTP MIS for desludging could accelerating the access to safely managed sanitation in Pinrang district. Furthermore, enhancing the safely managed sanitation will be valuable for the health of society in Pinrang District including children. Also, it will be valuable to replicate this approach to other district in Indonesia inorder to accelerating access to safely manage sanitation.

KEYWORDS: *Faecal Sludge Management, Safely Managed Sanitation, Information Management System,WASH and Technology*

Wadah Partisipatif untuk Penyediaan Layanan Air, Sanitasi, dan Kebersihan di Fasilitas Pelayanan Kesehatan yang Adil dan Setara

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KATA KUNCI: WASH in HCF, WASH di Puskesmas, pendekatan partisipatif, akuntabilitas sosial, GESI, WASH FIT

LATAR BELAKANG DAN PERNYATAAN MASALAH

25.67% Pusat Kesehatan Masyarakat (Puskesmas) memiliki layanan sanitasi terbatas[1] di Indonesia, sedangkan di tiga kota program WASH SDG SNV Indonesia lebih dari 80% fasyankes termasuk Puskesmas juga memiliki layanan sanitasi terbatas[2]. Definisi layanan sanitasi terbatas mengacu pada *Joint Monitoring Program* (JMP), di antaranya adalah tidak adanya toilet terpisah laki-laki dan perempuan, dan antara pasien dengan staff, dan tidak ada toilet khusus penyandang disabilitas. Data tersebut juga menunjukkan bahwa aspek kesetaran gender dan inklusi sosial (GESI) masih kurang diperhatikan.

Penyediaan sarana dan layanan air, sanitasi, dan kebersihan yang inklusif di Fasilitas Pelayanan Kesehatan (fasyankes) memerlukan akuntabilitas dan ketanggapan yang kuat dari Dinas Kesehatan sebagai institusi pengampu dan manajemen fasyankes. Pelayanan yang tanggap dapat mendorong pemahaman mendalam tentang kebutuhan yang beragam sehingga dapat memenuhi kebutuhan tersebut, sedangkan akuntabilitas dapat mendorong kinerja yang lebih baik. Selain itu, akuntabilitas juga berkontribusi terhadap pelayanan yang berkelanjutan dengan melibatkan pemangku kepentingan dan menyebarkan informasi secara transparan.

METODOLOGI DAN HASIL

Melalui program WASH SDG, SNV Indonesia melakukan kajian di tahun 2020 untuk melihat kesenjangan antara peraturan yang ada di tingkat global dan nasional dengan praktiknya di tingkat kota. Kami menemukan bahwa peraturan di tingkat nasional dan global sudah tersedia, namun panduan praktik pelaksanaan di tingkat kota belum ada, terutama yang spesifik tentang

air, sanitasi, dan kebersihan[3]. Kami melakukan uji coba di 6 puskesmas di Tasikmalaya, Bandar Lampung, dan Metro dengan mengembangkan indikator penilaian untuk peningkatan sarana air, sanitasi, dan kebersihan. Setelah itu, kami menyelaraskan dengan alat WASH FIT dan mengadaptasi beberapa indikator berdasarkan hasil uji coba tersebut bersama puskesmas, termasuk juga menambahkan indikator tentang Manajemen Kebersihan dan Kesehatan Menstruasi (MKM).

SNV bersama mitra lokal telah membangun wadah partisipatif sebagai tempat berdiskusi, mendemonstrasikan komitmen yang kuat, serta berbagi informasi secara transparan antara Dinas Kesehatan Kota, puskesmas, dan masyarakat. Diskusi di wadah tersebut menghasilkan rencana tindak lanjut yang disepakati seluruh pihak untuk meningkatkan layanan air, sanitasi, dan kebersihan, yang kemudian dilaksanakan oleh pihak manajemen puskesmas.

Hasil penilaian dengan WASH FIT di tahun 2022 menunjukkan bahwa 6 dari total 14 Puskemas yang didampingi telah berupaya menyediakan toilet dengan desain universal (misal: menggunakan kloset duduk, melebarkan pintu masuk toilet agar kursi roda bisa masuk), menyediakan kebutuhan MKM di toilet (misal: pembalut, tisu, dan tempat sampah tertutup), dan menambahkan tangga kecil di sarana Cuci Tangan Pakai Sabun (CTPS) agar bisa dijangkau oleh anak-anak. Di Kota Metro, hasil perbaikan tersebut berhasil mendorong Dinas Kesehatan Kota untuk melakukan replikasi dengan berkomitmen untuk menaikkan alokasi anggaran hingga 30% di tahun 2023.

DISKUSI DAN REKOMENDASI

Melibatkan dinas pengampu dalam setiap kegiatan pendampingan penting untuk menciptakan rasa kepemilikan dari dinas sehingga bisa paham prioritas untuk replikasi sehingga kemajuan sanitasi bisa berkelanjutan. Kemudian, **menyelaraskan dengan visi dan misi kota** sehingga bisa mendapat dukungan penuh dari pemerintah kota terutama walikota untuk kedepannya mengalokasikan anggaran untuk replikasi. Selain itu juga dengan adanya arahan dari kepala daerah, akan mampu mendorong pemerintah kota dan jajarannya, serta fasilitas kesehatan untuk meningkatkan kapasitas dan pengetahuan mengenai WASH di fasyankes. Karena **pengetahuan dan kesadaran kepala puskesmas penting untuk meningkatkan komitmen** dimana wewenang untuk pengaturan pendanaan ada di kepala puskesmas.

KESIMPULAN

Pendekatan partisipatif penting untuk dilakukan di seluruh tahapan program mulai dari perencanaan, pelaksanaan, pemantauan dan evaluasi, serta penyepakatan rencana tindak lanjut. Harapannya, pendekatan ini dapat mendorong ketanggapan yang lebih baik, pengaturan penyediaan layanan yang kuat, dan peningkatan akses air, sanitasi, dan kebersihan di puskesmas yang adil dan setara.

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Menstrual health management campaign targeting community members and adolescents in South Sulawesi

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INTRODUCTION

Menstrual health management (MHM) deals with the specific hygiene and health requirements of women during menstruation. Water, sanitation and hygiene facilities appear to be inadequate in many school settings including in Indonesia. A program called “BERANI,” or Better Reproductive Health and Rights for All in Indonesia (UNICEF) was conducted from 2019 to 2021 in Bone, South Sulawesi, focusing on child marriage and menstrual health management issues. This study aims to explore the MHM campaign and the parents’ and adolescents’ responses to the campaign.

METHODOLOGY

The MHM campaign through the BERANI program was conducted in the six intervention sub-districts in Bone Regency, South Sulawesi. The communication materials focusing on child marriage prevention and menstrual health management issues were developed (e.g., board games, story books, ustadzah toolkit, and khotbah seragam). Adolescent children received the BERANI campaign through the Life Skills Education (LSE) activities at school delivered by teachers; while to reach parents and adults, a series of community meetings were conducted from September to December 2020. A mixed method research using quantitative and qualitative approaches was conducted. A total of 1,004 respondents and 1,000 respondents participated in the baseline and the endline study respectively (consisting of 50% were parents and 50% were adolescents aged 13-15 years). A total of 80 interviews and 12 FGDs were conducted.

RESULTS

Overall, a total of 1,490 community members were reached in the community meetings, consisting of 91.5% women (n=1,363) and 8.5% men (n=127). While for the school-based intervention, a total of 159 teachers and 5,022 children aged

13-15 years (2.598 girls and 2,424 boys) participated in LSE activities. There was an increase in the average score for knowledge related MHM from 5.30 (SD= 2.7) to 6.95 (SD= 3.5). Girls were more likely to have a higher level of knowledge on MHM compared to boys. Children in school were more likely to have a higher level of expertise related to MHM than children out of school. Children in higher grades were more likely to have a higher level of knowledge on MHM than those in lower grades. The qualitative study also found that some respondents mentioned the importance of providing menstrual pads at school so that girls can change the pads at school. In the qualitative study, parents stated that BERANI had promoted menstrual health management as after receiving the information on MHM, children, particularly girls become more open in discussing the MHM. The introduction of reusable pads was also considered as new and beneficial.

CONCLUSIONS

Overall, the BERANI program has improved adolescents' knowledge of MHM through Life Skills Education (LSE). Parents also responded positively to the campaign as they mentioned that the BERANI program has introduced them to the MHM topics so that they could discuss with their children. This study also suggests that men and boys can support women and girls to manage menstruation effectively. There is a need to continue promoting MHM with support from local government and relevant stakeholders.

Greenhouse Gas Emission (GHG) from onsite domestic wastewater treatment in Surabaya City

Mar'atusholihah and Ervin Nurhayati

INTRODUCTION

In Surabaya City, Wastewater treatment is dominated by onsite treatment using anaerobic treatment types such as septic tanks, latrine, and anaerobic baffled reactors (ABR). The anaerobic type is used because it has a high percentage of removal and produces less sludge. Unfortunately, septic tanks and pits latrine can contribute GHG emissions of 55 Mt CO_{2eq}/year or contribute 4.7% of the methane gas produced in the world in 2021. Meanwhile, aerobic type treatment (Centralized Wastewater Treatment Plant) has a smaller CH_4 emission factor than anaerobic, but indirect emissions in centralized WWTPs originating from the use of chemicals and building structures, and the use of electrical energy contribute 5% and 56% of the total WWTP emissions, respectively. Whereas at onsite treatment, indirect GHG emissions from sludge transportation have a GHG contribution of 2.5%. In previous research GHG emission inventory just calculated direct sources and uses the average Total Organic Wastewater (TOW) in Indonesia. Meanwhile, TOW specific in Surabaya are limited. Therefore, it is necessary to analyze the characteristics of domestic wastewater based on the type of treatment, to produce more specific direct GHG emissions. In addition, this study also calculates GHG emissions from indirect sources such as transportation of sludge and operational pump in wastewater treatment plant.

METHOD

Data collection with random sampling of wastewater treatment in Surabaya city. Based on technology used and influent of wastewater treatment (blackwater and greywater). Samples were analyzed using the Winkler method to measure Biochemical Oxygen Demand (BOD) concentrations and the Kjeldahl method to measure Total Nitrogen (TN). Then, concentration BOD and TN used to estimate direct GHG emissions CH_4 and N_2O, respectively. Calculated GHG emissions based on Intergovermental Panel Climate Changes (2019), where emissions factor of direct GHG are 0.33 kg CH_4/kg BOD (Septic tank), 0.48 kg CH_4/kg BOD (anaerobic reactor), 0.3 kg CH_4/kg BOD (Discharge WWTP), and

0.0052 kg N_2O-N/ kg N (Discharge WWTP). Meanwhile, indirect GHG emissions calculated from transportation sludge (from WWTP to Sludge treatment) and operational WWTP was electricity of pump based on IPCC and regulation in Indonesia. Emissions factor of transportation (light duty truck-diesel) and operational pump are 74100 Kg CO_2/TJ, 3.6 Kg CH_4/TJ, 3.6 Kg N_2O/TJ and 0.87 ton CO_2/MWh.

RESULTS AND DISCUSSION

The results of GHG emissions are classified into 8 types at village WWTP, 4 types on the restaurant WWTP, and 7 types based on the Rusunawa WWTP. There are ABR and Filtration with blackwater (BW) influent well operated and not operated, Anaerobic biofiltration with greywater (GW) influent well operated and not operated, ABR and Filtration with BW and GW influent well operated and not operated, septic tank well operated and not operated, septic tank and ABR and Biofilter with BW and kitchen wastewater (KW) well operated, not well operated, and not operated. The GHG emissions each type shown in the Table 1.

Table 1. Direct and Indirect emissions each group in Surabaya City.

Type Treatment, Influent, Operational	Total Direct Emissions (Ton CO_2-e/ yr)	Total Indirect Emissions (Ton CO_2-e/ yr)	Total GHG Emissions (Ton CO_2-e/ yr)
ABR + Filtration, BW, Operated	211.638	0.544	212.182
ABR + Filtration, BW, Not Operated	63.082	0.067	63.149
Anaerobic biofiltration, GW, Operated	0.718	1.802	2.519
Anaerobic biofiltration, GW, Not Operated	0.970	0.515	1.484
ABR + Filtration, BW+GW, Operated	683.183	0.940	684.123
ABR + Filtration, BW+GW, Not Operated	17.213	0.000	17.213
Septic tank, Operated	375.758	0.395	376.153
Septic tank dan ABR + Biofiltration, BW+KW, operated	81.543	0.829	82.372
Septic tank dan ABR + Biofiltration, BW+KW, Not Optimally operated	18.726	0.163	18.889
Septic tank dan ABR + Biofiltration, BW+KW, Not operated	7.715	0.126	7.841
Septic tank, BW, Not operated	407.862	0.582	408.444
ABR, BW, Not Optimally operated	171.493	0.282	171.776
ABR, BW+GW, Not Optimally operated	263.432	0.276	263.708

If data normalization is carried out based on the number of people served, it can be seen in Table 2.

Table 2. Normalization total GHG emissions with person each group in Surabaya City.

Type Treatment, Influen, Operational	Person	Total GHG Emissions (Ton CO_2-e/ person.yr)
ABR + Filtration, BW, Operated	6400	0.033
ABR + Filtration, BW, Not Operated	1530	0.041
Anaerobic biofiltration, GW, Operated	2656	0.001
Anaerobic biofiltration, GW, Not Operated	2496	0.001
ABR + Filtration, BW+GW, Operated	5405	0.127
ABR + Filtration, BW+GW, Not Operated	540	0.032
Septic tank, Operated	5204	0.072
Septic tank dan ABR + Biofiltration, BW+KW, operated	3148	0.026
Septic tank dan ABR + Biofiltration, BW+KW, Not Optimally operated	1118	0.017
Septic tank dan ABR + Biofiltration, BW+KW, Not operated	669	0.012
Septic tank, BW, Not operated	7980	0.051
ABR, BW, Not Optimally operated	2475	0.069
ABR, BW+GW, Not Optimally operated	2220	0.119

CONCLUSIONS

Total GHG emission from domestic wastewater in Surabaya was 2,303.33 Ton CO_{2eq}/year (direct emissions) and 6.522 Ton CO_{2eq}/year (indirect emissions). The GHG emissions from ABR and Filtration with combine system was (0.1414 ton CO_2/person.year) higher than anaerobic biofilter, septic tank with separated system and combine system. Whereas, WWTP treatment lowest contributed GHG emission is Anaerobic biofilter (greywater) amount of 0.0006 ton CO_2/ person.year. However, anaerobic biofilter (greywater) contributed higher pollution is freshwater/body water.

Relationship of knowledge of household attitude and behavior with household waste management in paringin district, balangan regency

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ABSTRACT

Proper and frequent handwashing with soap (HWS) has been proven effective to prevent the ransmission of SARS CoZV-2 and other infrectious diseases such as gastrointestinal and respiratory tract infections, trachoma, and hookworm infections. The implemented social restrictions and “5M” policy, including HWS, has been successful in lowering the number of COVID-19 cases in Indonesia. The decreasing COVID-19 cases has led to the easing of health protocols and social restrictions. However, precautions are important since increased mobility and euphoric behaviour can re-escalate COVID-19 cases. Against this background, we aim to investigate: (1) the level of HWS behaviours after the easing of COVID-19 restrictions; and (2) the effect of contextual, technological, and psychosocial factors to these behaviours. Focusing in urban Jakarta, this study combines RANAS (Risk, Attitude, Norms, Abilities, and Self-regulations) and IBM-WASH (the Integrated Behavioural Model for Water, Sanitation, and Hygiene) frameworks. This study used a validated questionnaire with five main components: (1) respondent attributes; (2) behavioural items; (2) psychosocial factors; (3) contextual factors; (4) technology; and (5) HWS behaviours as the mixed effect of the first four components to HWS behaviour has limitedly studied. Using a snowball sampling strategy, 316 urban Jakarta residents participated in this research.

A descriptive analysis was performed to understand the distributions of the data. Using the three-box method, low, moderate, and high levels of HWS behaviours were determined. A principal component analysis (PCA) was applied to reduce the dimensions of the data. Independent variables (i.e. psychosocial, contextual, and technological variables) were then regressed to see which factors have a major influence on the implementation of hygiene behaviour by bootstrapping technique. The results revealed that 62% of the respondents have high HWS behaviour, even after the easing of COVID-19 restrictions. The regression

analyses indicate that if the independent variables were regressed separately, psychosocial factors have the highest influence on hygiene behaviour (adjusted R2 =0.507). However, the combinations of the effects of psychosocial, contextual, and technological factors provide the highest adjusted R2 (0.520). This study further provides recommendations in all areas of Risks, Attitude, Norms, Abilities, and Self-regulations (RANAS) using the standard Behavioural Change Technique (BCT) table. The results should be considered in designing health behaviour promotions and interventions, especially in regard to maintaining personal hygiene behaviours in the post-pandemic situations.

The chronotope of city: Exploring the jurisdiction game of water privatization in Jakarta, Indonesia

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KEYWORDS: *Chronotope*, Jakarta, spatial jurisdiction, water management, temporality

BACKGROUND

Legal geographers suggest that there is an inextricable nexus between law and the city—a constantshaping/reshaping interaction between the 'spatial' and the 'legal'. This article suggests that city isan aesthetic representation of jurisdiction over resources construed upon a spatio-temporal configuration of lived experience. Specifically, this study is interested in demonstrating the role oflegal temporality in understanding water resource governance in Indonesia. It investigates water governance within Mikhail Bakhtin's *Chronotope*, read as the way legal techniques employed by legal actors to synthesize the spatial and temporal frame of the inquiry which in turn shapes their imagination in assigning meaning to 'jurisdiction' of a city. In that sense, suggested by governmentality studies, jurisdiction should be understood not exclusively in terms of juridico-normative discourse, but rather as a network involving a wider range of actors—state and non- state. It is therefore about jurisdiction games: a determination of who, what, and how of governance.

PURPOSE

This article contends that legal temporality shapes the spatial jurisdiction of a city through navigating what I call Experiential View of time. Experiential View does so by enabling legal actors' creativity to hybridize different linguistic aspects of consciousness so that they can assign meaning and value to certain objects of inquiry. Such a view is basically a contention of the traditionalChronological View that grasps spatial jurisdiction as a static and irreversible element of a city. This article aims to serve several purposes, that is, to (1) extrapolate the concept of legal temporality into the discourse of spatial jurisdiction, (2) identify aesthetic elements of a city that is informed by linguistic aspects employed by legal actors in a

caselaw, and (3) investigate the (spatial)jurisdiction games of a case related to the city's water governance.

METHOD

This article demonstrates an interdisciplinary approach, ranging from doctrinal law, philosophy of time, and cultural geography. My focus is to understand the way judges (from the lower Courts up to the Supreme Court) frame time and temporality of water governance in the *Jakarta Water Privatization* citizen lawsuit (2015-2017). By extrapolating Henri Bergson's theory of time as duration to the theory of *Chronotope*, this study identifies several temporal narratives that reflect or symbolize time as citizen's lived experience. In the decisions, the courts of law hybridize four different aspects of temporal narratives regarding privatization over water governance in Jakarta, including: economic (company shortfall), management (public-private affairs), legal (contract validity), and rights (quality, quantity, and continuity of water service).

FINDINGS AND CONCLUSION

This semantic analysis helps us understand the way in which the courts assigned meaning and value of qualitative elements of water governance in the city. Understood in this way, water (spatial)jurisdiction pivots on the lived experience in the city, asserting a conflation of the past, present,and future of the citizens' lived experience. We may furthermore claim that Jakarta's water governance is essentially an image of spatio-temporal configuration of lived experience. By assigning city in the *Chronotope*, we could understand that the issue of city's resources managementis not only about *who* and *what* of governance, but also *how* it is being exercised.

The presence of mixed SMX and TMP in the water and sediments of a shrimp aquaculture area in Yunlin, Taiwan

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Aquaculture is one of the most sustainable sources of fish protein for humans, but production must increase by 50% by 2050 to meet global demand. Intensive shrimp culture requires lots of shrimp food and antibiotics to boost production and prevent disease. Farmers mixed antibiotics into shrimp and fish feed. Antimicrobial residue in shrimp and fish can result from feed mixing. Most aquaculture antibiotics are directly released into aquaculture water or surrounding water due to limited absorption efficiencies, posing an ecological risk to aquatic organisms. Aquatic antibiotic residues in the environment are usually mixtures.

Trimethoprim (TMP), used in cotrimoxazole (ratio 1:5) with sulfamethoxazole (SMX), was also found in the water. TMP and SMX residues in shrimp pond water and mud were high due to overuse and misuse of antibiotics. In the mud, TMP and SMX concentrations varied widely. These studies indicate that SMX, TMP, and their combinations in aquatic environments may be harmful. Environmental fate studies are needed to understand antibiotic transformation rates. SMX-TMP transformation in aquaculture must be better understood than in other aquatic environments. Thus, applying the policy to animal medication SMX and TMP transformation ratesis crucial.

We examined the effects of illumination, oxygen levels, and microbial activity on SMX- TMP mixtures (SMX_{mix}; TMP_{mix}) in sediment and water. Antibiotic fates in aquaculture ponds are revealed. Shrimp (*Litopenaeus vannamei)* ponds in Yunlin County, southwest Taiwan, provided sediment and water samples. High-performance liquid chromatography (HPLC) detected the antibiotic content

in the samples and was provided for calculating the half-lives of SMX and TMP. The standards of SMX were 50, 25, 10, 5, and 2 mg/L, and TMP was 10, 5, 2, 1, and 0.4 mg/L. SMXmix and TMPmix's t*1/2* in water were significantly slower than in slurry. In the SMXmix, with anaerobic sterile (191 d in water and 175 d in sediment slurry) and non-sterile (173 d and 39 d in water and sediment slurry, respectively). Moreover, in the aerobic treatment, TMPmix was 2-3 times slower in the water than in the sediment slurry, both in sterile and non-sterile conditions.

It is generally believed that light has little to no effect on the photodegradation of pharmaceuticals in soils and sediments because water, solid particles, and organic matter impedelight penetration. Biodegradation is an important route for antibiotic elimination. The fact that SMX and TMP degraded more rapidly in non-sterile soil suggests that biodegradation may accelerate the removal of antibiotics from the soil. Other variables, such as the physiochemical properties such as the composition of the soil, and environmental factors, can also affect degradation. Most antibiotic persistence in soils depends on soil characteristics, such as organic matter content, pH, moisture, temperature, oxygen status, and soil texture.

KEYWORDS: *Sulfamethoxazole, Trimethoprim, Mixed-Antibiotics, Biodegradation*

Analysis of packaged drinking water use in Indonesia in the last decades: trends, socio-economic determinants and safety aspect

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BACKGROUND

Packaged drinking water (PDW) is one of drinking water options that is widely consumed and has grown in recent years. Global PDW consumption is estimated to increase by 513 billion liters in 2025. Meanwhile, in Indonesia, the consumption of PDW was increasing. The determinant factor of the rising trend of PDW use in Indonesia was uncommon. The increase in PDW consumption is not paralleled with water security. People considered that PDW was the safest source of water. Unsafe and poor-quality of water leads to waterborne illnesses, e.g., diarrhea, malnutrition, and cognitive development. The purpose of this study is to examine the trends in PDW consumption over the last two decades as well as the socioeconomic determinants of PDW consumption in Indonesia.

METHODS

We conducted linear regression to estimate the future PDW consumption in Indonesia and bivariate Pearson correlation to reveal the correlation between economic and population growth. We used data from Indonesian statistics in this analysis. We also conducted logistic regression to find significant socio-economic determinants of PDW consumption from the Indonesian Demographic Health Survey (IDHS) 2007, 2012, and 2017 datasets. In addition, we conducted a systematic literature review (SLR) on the analysis of PDW safety aspects. The keywords collected for the match paper came from three databases: Pubmed, Scopus, and ScienceDirect using the keywords "water quality" AND "commercial drinking water" OR "packaged drinking water" OR "potable drinking water" OR "refilled drinking water" OR "bottled drinking water" OR "fecal contamination" OR "Escherichia coli" AND "Indonesia." The SLR process used the PRISMA guidelines in the analysis.

RESULT

This study found that the increasing rate of PDW consumption per year in Indonesia was 1.24% from 2000 to 2020 annually, and 50% of the Indonesian population is predicted to consume PDW in 2026. The increasing use of PDW in Indonesia was significantly associated with the economic growth of the country, i.e., proxied by the gross domestic product and urban population. Logistic regression analysis results that the age of the household head, mother's educational level, father's educational level, wealth index, type of residence, regions, and type of toilet facility were significantly associated with PDW usage. The type of residence, wealth index, and regions were considered to have the largest influence on PDW consumption, i.e., the highest values, in all three dataset comparisons. A systematic literature review found nine eligible studies, and six studies found fecal contamination in the PDW.

DISCUSSION/IMPLICATIONS

The analysis revealed that the trend of PDW consumption in Indonesia is strongly correlated with the economic growth level of the country, proxied by urbanization and GDP levels. We argue that the economic growth of a country indirectly influences one's working time, i.e., increased working time, limits spare time, and makes them choose a time- and cost-efficient drinking water option, i.e., PDW. Urban households were more likely to consume PDW compared to rural households. For starters, urbanization increased the accessibility of PDW producers or markets, whereas access to PDW in rural areas was more difficult due to limited infrastructure. Moreover, there is a tendency among the urban population to consume ready-to-use drinking water, i.e., PDW. Moreover, the increased educational levels of parents may lead to increased awareness of the benefits of PDW as the main source of drinking water, e.g., quality, convenience, and affordability.

Exposure to mass media has no discernible relationship with PDW consumption. The increased PDW consumption in the neighborhood may create a norm, i.e., social pressure to use PDW, which will create a 'reinforcing effect' and rapidly increase PDW consumption, as discussed in the context of household water treatment (HWT) behavior in developing countries. Another set of significant variables is income, educational level, and urban area. In light of this finding and other study findings, we conclude that young people in urban areas will continue to dominate the PDW consumer market in the future. These young people can then be a potential target of intervention aimed at improving PDW safety in Indonesia, e.g., by educating them to always keep their PDW dispensers clean. Half of the analyzed samples were fecally contaminated with low to medium-risk fecal contamination, and one study had a high risk of fecal contamination. Unsafe drinking water threatens human health, and diarrhea is the most common disease that occurs through water transmission. Approximately 11% of children's deaths are caused by diarrhea from unsafe drinking water. Our statistical analyses confirm that PDW is associated with fewer diarrhea cases in children, although PDW is not always safe, which could be because other types of water sources have worse water quality than PDW and are not treated. However, improving the quality of PDW and minimizing recontamination to reduce the risk of diarrhea in children is critical because PDW causes diarrhea in children.

CONCLUSION

There is a fast increase in PDW consumption in Indonesia, and 50% of people in Indonesia are expected to consume PDW in 2026. The increasing PDW consumption in Indonesia was strongly associated with the economic growth of the country, which is represented by the GDP and urban population. Regression analysis revealed that socio-economic characteristics, including the age of the household head, the mother's educational level, the father's educational level, the wealth index, the type of residence, and the type of toilet facility, significantly predict PDW consumption. Our findings indicate that young people in urban areas may dominate the PDW market in the future. Moreover, past studies revealed a high chance of fecal contamination in the PDW, suggesting the need to better regulate and implement the hygienic procedure of PDW production, distribution, and storage, i.e., before reaching the consumer, in Indonesia. Finally, people can perform HWT and make sure that the water dispenser and the surrounding area are hygienic to prevent recontamination at the household level.

Personal and Environmental Factors in Menstrual Health Hygiene Practices Among Girls in Central and South Sulawesi

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INTRODUCTION

In Indonesia, menstrual hygiene in adolescents is still relatively inadequate. Due to a lack of accurate information, adolescents still have a limited understanding of the menstrual cycle and menstrual hygiene. Menstruation as a taboo topic to discuss in society, lack of clean water, sanitation, personal hygiene, lack of services, and infrastructure particularly in low- and middle-income countries are several problems related to menstrual hygiene among women and girls. There are five factors contributing to menstrual hygiene: biological, personal, interpersonal, environmental, and societal. This study will highlight two factors: personal factors (knowledge and behavior) and environmental factors (water, availability of sanitation, and hygiene facilities).

METHODOLOGY

The study was a baseline study for the BERANI (Better Reproductive Health and Rights) program. The study used a quantitative approach with a cross-sectional design. The participants consisted of adolescent girls aged 13–15 years in Central Sulawesi and South Sulawesi. A total of 483 respondents (249 respondents from South Sulawesi and 234 respondents from Central Sulawesi) joined the study.

RESULTS

Adolescent girls' knowledge about menstrual hygiene was still low. A total of 49.4% of girls didn't know that bathing when menstruating was good for health. Only 39.7% of girls looked for additional information on menstruation particularly on how to take a shower or clean themselves during menstruation. Most girls (84.9%) didn't want to change menstruation pads in the school

bathroom. Several reasons not to replace pads at school: 51.9% of girls reported that there was no trash can to dispose of sanitary napkins, 40.9% of girls reported that they were afraid of being spied on, 27.9% of girls reported that there were no pads at school. 20.2% of girls reported that the toilet was dirty, 11.7% of girls reported that the toilet door did not have a lock, 8.2% of girls reported that the toilet was mixed between boys and girls, and 5.5% of girls reported that there was no water and no bin. Regarding availability sanitary pads, 46.1% of girls reported that sanitary pads were not provided at school. Out of the girls who said school did not provide sanitary pads, 65.0% reported students must pay for sanitary pads. Out of girls who had experienced menstruation (72.9%), most of them (65.8%) did not attend school due to menstruation at least one day. The reasons include fear of dirtying the uniform (32.3%), feel sick during menstruation (18.2%), fear of smell (16.3%), no place for washing or changing pads in school (10.2%), fear of others mocking them (9.0%), and the school toilet was dirty (5.6%).

CONCLUSION

Girls' management confidence would increase if there is less stigma associated with menstruation in schools, as they will be more able to talk about their menstruation and seek peer support. Features of sanitation facilities that help menstrual management, such as disposal, lighting, and cleanliness, are crucial at home and school. Teachers and parents are expected to continue providing knowledge about menstrual hygiene to girls.

Safe Child Feces and Diaper Disposal Behavior Change Determinants in Rural Sekadau, West Kalimantan, and Urban Surabaya, East Java

Corie Indria Prasasti, Retno Adriyani, Sudarmaji, Muthmainnah, Indah Budhiastutik, Ayu Siantoro, Mita Sirait, & Charles Frans

People tend to think that toddler feces are harmless, allowing children to defecate in the open. They are also more likely to throw disposable diapers containing feces carelessly to the trash container, open field, or even river without cleaning the feces first. Meanwhile, cloth diapers were washed on the bathroom floor or public laundry where the feces are disposed of into an open drain for dirty water. According to the 2018 Indonesian Basic Health Research (Riskesdas) by the Ministry of Health, the proportion of unsafe child feces and diaper disposal is 33% in rural communities and 34% in urban communities. Improperly handled used diapers attract stray animals and fly infestation. Those cause harmful bacteria in feces to spread and increase the risk of disease in children, mainly diarrhea. Moreover, even though the house has a toilet, if they do not dispose of a toddler's feces and diaper safely, the family should be considered open defecating (OD).

Unsafe child feces and diaper disposal contributes to an unhealthy environment, such as polluting drinking water sources with feces and wastes. Disposable diapers contain chemicals and plastic as the main ingredients. Plastic pollutes the environment as they are difficult to decompose naturally, so they need to be separated from other solid waste, especially organic waste such as feces. Proper handling is needed to safely dispose of used diapers containing both plastic and organic materials. This can be done by separating or cleaning the feces in the diapers into the toilet hole or burying them, then throwing the cleaned used diapers into a separate trash container. Using adaptations of Health-Belief Model and Theory of Planned Behavior, this research aims to investigate determinants of the safe child feces and diaper disposal behavior change described in the former sentence by parents or caregivers of toddlers in rural and urban areas.

This research consisted of two studies, a quantitative survey and a qualitative focus group discussion (FGD). The dependent variable of this research is

toddler feces and diapers disposal behavior. The independent variables are 1) community characteristics (age, gender, occupation, education), 2) home environment conditions, 3) knowledge, 4) perceptions (perceived severity/ seriousness, perceived susceptibility, perceived benefits, perceived barriers, cues to actions, social norms, and self-esteem), and 5) preferred intervention strategies as the independent variables.

The household survey involved 508 respondents from Wahana Visi Indonesia ministry areas in five rural villages (*desa*) in 2 sub-districts (Nanga Taman and Sekadau Hilir) of Sekadau Regency, West Kalimantan (n = 257) and five urban villages (*kelurahan) in* 2 sub-districts (Simokerto and Kenjeran) of Surabaya City, East Java (n = 251). The majority of respondents are young mothers (20-30s years old) who are housewives with elementary to secondary education and below 5 million rupiahs household income. The household respondents were selected using purposive sampling with having toddlers as the main criteria. Exploratory factor analysis, path analysis, and regression were conducted for the quantitative data.

Furthermore, eleven FGD sessions were also conducted in the two study areas, five in rural Sekadau and six in urban Surabaya. Four FGD sessions involve toddlers' parents or main caregivers (mostly mothers) as the priority group to perform the behavior change. Seven FGD sessions involve groups who can influence the priority group on whether to perform the expected behavior, which are family members (e.g., husbands or the toddler's fathers); health cadres and healthcare professionals; faith, custom, and community leaders; and government health offices representatives. Thematic analysis was employed for the qualitative data.

Survey results showed that unsafe child feces and diaper disposal reached 63.43% in Sekadau, and 51% in Surabaya. This happened even though access to 24-hour clean water in Sekadau reached 94.16% and 95.22% in Surabaya. Respondents in both study locations above have more than 90% access to sanitation. However, 99% of Sekadau respondents have no access to waste management, while 92% of Surabayans have it. Perceived severity/seriousness are significant determinants in both urban and rural locations, showing that parents/caregivers would be more likely to perform safe child feces and diaper disposal if they believe the severity/seriousness of health risks caused by improper toddlers' feces and diaper handling. As perceived barriers are also significant, parents/caregivers would be more motivated to dispose of child feces and diaper disposal safely if the barriers are minimized (e.g., reducing household chores). Yet, it was social norms and myths (e.g., throwing used diapers into the river to avoid *suleten* skin disease in toddlers) found to be more potent in Sekadau and Surabaya. The effects of community and government norms appeared to be stronger in Sekadau, while social norms in family and neighborhood are more influential in Surabaya.

While the survey indicated that parents/caregivers' knowledge regarding safe child feces and diaper disposal is sufficient, FGD participants, especially in Sekadau, expressed the need for clearer socialization and firmer regulations. In both study locations, programs and regulations governing child feces and diaper disposal are indeed lacking. The only policy is regarding household waste management, mostly in urban areas. In fact, waste management facilities are rarely available in rural areas. Furthermore, healthcare workers, health cadres, and waste management officers still need specific information and technical knowledge regarding safe and healthy management of disposable diaper waste. Interactive education (videos, games, competitions) is needed for sustainable interventions related to the techniques of managing child feces and diaper waste and unraveling myths at the family and community level. Multisectoral actors, including the disposable diapers industry and mass media, need to be involved in behavior change intervention.

Child feces and diaper disposal behavior requires special attention to create a clean and healthy environment. Demographic factors such as age, knowledge, and education affect feces disposal behavior perceptions in both urban and rural areas. Perception will encourage certain child feces disposal behaviors; therefore, it is necessary to change child feces and diaper disposal behavior in accordance with demographic factors and community needs.

Business and Behavioral Aspects of Drinking Water: A Systematic Literature Review and Research Agenda

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INTRODUCTION

As the population grows and the environment is further altered by climate change, fresh and clean drinking water availability decreases (Fida et al., 2022). Safe drinking water remains inaccessible to around 1.1 billion people worldwide, and biological pollution of drinking water causes 400 child fatalities each hour (Gadgil, 1998). Globally, the growth of society and industry is closely tied to the availability of water (Ruffino et al., 2022). Drinking water is a vital commodity in human life. The increasing scarcity and decreasing quality of drinking water must be addressed immediately. The study and technology of drinking water is a concern that continues to grow today. Since the creation of drinking water regulations, institutional and individual research on the topic has increased dramatically (Reddy, 2022). However, reviews of drinking water from a business

and behavioral perspective still need to be made available. Hundreds of study papers utilizing the same theories, metrics, and procedures have been published. One of the primary objectives of a review article is to identify critical research gaps based on which concepts, theories, and methods are extensively utilized in various settings and in which contexts (industry and nation) studies have been conducted (Paul & Rialp, 2020). The use of a systematic method in mapping the issues to be raised is expected to significantly contribute to knowledge, especially on the topic of drinking water from a business and behavioral perspective.

METHODOLOGY

This paper conducting a systematic literature review (SLR) to answer research questions within the domain of drinking water. SLRs are distinguished from other forms of reviews by adopting a procedure that is reproducible, logical, and transparent (Raghu & Rodrigues, 2020). A literature review article provides a complete assessment of relevant literature and synthesizes previous studies to build the foundation of knowledge (Paul & Rialp, 2020). The approach and presentation of systematic reviews are systematic and replicable (Siddaway et al., 2018). Important aspects of systematic literature reviews include a controlled execution of the review and a high level of openness regarding the review methodologies used (Hiebl, 2021). High-quality literature reviews collect, synthesize, and evaluate one or more literatures to provide an overall sense of the extent, nature, and quality of evidence in relation to a specific research issue, exposing the gaps between what we know and what we need to know. Literature reviews have the potential to make sense of large quantities of scientific data and are frequently highly cited and influential (Siddaway et al., 2018). Existing knowledge serves as the foundation for all academic research endeavors, regardless of discipline. Therefore, all academics should prioritize doing so accurately. However, the complexity of this undertaking has increased. Knowledge production in business research is rising at a phenomenal rate while staying fragmented and inter-disciplinary. This makes it difficult to keep up with cutting-edge research and remain on the cutting edge, as well as to evaluate the collective evidence in a given research field. This is why the literature review is more important than ever as a research method (Snyder, 2019)

Defining research questions (RQs):

1. What are the business aspects of drinking water studies?
2. What are the behavioral aspects of drinking water studies?
3. What directions and suggestions for future research agenda?

Databases that did not allow the search items along with Boolean operators or databases that denied access to full articles were not included.

Selection and quality assessment:

- Inclusion criteria
- Exclusion criteria

RESULT

Our research demonstrates that prior studies have not addressed every aspect of drinking water's complexity. In addition, the results imply that business and behavioral theories that can enhance our understanding of drinking water should be investigated. We feel that our research gives valuable insight into the condition of existing drinking water management literature, which is crucial given that drinking water is an essential human requirement at all times.

It is a fast-expanding phenomena that has demonstrated its ability to create intriguing and engaging business and behavioral solutions. As methodologies evolve, we invite future research to evaluate the generalizability of our findings to domains other than management and applied psychology and to refine and update our checklist to reflect the state of the art in terms of best practices for methodological literature reviews.

CONCLUSION

Our assessment reveals that past research has not addressed every aspect of the complexity of drinking water. In addition, the results imply that business and behavioral theories that can enhance our existing understanding of drinking water should be investigated. We feel that our research provides valuable insight into the current state of drinking water management literature, which is essential because drinking water is a constant human necessity.

It is a rapidly expanding phenomena that has shown to offer entertaining and persuasive economic and behavioral solutions. As methodologies evolve, we invite future research to evaluate the generalizability of our findings to domains other than management and applied psychology, and to refine and update our checklist to reflect the state of the art in terms of best practices for methodological literature reviews (Aguinis et al., 2020). Developments in methodological literature review need that researchers continually enhance their methodological toolkits. (Aguinis et al., 2020)

KEYWORDS: Drinking Water, Business, Behavior, Systematic Literature Review

Kinetic study of domestic wastewater treatment by filtration using coconut (Cocos nucifera) fibers

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BACKGROUND

Domestic wastewater that has not been treated poses a number of hazards to both people and the environment. Poor sanitation affects a nation's economy, particularly in emerging nations. Therefore, it is necessary to use low-cost and widely available solutions to remedy poor water quality in developing countries. Coconut fiber is widely accessible and regarded as a renewable resource. Its availability is more affordable than that of other synthetic fibers, which encourages its use in a variety of applications.

The main objective of this study is to evaluate the effect of hydraulic retention time (HRT) and media thickness to TSS removal and investigate kinetic study of TSS removal in domestic wastewater using coconut fiber. This investigation will

help find the best kinetic models to design full-scale of coconut fiber reactor to achieve optimum sizing and predict the TSS concentrations of the effluent, which have not been discussed in the literature.

METHODOLOGY

Sample collection and analytical methods

Two hundred litre (200 L) of the domestic wastewater was collected from four urban drainage station in a residential near Universitas Negeri Medan. After that, wastewater is homogenized by being combined in one tank. This study used four sampling points. The standard method for wastewater collection in Indonesia is SNI 6989.57:2008. Samples were collected in 230 L drum then, the drum were transported to the laboratory for characterization and experiment.

Characterization of sample including TSS and Scanning Electron Microscope-Energy Dispersive X-Ray (SEM EDX) analysis. TSS parameter was examined on the basis of oven-drying at 103–105 °C (SNI: 6989.3:2019). SEM EDX analysis is to see the morphology of coco fiber media. In the SEM analyses, coco fiber sample was coated with a thin layer of gold and mounted on a copper stub using a double-stick carbon tape. The sample was then scanned by a SEM model S-3000N (Hitachi Company, Japan).

Lab-scale experiment

The reactor is following (Mulyana et al., 2021). Briefly, the coconut fibers were filled in the polyvinyl chloride (PVC) reactor with height 120 cm and diameter 20 cm with HRT and depth variations, 1, 2, 3, 6, 12, 18, 24, 48, 72 hours and 20, 40, 60, 80, and 100cm, respectively.

Kinetic models selection and equations

A kinetic model simplifies the relationship of variables affecting TSS removal in domestic wastewater, which is applicable for the design of the units. Moreover, performance prediction and unit optimization are obtained by using chemical organic matter removal constant rates and their models. Substrate removal rate can be determined using first-order and second order as the most fundamental models.

RESULT

Effect of HRT and media thickness to TSS concentration

The result of total suspended solid concentration in different HRT and depth can be seen in the Figure 1. It can be shown that the higher HRT generate lower TSS concentration compare to shorter HRT.

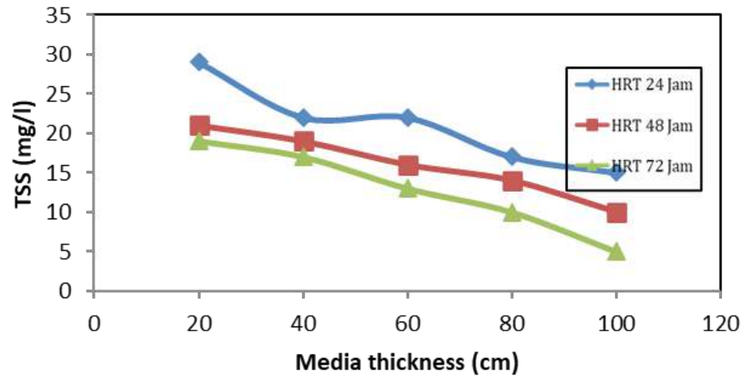

Table 1. TSS removal efficiency in HRT variations

Concentration (mg/l)	HRT (h)								
	1	2	3	6	12	18	24	48	72
S0	35	35	35	35	35	35	35	35	35
S	54	33	24	32	20	20	15	10	5
TSS Removal (%)	-54.29	5.71	31.43	8.57	42.86	42.86	57.14	71.43	85.71

The removal is getting better after 72 hours with an efficiency removal value of more than 85%.

Table 2. Kinetic of TSS removal in filter using coconut fibers

HRT (h)	Orde 1			Orde 2		
	R^2	q_1 (mg/gr)	k_1 (gr/mg jam)	R^2	q_2 (mg/gr)	k_2 (gr/mg jam)
24	0.9229	2.6×10^{13}	0.165	0.9229	6.06	0.00088
48	0.9851	2.9×10^{10}	0.135	0.9851	7.4	0.00075
72	0.9816	1.3×10^{10}	0.175	0.9816	5.71	0.00131

The most suitable kinetics in representing TSS removal data by coconut fiber is order 2 at 48 hours HRT, while the correlation test shows that HRT has no significant effect on TSS removal in domestic wastewater samples

DISCUSSION/POLICY IMPLICATIONS

This investigation will help find the best kinetic models to design full-scale of cocofiber reactor to achieve optimum sizing and predict the TSS concentrations of the effluent.

CONCLUSION

1. Coconut fibers can be recommended as an on-site TSS removal medium with a removal efficiency of 85.7%
2. The suitable elimination kinetics were of order 2 at 48 hours HRT (R=0.9851)

Socio-Ecological Barriers to Women Empowerment in Sanitation in Eastern Indonesia

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BACKGROUND

Water, sanitation and hygiene (WASH) program is a strategic entry point for gender mainstreaming, while gender sensitive WASH program can lead to a better WASH outcome [1, 2]. Frameworks have been developed to assist practitioner in improving and evaluating gender outcome in WASH program [3, 4]. However, practitioner need to understand the underlining barriers to women empowerment at different socio ecological level in community before implementing the intervention program. Socioecological model based on the Ottawa Charter frameworks has been used to understand barriers to sanitation access along the service stages [5, 6].

The socio ecological levels include structural, environmental, cultural, individual and service level, while the sanitation stages include acceptance, construction, utilisation, maintenance and safe reuse and disposal. Gender sensitive sanitation programs have been piloted in some parts of Indonesia, but has not been scale up to national level. Using a case study of national sanitation program (Sanitasi Total Berbasis Masyarakat – STBM) in Eastern Indonesia, this paper discusses barriers to sanitation access at each socio-ecological level using gender

empowerment lens. The experience in the area might assist practitioner to identify determinants before designing sanitation intervention with better gender outcome.

METHODS

A qualitative study was conducted in two districts, Central Lombok in West Nusa Tenggara and West Manggarai in East Nusa Tenggara) from June – August 2022. District of Central Lombok currently has been declared as Open Defecation Free (ODF) district with 100% sanitation access, while West Manggarai Barat has 71% sanitation coverage [7]. Data was collected from 4 FGD with women groups, 2 FGD with adolescent groups, and 30 in-depth interviews with local stakeholders related to WASH and GEDSI such as health/community cadres, formal and informal community leaders, community facilitators (local NGOs), and government staff. FGD and interview recordings were transcribed and analysed with thematic analysis using NVivo software. The findings were then verified and action plan was discussed in a workshop with key stakeholders at each districts.

FINDINGS AND DISCUSSION

Sanitation access, participation and related roles of women

In general, there has been an awareness that housewives, especially housewives with children, are the ones who deal with water and sanitation within the house and therefore are seen as having more responsibility regarding that matter. The absence of a sanitation facility within the house will induce the open defecation practice among women, including improper disposal of diapers due to a lack of trash bin. Even if sanitation facilities are available, women often complain that the facility is not comfortable or they lack privacy. They usually has the responsibility to clean the toilet while water availability is limited. This creates a double burden for women for other domestic chores they have in the houses.

Barriers to Women Empowerment in Sanitation

Structural barriers:

Although ideas regarding sanitation for women are present, the lack of explicit regulation at district level makes government officials hesitate to act. This is often because the current focus of the local government is still on increasing sanitation access for the general population. Moreover women organisation at the village level often have low power and only accept what has been decided for them. FGD participants mentioned that they were rarely invited, although they said that they are happy if they can participate in the meeting. This shows that when the program guidelines do not clearly regulate how and when to involve women, the women participation tend to be low.

Environmental barriers

Women limited mobility and house distance to village office often being a barrier to women participation in sanitation program. The setting and the time selected for program meeting sometimes do not match with housewives' daily schedule. Sanitation facilities are not supported with women needs such as not providing enough privacy and lack facilities during the menstrual period (covered trash bin and menstrual pad)

Cultural and Norm barriers

The voices of women are often unheard because of the cultural issue and the mentality of women themselves. Some participants suggested that the patriarchal culture in the area explains why women often hesitate to voice their opinion and why women opinion is seen as not important to be considered. This occur at both household and community level which create imbalance role in decision making and maintenance of sanitation access.

Individual barriers

There is lack of awareness of women rights to sanitation among participants at both community and government levels. Specific right to sanitation are somewhat absent in the policy discussion within the women empowerment sector. From FGD, participants reported that women's voices are being noticed the women are well educated and participated in the workforce. This suggests that if women have resources, skills or power, they are more likely to voice their opinions and sometimes leading an action.

Service barriers:

Although women's involvement in STBM has been extensive through the involvement of community health cadres, the capacity to facilitate gender transformative program is limited. The awareness and capacity of village women organisation is also limited regarding gender issues and how to address it in sanitation program.

Summary of barriers and and potential action strategies to address each level of barriers can seen in Table 1.

CONCLUSION

Barriers to women empowerment in sanitation program exist at different socio-ecological level. Those barriers are lack of commitment and clear guidelines,

women mobility, women roles in patriarchal culture, women lack awareness, low education and economic status and lack capacity of human resources with gender sensitive facilitation skills. Then, it requires action strategies addressing the barriers accordingly at different socio-ecological level to better integrate gender consideration in national sanitation program.

Table 1. Summary of barriers and potential action strategies to improve women empowerment in sanitation

Social Ecological Level	Barriers	Potential Action strategies
Structural	The lack of regulation, guidelines and its implementation that clearly assist how to involve women in each sanitation stages	*Building healthy public policy* Institution strengthening including improving political will and commitment, explicitly address gender issues in sanitation program guideline, optimization of budget availability to support gender sensitive process Improve coordination and collaboration among government and non-government organizations
Environ-ment / Infra-structural	Geographical/ infrastructural challenges to involve women in meetings	*Create supportive environment* Provide support for women mobilisation and prioritise gender sensitive sanitation infrastructure
Cultural and Norm	The voice of women are rarely heard due to patriarchal culture	*Community action* Strengthen the role of religious actors in education and empowerment programs Mainstreaming gender related WASH issues in the community by also involving male in gender transformation process
Individual	The lack of awareness of the rights for sanitation for women; Low level of education and income status	*Improve individual skill* Improving access to information through various media Establish a discussion forum for specific groups in the community, including women, young girls, and people with disability at the village level.
Service	The limited number and capacity of human resources to facilitate gender transformative sanitation program	*Re-orient program (service)* Improving awareness and capacity of government staff, village government, and community workers related to gender transformative process Establish and strengthen women organisations Provision of complete and updated data relevant to gender in sanitation

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Pembangunan Toilet Tahan Banjir Di Desa Pijot, Lombok Timur untuk Mendukung Sanitasi Berketahanan Iklim

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ABSTRACT

Indonesia sebagai negara kepulauan sangat rentan terhadap dampak perubahan iklim yang berpotensi membahayakan masyarakat. Menurut Bappenas, sebanyak 42 juta orang yang tinggal di daerah pesisir dataran rendah memiliki risiko dari dampak kenaikan air laut yang mencapai 150-450 mm pada tahun 2050. Desa Pijot, Kabupaten Lombok Timur merupakan salah satu daerah pesisir yang terdampak banjir akibat rob, pasang laut, serta curah hujan tinggi. Kondisi ini menjadi suatu ancaman bagi sistem air dan sanitasi mulai dari toilet, tangki septik, hingga instalasi pengolahan air limbahnya. Hal tersebut disebabkan karena perubahan iklim belum dimasukkan sebagai salah satu komponen yang dipertimbangkan dalam perencanaan pembangunan fasilitas sanitasi dan adanya keterbatasan masyarakat akan informasi mengenai bahaya iklim yang mengancam serta dampaknya terhadap fasilitas sanitasi.

Saat ini masyarakat di Desa Pijot baru pada tahap memiliki sanitasi layak, di mana setiap rumah memiliki kloset leher angsa dan penampungan tinja. Sebagaimana sanitasi layak pada umumnya, penampungan tinja yang digunakan belum kedap dan hanya berupa buis beton yang dasarnya tidak diberi perkerasan. Selain itu, toilet juga masih menggunakan saluran pembuangan lantai biasa yang terhubung langsung ke saluran drainase desa. Sistem sanitasi seperti ini, selain belum aman, juga rentan terhadap bahaya iklim seperti banjir. Air banjir dapat dengan mudah masuk ke penampungan tinja dan saluran drainase desa sehingga meluap dari kloset maupun floor drain. Hal ini menjadi salah satu penyebab lebih dari 14% penduduk di Kabupaten Lombok Timur masih melakukan praktik BABS karena sarana sanitasi yang tidak berfungsi.

Oleh karena itu, untuk mendukung sistem sanitasi yang aman dan berketahanan iklim, dibutuhkan sosialisasi dan pembangunan toilet yang tahan banjir. Penelitian ini bertujuan untuk membuat desain toilet tahan banjir serta melakukan pembangunan toilet tahan banjir di Desa Pijot.

Mitra penelitian ini adalah Lingkaran Pendidikan Alternatif (KAPAL) Perempuan hasil binaan LPSDM. Dari segi teknis, sebuah toilet tahan banjir perlu memenuhi tiga kriteria: mampu mencegah intrusi air pada saat banjir, mampu mengalirkan air buangan di tengah kondisi banjir, dan memiliki sumber air yang dapat beroperasi ketika banjir. Pencegahan intrusi air banjir dilakukan dengan peninggian bangunan toilet di atas muka air banjir serta pemasangan check valve pada jalur pipa sebelum kolam sanita untuk mencegah air banjir memasuki tangki septik dan kloset. Pengaliran air buangan saat kondisi banjir dicapai dengan menanam tangki air khusus yang berfungsi sebagai wadah tampungan baik untuk air buangan dari floor drain maupun air keluaran tangki septik pada saat check valve dalam kondisi tertutup. Pasokan air bersih dijaga dengan menempatkan pompa air serta toren pada dak atas toilet. Selain itu, untuk menjaga keamanan lingkungan, toilet menggunakan tangki septik prefabrikasi dan pengolahan tersier kolam sanita dengan tanaman Ekor Kucing (T. latifolia) dan bunga Tasbih (C. indica) yang berfungsi mengurangi kadar nitrogen dan fosfor pada air buangan. Keseluruhan desain dari toilet ini menggunakan alat dan bahan yang tersedia di pasaran untuk mempermudah proses pembangunan.

Penerima manfaat toilet tahan banjir ini berjumlah 30 Kepala Keluarga di Desa Pijot. Dengan adanya pembangunan toilet tahan banjir yang disosialisasikan kepada masyarakat penerima manfaat, diharapkan masyarakat lebih memilih untuk menggunakan toilet tahan banjir yang dibangun sehingga dapat mengurangi praktik BABS. Selain itu, diharapkan desain toilet tahan banjir ini ini dapat dijadikan acuan di daerah lainnya.

The impact of COVID-19 on women's access to water, sanitation, and hygiene in an Indonesian fishing village

W. Capri & N. Francis (Indonesia & Australia)

INTRODUCTION

This project sought to document the impacts of and response to the COVID-19 pandemic in Tambak Lorok,an urban fishing village on the coast of Central Java, Indonesia. In particular, the perspectives of women residents were prioritised to better understand the relationship between the pandemic, access to water, sanitation and hygiene (WASH) and changes in gender roles.

Several of the negative health, economic and social impacts of poor access to WASH, for example the burden of water collection; health consequences of lack of access to sanitation facilities and the increased risk of infection in health care facilities, are borne dispropritonately by women (Grant, Huggett et al. 2016).There is also increasing evidence that suggests that women are dispropritonately affected by the health, economic and social impacts of the COVID-19 pandemic (Al-Ali 2020, Azcona, Bhatt et al. 2020, Chang 2020). This includes increased violence against women, less access to sexual and reproductive health and decreased livelihoods for women who are overrpresented in the informal sector. Furthermore, women are bearing additional household burdens (for example childcare, cleaning, cooking, shopping and home- schooling) (United Nations 2020). Many of these additional household burdens are WASH-related given that hand hygiene is one of the most important strategies for preventing the spread of coronaviruses and extra water is needed for cleaning surfaces and clothing ((World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) 2020). Consequently, organisations such as UN Women have called for more data about the impacts of the pandemic to support the development and implementation ofgender-responsive policies globally (Azcona, Bhatt et al. 2020 p3).

This study focused on the experiences of women in Tambak Lorok: the largest urban fishing village in Semarang City which is on the north coast of Central

Java, Indonesia (Astuti and Handayani 2020). As with other coastal areas in Semarang, Tambak Lorok experiences high tides (locally referred to as *rob*) which lead to flooding of houses, roads and public transport systems as well as overwhelms local drainage systems (Ley 2020) and access to safely managed WASH is generally poor (Ley 2020).

METHODS

The research methods included a desktop analysis of online media relating to the pandemic and WASH from March to October 2020; participatory visual data creation and phone interviews with women residing in Tambak Lorok; and interviews with representatives of key institutions and organisations operating in Tambak Lorok. Two webinars were conducted to share and receive feedback about the initial findings: one with the female participants and another with representatives of key institutions together with some of the female participants. This last webinar was an important opportunity to bring residents together with policymakers to support the process of building trust, transparency and sharing information with key stakeholders from Tambak Lorok.

FINDINGS

Overall, the findings suggest that the pandemic has impacted residents' access to WASH to varying degrees and that the impacts of the pandemic are experienced by women and men differently. Prior to the pandemic, 62-percent of the participants' households bought water gallons for drinking (higher quality than other available sources) but due to income losses this dropped to 40-percent during the pandemic. There did not seem to be any indication that access to sanitation had changed substantially since the beginning of the pandemic. However, several participants noted that cleanliness had become more important during the pandemic than previously. Therefore, the inability to clean their toilets properly and the backwash of faeces from a lack of septic tanks (only 50-percent coverage in Tambak Lorok) and open defecation (due to the coastal flooding) was more concerning than usual. Access to hygiene has improved since the pandemic because there are now handwashing stations in front of most houses.

Of the participants, 75-percent reported that they (women) were responsible for all of the housework. Whilst this allocation of roles did not change during the pandemic, several participants reported that the *amount* of housework increased during the pandemic despite their husbands working less. For example, several women reported that the pandemic-specific tasks of keeping children at home, home-schooling and washing masks and clothes fell mostly to them. The findings also suggested that women were more responsible for health promotion and generating extra income when their husbands' work decreased.

CONCLUSION

Despite the impacts of the pandemic on the women participants' lives, the main challenge they identified was still *rob*, the daily coastal flooding that brings water into their houses, spreads faeces (due to open defecation and inadequate sewerage) and leads to infections. Even in the context of the pandemic, their main request of policy makers was to manage the coastal flooding and to do this in consultation with multiple stakeholders and in conjunction with other planned activities such as the Community-Based Total Sanitation (STBM) program.

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Life Cycle Assessment Approach to Evaluation the Performance of Wastewater Treatment Plant for Reuse Water in Surakarta

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BACKGROUND

Jebres Village is a village located in Jebres District, Surakarta City with the largest population of 32,974 people, there is no sewerage piping service (Burgos et al. 2021). In the Jebres village area, there is the largest university in the city of Surakarta, namely the Sebelas Maret University. Each college building uses an on-site disposal system, namely the disposal that flows into the septic tank with periodic drainage, while in the bathroom, washing and worship areas, the waste is channeled directly without processing into the building drainage channel. The channel also receives waste from residents in several areas in the Jebres sub-district and empties into the Bengawan Solo River. This causes a decrease in the quality and quantity of the river as a receiving water body, even though the Bengawan Solo River has become the community's raw water source when the need for clean water sources increases. Therefore, the Waste Water Treatment Plant (WWTP) has been built since 2017 on the campus as an

environmentally sound wastewater treatment system to deal with domestic wastewater at the campus & the Jebres area. However, each type of wastewater treatment plant has an impact on the environment from the treatment process or from the operating support equipment. Wastewater treatment plants have the potential to emit significant amounts of greenhouse gases, namely carbon dioxide (CO_2), methane (CH_4), and nitrogen oxides (N_2O) (Sazali, 2020).

METHODOLOGY

This study analyzes the environmental impact caused by the processing of domestic wastewater from the WWTP using the Life Cycle Assessment method. The data used is the burden of industrial wastewater treatment and fuel in the operation of the wastewater treatment building installation. The variables in this study are independent and dependent variables. The data used in this analysis are discharge and analysis results of wastewater treatment (enfluent) from the WWTP area at campus, waste water treatment process, content in the water treatment process (influent wastewater), chemicals used in wastewater treatment processes, production waste, and energy used. Dependent variable are consist of examples of environmental impacts resulting from research include: carcinogenic, respiratory inorganics, ionizing radiation, ozone layer depletion, non-carcinogens, respiratory organic, ecotoxicity, terrestrial ecotoxicity, aquatic acidification, aquatic eutrophication, terrestrial acid/nutria, land occupation, global warming, non-renewable energy and mineral extraction..

Data Processing with Life Cycle Assessment (LCA) on Simapro 9.1.0.11 Software The secondary data that has been collected is then analyzed using the LCA method with the help of the Simapro 9.1.0.11 software tool. Based on ISO 14040, the LCA method consists of 4 main phases, which are as follows as shown in Figure 1. Most of the published LCA studies on WWTP follow the attribution model approach. However, the use of consequential modeling has found increasing application for wastewater systems. For example, where the consequences of the system change the area of interest (e.g., implementing a new process technology, changing the sludge treatment process (Heimersson et al. 2019).

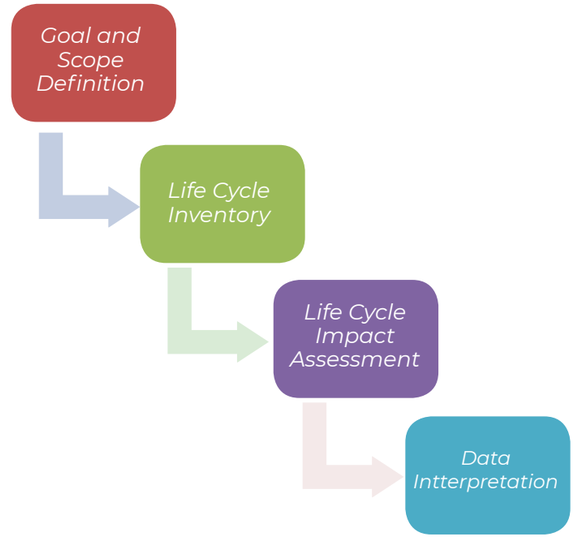

Fig 1. Life cycle assessment stage

RESULT

The results of data processing from the SimaPro software are divided into four assessments, namely network, characterization impact assessment, normalization impact assessment, and single score. Eco-indicator 99 generates 11 impact categories. Eleven impact categories were evaluated using a weighted basis according to a structural hierarchy perspective. The eleven impact categories are grouped into three categories of damage, namely human health, ecosystem quality and resources. The research location is in the WWTP service area of the Jebres Region which includes 5 RW areas, namely RW 10, RW 11, RW 12, and RW 14 in the Jebres area which has been disposing of domestic liquid waste into waterways that empties into the lake.

The following are sources of wastewater from campus, namely from students, lecturers and employees as well as the main and village communities around campus. The standard of water usage by students, lecturers and staff is 30 liters/day. The total discharge of wastewater produced is 1,293.6 m^3/day. However, as noon approaches there is a steady. Based on table 1, we can see that for all parameters the quality of wastewater is below the required quality standard. The regulation is the Minister of Environment Regulation No. 68 of 2016.

Table 1. Wastewater quality

No	Parameter	Unit	Results
1	BOD 5 days 20°C	mg/L	30
2	COD	mg/L	20
3	Total suspended solid (TSS)	mg/L	36
4	Oil & Grease	mg/L	1.47
5	Amonia (NH_3-N)	mg/L	9
6	pH	-	7.04
7	Total Phosphate (PO_4)***)	mg/L	1.2
8	Surfactants Anionic MBAS	mg/L	0.08
9	Nitrogen total	mg/L	10

These parameters include organic and nitrogen parameters, total phosphate and surfactants. There is a total coliform parameter that has not been measured which is an important parameter that forms the basis for whether the wastewater is in accordance with the quality standard or not. Wastewater contains a lot of total coliforms produced from black water and greywater. Figure 2 shows the inventory data entered into the software to see the performance of the wastewater treatment plant. When associated with the discharge of input and output wastewater it results in a pollution load.

Outputs								
Emissions to air	Subcompartment	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment
Add line								
Emissions to water	Subcompartment	Amount	Unit	Distribution	SD2 or 2SD	Min	Max	Comment
BOD5 (Biological Oxygen Demand), ID	groundwater	0.011232	kg	Undefined				
COD (Chemical Oxygen Demand), ID	groundwater	0.0262656	kg	Undefined				
Nitrate	groundwater	0.000019872	kg	Undefined				
Suspended solids, unspecified	groundwater	0.033696	kg	Undefined				
Iron	groundwater	0.000281664	kg	Undefined				
Manganese	groundwater	0.000124416	kg	Undefined				
Cadmium	groundwater	0.000068256	kg	Undefined				
Zinc	groundwater	0.000118368	kg	Undefined				
Lead	groundwater	0.00000432	kg	Undefined				
Nickel	groundwater	0.000010368	kg	Undefined				
Chromium VI	groundwater	0.000002592	kg	Undefined				

Fig 2. Inventory data

Environmental impact assessment data is processed using SimaPro 9.1.0.11 software, several stages are needed, namely the determination of goals and scope, life cycle inventory (LCI), life cycle impact assessment (LCIA), and data interpretation. The scope of this research is limited to the collecting well unit, the first settling basin, the floating substance tank, and the oxidation pond. At the Life Cycle Inventory (LCI) stage, input data is carried out in the form of the concentration of pollutant load from each processing unit and the discharge of each unit, as well as the amount of energy required for the installation operation process. At the Life Cycle Impact Assessment (LCIA) stage, the stage of determining environmental impacts is divided into several stages, namely characterization, normalization, weighting and single score. The results of data interpretation will show the impact of the process on further improvement. The data included in this study is data obtained from the WWTP center.

CONCLUSIONS

The results of processing with Life Cycle Assessment produce information in the form of network, characterization impact assessment, normalization impact assessment, and single score. Of the 4 inputs, the wastewater treatment process activities that contribute the most to the environmental impact are the emissions generated from processing raw water into clean water, the use of natural gas or electrical energy. The use of electricity indirectly affects the categories of reduction of natural resources (fossil fuels) and human health (climate change) due to CO_2 combustion. The largest use of electricity/energy is due to the use of pumps with large power at the stage of taking water raw materials and the long shipping distance from the intake to the Water Treatment Plant.

WASH Access or Behavior? Which one contributes to the children under 5 years old's nutritional status? A situational analysis for Children are Well Nourished Technical Program in 15 Districts in Indonesia

Mita Sirait, Asi Lusia, Sherly Vantono

BACKGROUND: Stunted is still a problem in Indonesia. The prevalence of stunted in Indonesia has indeed decreased to 24.4% based on the results of the Indonesia Nutrition Status Survey (SSGI) in 2021 compared to the results of the 2018 Basic Health Research, which was 30.8%. However, although the prevalence of stunted has decreased nationally, the prevalence of stunted in Indonesia is still varied. There are still districts/cities with a high and very high stunted prevalence in Indonesia.

The variation in stunted prevalence in Indonesia is most likely related to the size of Indonesia's territory. A country with 38 provinces and 514 districts/cities having different regional characteristics, demography, economic level, regional topography, customs, education level, etc. Coupled with the gap between rural and urban areas, which is also still a classic problem in Indonesia. With these differences in characteristics, any program to address stunting issues in Indonesia will obviously be a challenging intervention.

The Indonesian government has set a reduction in stunted prevalence to 14% by 2024. To that end, several strategies have also been set up by the Indonesian government as stated in the National Strategy for the Acceleration of Stunted Prevention 2018-2024. In line with that, Wahana Visi Indonesia (WVI) has also set a country's strategic direction for 2021-2025 where one of the priorities is improving the nutritional status of children aged 0-5 years with intervention known as the Children are Well Nourished Technical Program (CWN TP). It aims to improve feeding and caring practices for families with 0-59.99 month-old children, improve food security among families, and improve disease prevention for children, families, and communities by employing Positive Deviance Hearth (PDH)+ project model, Integrated Water Sanitation & Hygiene (WASH) project model, Saving for Transformation (S4T) project model, and Citizen Voice and Action (CVA) project model.

METHODS: WVI conducted a baseline to determine the initial state of the area prior to the CWN TP implementation in 13 Area Programs (AP) in 15 districts and 5 provinces and 4 zones (West Kalimantan, NTT - Flores, NTT Bamora, Sambawa). The locations were Nias Selatan, Bengkulu Selatan, Simokerto, Ende, Manggarai Barat, Manggarai, Manggarai Timur, Nagekeo, Ngada, Sumba Barat Daya, Kupang, Timor Tengah Selatan, Melawi, Sintang and Sekadau. The objective of the study was to gain situational analysis that focused on WASH and nutritional status for setting up standard indicators and priority intervention.

The study employed 30 clusters x 7 households (HH) survey using cross sectional design study. The respondents were caregivers who had under five children. It used the probability proportional to size (PPS) method as a sampling method to determine the 30 clusters. The total number of samples in this study was 5,250, the number of samples taken from each AP was 210. The data was analyzed descriptively at national level and used statistical inferences according to analysis plan. WVI developed and used structured questionnaire as the tool to collect the data and using KOBO Collect for data entry. Data analysis was done using SPSS, Microsoft Excel, and Power BI.

RESULTS AND FINDINGS:

Respondent Characteristics

Based on the study, there were 2956 children under five with total boys 1483 (50.17%) and girls 1473 (49.83%). Data segregate by sex and age divided by 3 groups, under 6 months, 6-23.9 months, and 24-59.9 months years old (Table 1).

Table 1. Data Distribution of Children under five by sex and age (N=2956)

Age group	Boys n (%)	Girl n (%)	Total
< 6 months year old	139 (50.18%)	138 (49.81%)	277
6 - 23.9 months year old	404 (50.81%)	391 (49,18%)	795
24 - 59.9 months year old	940 (49.89%)	944 (50.10%)	1884
Total	1483 (50.17%)	1473 (49.83%)	2956

Nutritional Status

Nutrition status from 13 Area Program intervention was assessed by stunted, wasted, and underweight. Total the prevalence of stunted (43.4%) was higher than prevalence of underweight (28.03%) and wasted (16.4%). TTS was the highest stunted followed by Manggarai and Kupang. Moreover, TTS and Kupang are highest wasted.

Table 2. Nutrition Prevalence by Area program

AP	Stunted (%)	Wasted (%)	Underweight (%)	Diarrhea
Nias Selatan	39.8	16.8	22.3	21.8
Bengkulu Selatan	23	14.2	14.2	7
Simokerto	27.2	18.9	26.7	14.4
Ende	47.3	12.8	26.6	2.6
Manggarai Barat	55.6	6	20.5	12
Manggarai	45.1	15.8	22.8	5.6
Manggarai Timur	43.9	20.4	25.5	6.2
Nagekeo Ngada	41.9	13.1	25.8	1.4
Sumba Barat Daya	44.9	28.8	35.1	8.9
Kupang	53.4	15.1	38	6.7
TTS	60.5	21	45	3.8
Melawi Sintang	37	16	29.8	10.4
Sekadau	45	13.9	32	8.6
Mean (Med-Max)	43.4 (44.9 – 60.5)	16.4 (15.8 – 28.8)	28.03 (26.6 – 45)	8.4 (7 – 21.8)

Prevalence Diarrhea of children under five in last 2 weeks from the survey is 8,3% (CI: 7,36% - 9,5%; n=222) with 55% of boys and 45% of girls. However, the prevalence of Diarrhea on children under five by zone indicate that Sambawa zone is the highest with 14.6%.

Table 3. Distribution of Prevalence Factors affected Nutritional Status of Children U5

AP	HH using a basic sanitation facility	HH using basic drinking water facility	HH have effective options for solid waste treatment	HH doing wastewater management	HH practicing processing safe drinking water	Parents practicing Hand washing with soap
Nias Selatan	23.6	72.7	3.2	15.7	48.1	56.9
Bengkulu Selatan	72.4	44.3	5.4	39.9	66.5	43.3
Simokerto	65	60.4	97.2	13.4	37.8	46.5
Ende	40.9	75.9	8.6	25.4	58.2	56
Manggarai Barat	42.1	72.2	41.6	35.9	71.8	62.2
Manggarai	40.4	58.6	22.7	40.4	52.7	61.1
Manggarai Timur	25.9	60.4	41.6	43.7	44.7	57.9

Nagekeo Ngada	46.2	69.3	12.9	25.8	36	62.7
Sumba Barat Daya	0.4	80.5	7.4	2.6	9.5	31.2
Kupang	58.1	19.1	0.5	0.5	60.5	4.7
TTS	40	31.9	9	39	47.6	7.1
Melawi Sintang	44	33	5.2	31.4	50.3	44
Sekadau	57.7	50.2	9.3	28.6	64.3	63
Mean (Med-Max)	42.8 (42.1-72.4)	56 (60.4-80.5)	20.4 (9-97.2)	26.3 (28.6-43.7)	49.8 (50.3 – 71.8)	45.9 (56 – 63)

The highest percentage of parents who wash their hands properly was in the NTT-Flores zone (58.9%). The proportion of HH practicing safe household drinking water at national level was 49.57% (CI: 47.69% -51.45%), only 20.21% (CI: 18.73% - 21.75%) of households have effective options for solid waste treatment, and was only 25.9% (24.24% - 27.54%) of HH doing wastewater management.

Bivariate Data

Bivariate Data on this study divided by results of analysis factors associated with diarrhea and nutritional status (underweight, wasted, and stunted). First, Factor associated with diarrhea was analyzed by SPSS (Table 4). By the result of this study, Household practicing safe drinking water management is associated with diarrhea (p=0.015). If the households not practicing safe drinking water management, there is 1.7 times increasing risk of Diarrhea (OR 1.7 (CI 1.1-2.6).

Table 4. Result of Bivariate analysis of Factors associated with diarrhea

Factors Associated	Diarrhea		Total	p-value	Crude OR (CI 95%)
	Yes n (%)	No n (%)			
HH using a basic sanitation facility					
No	30 (10.3)	260 (89.7)	290	1.625	-
Yes	178 (8.1)	2007 (91.9)	2185		
HH practicing safe drinking water management					
No	27 (12.9)	183 (87.1)	210	0.015*	1.7 (1.1 – 2.6)
Yes	195 (8)	2242 (92)	2437		
HH using basic drinking water facility					
No	86 (7.5)	1060 (92.5)	1146	0.152	0.8 (0.6 – 1.1)
Yes	136 (9.1)	1365 (90.9)	1501		

*p-value < 0.005 = associated

By this study, researcher also found the factors associated with nutritional status of children under five in 13 area program. Factors associated with underweight is open defecation. The family having a toilet in their house is associated with underweight. May this factor not corelated directly. If household who having children under five have a toilet in their house, it will decrease risk of infectious disease caused by lack of environmental sanitation, then it will decrease risk of underweight of children under five (Table 7).

Table 7. Result of Bivariate analysis of Factors associated with Underweight

Factors Associated	Underweight		Total	p-value	Crude OR (CI 95%)
	Yes n (%)	No n (%)			
HH using a basic sanitation facility					
No	70 (26.6)	193 (73.4)	263	0.605	1.08 (0.8 – 1.4)
Yes	565 (28.1)	1443 (71.9)	2008		
HH practicing processing safe drinking water					
No	58 (27.5)	153 (72.5)	211	0.692	1.066 (0.777 – 1.462)
Yes	638 (28.8)	1579 (71.2)	2217		
Parents boiling water before drinking					
No	26 (29.9)	612 (28.7)	87	0.816	0.946 (0.5-1.5)
Yes	61 (70.1)	1518 (71.3)	2130		
Parents practicing hand washing with soap					
No	399 (30.1)	925 (69.9)	1324	0.079	0.853 (0.71 – 1.02)
Yes	297 (26.9)	807 (73.1)	1104		
Family defecating in the toilet					
No	61 (38.9)	96 (61.1)	2074	0.014*	-
Half	55 (27.9)	142 (72.1)	197		
Yes	580 (28)	1494 (72)	157		

*p-value < 0.005 = associated

The result about factors associated with wasting in children under five is open defecation (Table 5).

Table 5. Result of Bivariate analysis of Factors associated with Wasted

Factors Affected	Wasted		Total	p-value	Crude OR (CI 95%)
	Yes n (%)	No n (%)			
HH using a basic sanitation facility					
No	44 (16.7)	219 (83.3)	263	0.871	0.972 (0.7 – 1.4)
Yes	328 (16.3)	1680 (83.7)	2008		
HH practicing safe household drinking water management					
No	31 (14.7)	180 (85.3)	211	0.348	1.209 (0.8 – 1.8)
Yes	382 (17.2)	1835 (82.8)	2217		
Parents boiling water before drinking					
No	16 (18.4)	71 (81.6)	87	0.770	0.921 (0.53 – 1.6)
Yes	366 (17.2)	1764 (82.8)	2130		
Parents practicing hand washing with soap					
No	239 (18.1)	1085 (81.9)	1324	0.135	0.85 (0.68 – 1.05)
Yes	174 (15.8)	930 (84.2)	1104		
Family defecating in the toilet					
No	41 (26.1%)	116 (73.9%)	157	0.005*	-
Half	28 (14.2%)	169 (85.8%)	197		
Yes	334 (16.4%)	1730 (83.4%)	2074		

*p-value < 0.005 = associated

Moreover, factors that associated with stunting in children under five are Parents boiling water before drinking and Parents practicing hand washing with soap. If the parents not practicing the sanitation, the risk of stunting will be increase (Table 6).

Table 6. Result of Bivariate analysis of Factors associated with Stunting

Factors Affected	Stunting		Total	p-value	Crude OR (CI 95%)
	Yes n (%)	No n (%)			
HH using a basic sanitation facility					
No	108 (41.1)	155 (58.9)	263	0.618	1.069 (0.8 – 1.4)
Yes	857 (42.7)	1151 (57.3)	2008		
HH practicing safe household drinking water management					
No	82 (38.9)	129 (61.1)	211	0.247	1.186 (0.88 – 1.58)
Yes	953 (43)	1264 (57)	2217		
Parents boiling water before drinking					
No	23 (26.4)	64 (73.6)	87	0.001*	2.157 (1.33- 3.5)
Yes	930 (43.7)	1200 (56.3)	2130		
Parents practicing hand washing with Soap					
No	602 (45.5)	722 (54.5)	1324	0.002*	0.774 (0.66 – 0.91)
Yes	433 (39.2)	671 (60.8)	1104		
Family defecating in the toilet					
No	70 (44.6%)	87 (55.4%)	157	0.807	-
Half	81 (41.1%)	116 (58.9%)	197		
Yes	884 (42.6%)	1190 (57.4%)	2074		

*p-value < 0.005 = associated

DISCUSSION: The result shows that there were 2.956 children under five involved in this study (female=49.83%; male=50.17%). Most of them were aged 24-59.9 months (63.73%). The prevalence of stunted growth was very high at 43.2% (CI: 41.32% - 45.2%); then wasted at 16.40% (CI: 15.01% - 17.9%) and underweight at 28.30% (26.56% - 30.06%). The prevalence of stunted, wasted, and underweight was higher in boys than in girls. The prevalence of diarrhea in children under 5 years at the national level was 8.3% (CI: 7.36% - 9.51%) with 55% were boys and 45% were girls. This value was lower than the results of SSGI 2021 (9.8%). The highest prevalence of diarrhea was in the Sambawa zone (14.8%) which was higher than SSGI 2021(9.8%). The result also found that stunted in Sambawa was also high. A spatial study in Sumatra found that stunted had a spatial correlation with open defecation free (ODF) and correct hand washing but not diarrhea3. The proportion of households using a basic sanitation facility in 13 APs was 42.7% and using a basic drinking water facility was 57%. This percentage was still lower than the SSGI 2021 results, where the percentage of the population with proper sanitation was 81.9% and drinking water facilities was 66.3%. The percentages of these two indicators were consistently low in the NTT- Bamora zone. NTT is an area that has difficult access to safe water in many areas within the region. The results of Indonesia Basic Health Research 2018 illustrated that NTT was the province with the most difficulty accessing water in Indonesia, which is 13.81%. This figure was very high when compared to the proportion of water access difficulties in Indonesia of 2%. This water shortage will inevitably have an impact on access to proper sanitation. The percentage of correct handwashing at national level was 46%. It was below the Basic Health Research 2018 (49.8%) result. The highest percentage of parents who wash their hands properly was in the NTT-Flores zone (58.9%) and the lowest was in NTT-

Bamora (14.8%). The proportion of HH practicing safe household drinking water at national level was 49.57% (CI: 47.69% -51.45%), only 20.21% (CI: 18.73% - 21.75%) of households have effective options for solid waste treatment, and was only 25.9% (24.24% - 27.54%) of HH doing wastewater management.

Deeper analysis shows that there was no relationship found between WASH access and diarrhea, except with safe drinking water management (p-0.015; OR 1.7). Interestingly, there has been found a correlation between stunting with boiling water for drinking water (p=-0.001 OR 2.1), and with hand washing with soap (p=0.002 OR 0.7). Also, the relationship between open defecation with wasting (P=0.005) and underweight (P=0.014).

CONCLUSION: Given the high prevalence of stunted, wasted, and underweight in all assisted areas, it is recommended to not only focus on improving WASH access but also giving attention to improving WASH behaviors. Although each area has a different magnitude of the WASH problem, and resolving one determinant will not necessarily solve the nutrition status problems in the community in all contexts, however, it will enable a healthy environment for all.

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Acknowledge: All Wahana Visi Indonesia Team reviewers (Health unit, PQA, RIS) and Indonesia WASH Symposium reviewers.

Keywords: WASH access, WASH behavior, nutritional status, stunting, wasting, underweight, situational analysis, WASH and stunting, WASH in U5 children.

Financial Modeling For Achieving Safely Managed On-Site Sanitation With Financial Flow Simulator (Esosviewtm) (Case Study: Tabanan Regency, Bali)

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INTRODUCTION: About 46% of the world's population, around 3.6 billion people, are without safely managed sanitation services, and globally, 494 million people still practice open defecation. In Bali Province, although access to basic sanitation services is 95.01%, only 14.55% of the population have access to safely managed sanitation, and 4.42% still practice open defecation. This percentage includes septic tanks that are emptied at least once in the last five years. Open defecation and the high rate of unsafely-managed sanitation in Bali can potentially result in wastewater infiltration into drinking water sources, discharging enteric microorganisms and fecal-borne pathogens, such as *E.coli*. As centralized, city-scale domestic waste treatments are expensive and complex, on-site sanitation is the key strategy to achieve safely-managed sanitation that includes fecal sludge management in many Low- to Middle-Income Countries (LMICs) such as Indonesia. WASH services are considered sustainable if the five dimensions of sustainability factors (financial, institutional, environmental, technological, and social) are adequately addressed in the WASH program. This research focuses on financial flow modeling to achieve universal access to safely-managed sanitation using a financial simulator, eSOSView™, in Tabanan Regency, Bali. The aims of this paper are: (1) to analyze existing Faecal Sludge Management (FSM) and financial model applied in the study area; (2)

to develop alternative financial models and analyze them using eSOSView™; and (3) to choose a financial model using Multi-Criteria Analysis (MCA) and its application in the study area. The results are useful to build recommendations for achieving 100% safely managed on-site sanitation in Tabanan Regency.

METHODS: A Real Demand Survey (RDS) of households and semi-structured interviews with the private and government sectors were conducted to collect data imputed into the model. One hundred households selected by cluster random sampling method participated in the RDS.Stakeholders from the Bali Province PALD Technical Implementation Unit (UPT), and the privateparty that provide Emptying & Transport (E&T) services were interviewed. This research resulted in five financial models. To choose the most suitable financial model for Tabanan Regency, Multi- Criteria Analysis (MCA) was employed. The MCA considered five aspects: financial feasibility (50%), public acceptance (15%), stakeholder capability (15%), compliance with the latest regulations and public policies (10%), and ease of implementing business models (10%).

RESULTS: Out of five financial models, Model 3 was chosen as the most suitable business model to achieve universal access to safely-managed sanitation in Tabanan Regency, Bali. In Model 3, households need to pay a certain amount for the emptying fee and sanitation tax. UPTD as the city's fecal sludge management operator receives discharge fees from the clients who dispose of their sludge to be treated at the fecal sludge treatment plant and budget support from the government authority (the Environmental and Forestry Service/DLHK). End-use products (fertilizers) from the fecal sludge treatment plant can be sold at pre-agreed prices to industries thatneed them. In the existing model, the fertilizers produced from the fecal sludge treatment plant (approximately 10 tons/month) are not for sale; they are used for the city parks, Tabanan Regency government offices, and Sembung Gede landfill, for free. In Model 3, we took the example of Semarang City. The base price per kg of fertilizers produced in 2014 was IDR 307/kg (including 5% profit). Considering an average annual inflation rate of 5%, fertilizers' base price per kg can increase to IDR 489/kg in 2022. The potential annual revenue from fertilizer sales of 10 tons per month is IDR 58,680,000. Additionally, UPTD can set the minimum purchase amount and enter into business cooperation agreements with agro-companies to sustain the business model.

DISCUSSION: In order to be able to implement Model 3 in the study areas, there are several aspects that need to be considered: financial aspect, public acceptance, government capacity, and regulations and policy. Annual sanitation tax of IDR 120,545 per household is required. By usingcross-subsidies, the value of the sanitation tax can be calculated based on economic status and made enforceable. Moreover, traditional leaders need to be involved in any initiatives to enhancepublic acceptance; they will be able to explain the implementation of the sanitation tax and fertilizer sales to the public in a thorough and understandable manner using a local cultural or customary approach. Consequently, UPTD Management of Waste and Fecal Sludge receives funds from the sanitation tax, which is administered by the Tabanan Regency Regional Tax and Retribution Service UPTD (PPRD) under the direction of the Bali Province Regional Revenue Agency (BPD). In addition, managing the financial transfer of fertilizer sales from the end-use industry is another duty assigned to the UPTD of Waste and Sludge Management. Based on the current laws and policies, it is evident that a legal framework is necessary to support the implementation of the sanitation tax, from household collection to the Tabanan Regency RegionalTax and Retribution Service UPTD (PPRD) to regulations for Bali Province Regional Revenue Agency (BPD) of the sanitation tax in Tabanan Regency. Local traditional leaders can also supportthe implementation of this sanitation tax by raising community willingness to pay and gathering supports for a fair sanitation tax.

CONCLUSION: eSOSView™ is an effective tool to assist local governments in performing financial model analysis with a simple and easy to understand user-interface. It helps them to design strategies and decision-making related to financial aspects in the FSM by providing comprehensive financial considerations. However, a deep understanding of the formulas and terminology used; and complete data are needed to fill in the eSOSView™ to get results with a minimal error rate. Moreover, not only the Tabanan Regency area but also this analysis can be applied to other areaswith the note that the criteria chosen for the MCA are subjective depending on the characteristics of the area and the considerations taken by the researcher so that for other researchers the results will be different. Based on the results of this study, the Government of Tabanan can achieve 100% safely managed on-site sanitation by applying emptying fees and sanitation taxes for households,discharge fees for private parties who dispose of the fecal sludge in FSTP, purchase prices for agro-companies who buy the fertilizer, and budget support from the DLHK. These aspects will bethe sources of revenues in Model 3 in eSOSView™.

KEYWORDS: *eSOSView™, fecal sludge management, financial flow, Indonesia, safely-managed sanitation*

Pro-poor Policy in Community-Based Drinking Water and Sanitation Program in Gunungkidul Regency

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BACKGROUND

Placing government at the front and center of the development agenda has proven to be important for encouraging a more just and peaceful society and the formulation of pro-poor policies (Beegle, 2019). Not only in developing countries, the broader issue of defining and measuring the affordability of the water and sanitation sector is also still at the forefront of policy in the United States (National Academy of Public Administration, 2017). In Tanzania, the implementation of rural water supply and sanitation programs demonstrated policy incoherence, technical deficiencies, and political influence such that only a small proportion of funds reached underserved areas (de Palencia, 2011). In Indonesia, Nugroho (2019) pointed out the importance of the capacity of informal and semi-formal Microfinance Institutions in reaching the poor in microfinance policies to develop an inclusive financial system. In India, pro-poor policies have been successful in reducing maternal mortality and existing supply-side disparities in the Indian health care system (Bhatia et al., 2021).

Gunungkidul Regency is one of the regencies in the Special Region of Yogyakarta that is most prone to drought. This can affect food security and can even increase poverty. The Community-Based Water Supply and Sanitation Program (PAMSIMNAS) is aimed at increasing access of rural communities to clean water and proper sanitation. Policies with a pro-poor approach are considered quite effective by the government because they emphasize the involvement of the poor as a policy target. The governance process for designing and implementing policy must underpin every aspect of how the state and its institution's function. However, governance processes often fail to deliver results, especially for the poor. This study aims to gain a comprehensive understanding

of pro-poor policies in the PAMSIMNAS Program in Gunungkidul Regency and the factors that hinder them.

METHODOLOGY

This study uses a qualitative descriptive research method. This research was conducted for 6 months, from March 2022 to August 2022. Data was obtained through in-depth interviews with purposively determined informants, namely parties related to understanding and involvement in the program. Researcher also collected data through observation and literature search to collect documents relevant to this study. Qualitative data analysis in this study was carried out interactively and continuously until completion. The data obtained were analyzed using data analysis techniques consisting of activity flow including data reduction, data presentation, conclusion drawing, and verification.

RESULT

The PAMSIMNAS program has been implemented in Wareng Village since 2017. It is in accordance with the provisions in the guideline as an area that is difficult to access clean water, has a continuous source of water and is outside the reach of the regional drinking company network. So far, it cannot reach all areas in Gunungkidul because the location of each region has a different topography. It is also due to the company's orientation to profits. As stated by the District Project Management Unit that the supply of drinking water is carried out through several chains such as a network of drinking water companies, raw water supply systems for rural drinking water, and individuals (building wells or buying water tanks). The first phase of the program failed to provide access and was unable to reach all areas in Wareng Village. In the next stage, in 2021, Pamsimas in Wareng Village has been used by residents in Dusun Singkar 1 and Singkar 2 with a total number served until September 2021, namely 75 House Connections (SR) or around 700 people. However, this result has not reached the target number, namely 240 SR. For the SR fee, it consists of a 1-meter package and 20 m of pipe, which is IDR 750,000 and a water bill of IDR 2,500/m3 with a charge for electricity of IDR 10,000/month. However, in practice there are still obstacles to the limited ability of the poor to access connections. In practice, the PAMSIMNAS program does not only target the poor, but can be accessed by all residents who need it.

DISCUSSION

The term pro-poor generally refers to an understanding of policies that directly target the poor or are intended to reduce poverty. In practice, policies should provide opportunities for the poor to be directly involved, or lead to outcomes which are pro-poor. The Civil Society Partnership emphasizes that the goals of pro-poor policies must be able to increase the assets and capabilities of the poor (ODI, 2004). One of the government policies within a pro-poor framework can include the direct provision of goods or services (Pettinger, 2019). However Thus Bird and Busse (2006) also put forward several challenges, focus and pro-poor policy sequences. One of them is whether the policy is only considered pro-poor if it directly benefits the poor, or also for other people who are not poor. Or it could be a policy categorized as benefiting everyone, but generate greater benefits for the poor. The PAMSIMNAS program has involved various stakeholders and the poor in its management. The Wareng Village government and the community have formed a Community Self-Help Group and Implementation Unit as a program implementing unit to ensure that the poor have access to safe drinking water and sanitation. However, there are still problems related to limited coordination and communication between various stakeholders and the community. This causes the program has not been implemented optimally. The lack of personnel turnover in the Implementing Unit needs to be addressed, one of which is by providing adequate incentives so that people are encouraged to participate. Apart from that, to overcome the problem of water that is often cloudy, it is necessary to improve infrastructure, such as providing water filters to overcome water turbidity when the rainy season arrives.

CONCLUSION

The Community-Based Water and Sanitation Program in Gunungkidul has not yet shown the realization of pro-poor policies. This is because the program's targeting has not specifically targeted the poor. In its implementation, the program still targets all elements of society regardless of their economic capacity. Several obstacles were also encountered, such as the poor quality of water sources during the rainy season and limited human resources in program management. However, the program has been able to increase people's access to clean water at an affordable cost. Various stakeholders have also demonstrated their roles and participation in program implementation.

KEYWORDS : Policy, pro-poor program, community-based, clean water, sanitation supply

Child Feces Disposal Management Practices in Urban and Rural Indonesia with Integrated Behavior Model WASH

BACKGROUND

Indonesia Health Profile describes that in 2020, the main cause of under-five (U5) mortality in Indonesia is infection 3.4% (age 10-28 days), diarrhea 19% (age 29 days - 59 months), and with a total of 3,953,716 diarrhea incidence reported in health facilities. In addition to causing death, chronic diarrhea is one of the factors that causes stunting in U5 children, which is also found at a high rate, 30.8% in Indonesian toddlers (Riskesdas, 2018). Diarrhea is a digestive tract infection caused by an unhealthy environment and unhygienic behavior. A lot of research has proven that diarrhea is preventable through Water, Sanitation and Hygiene (WASH) interventions.

Studies show evidence of a strong association between child feces disposal and diarrhea, yet no systematic interventions have been designed or implemented to address this problem in the WASH and Health programs in Indonesia. Wahana Visi Indonesia (WVI) conducted formative research in Sekadau and Simokerto to gain a more comprehensive understanding on the Child Feces Disposal Management (CFDM) practice and behavior. The study aimed at assessing child feces disposal management practices in a rural and urban context in order to develop systematic intervention based on the research findings.

METHODOLOGY

Located in 5 villages in Sekadau district and Surabaya city in in WVI Area Programs (AP) Sekadau and Simokerto, the study used quantitative and qualitative methods with approved ethical review. Quantitative data was collected using Open Data Kit (ODK) survey tools for 257 caregivers in Sekadau (rural) and 251 caregivers in Simokerto (urban) with purposive sampling method. Qualitative data was collected from 11 Focus Group Discussions (FGD) with community health volunteers, faith leaders, informal leaders, health workers and caregivers, also from Key Informant Interview (KII) with 4 local authorities, 6 health workers, and 3 waste banks/ collectors and lastly market observation in 10 local baby

shops and markets. Questions were developed by adapting questioners from Health Belief Model (HBM) and IBM WASH, and analyzed by using SPSS and manual transcription, coding and triangulation.

RESULT

Respondents' characteristic: The result shows that the majority of respondents were housewives, aged 26-35 years old, biological parents of U5 children, and only had one U5 child in their household. Child sex was balanced in composition; males in Sekadau (51.36%) and females in Simokerto (51.79%). The highest percentage of children's age was more than 36 months (Sekadau 30.74%, Simokerto 34.63%) followed by 7-24 months (Sekadau 28.40%, Simokerto 28.40%). In the last 30 days, it was found that the children had diarrhea (Sekadau 13.23%, Simokerto 5.98%), and other WASH related diseases and diaper skin rushes.

Dwelling characteristic: Respondents were dwelling with 24 hours access to water (Sekadau 94.16%, Simokerto 95.22%), and having access to latrine at home (Sekadau 93%, Simokerto 97.21%) with pour-flush squat toilet type (Sekadau 85.35%, Simokerto 91.8%), with pit containment model in Sekadau (75.49%), and septic tank containment in Simokerto (94.02%).

Child feces disposal of characteristic: Children defecating in the toilet was found better in Sekadau (50.97%) than in Simokerto (39.04%) and defecating in the diaper was found lower in Sekadau (42.8%) than in Simokerto (60.16%). Feces in the diaper were then disposed of in the toilet (Sekadau 36,5%, Simokerto 49%), and remained in the diaper to be disposed of in the trash bin (Sekadau 38.13%, Simokerto 45.82).

Knowledge characteristic: Most of respondents mentioned correctly about 1) Diseases caused by open defecation (Sekadau 85.21 %, Simokerto 78.09 %) ; 2) Impact of open defecation to the environment (Sekadau 91.44%, Simokerto 94.82%), 3) Safely disposing of feces from diaper (Sekadau 57.9%, Simokerto 72.11%), and 4) Proper disposing of diaper (Sekadau 63.42%, Simokerto 70.52%).

Perception and belief characteristic: In both location it was found perception that child feces were affecting the environment cleanliness and medium of sickness, not harming and not as dangerous as adult feces, children got diarrhea and other diseases was part of a normal childhood life, and that God approved cleanliness. Respondents mentioned that child health, comfort and safety were the main focuses of the caregivers in selecting products and practicing a behavior and some were always considering value for money and practical usage in relation to CFDM supplies and products.

Enabling environment characteristic: All health workers mentioned that there was no SBC activities related to child baby feces disposal management in place, there is no Information, Education and Communication materials available and accessible at national, district and sub district level. Although some of the local authorities and health workers were aware of regulation on sanitation and waste management, however they were not confident saying that the regulations were supporting proper baby feces disposal management.

IBM WASH characteristic: Summary of IBM WASH is described below.

Tabel 1. Summary of IBM WASH on Child Feces Disposal Management in Sekadau and Simokerto.

Level	Contextual	Psychosocial/ Software	Product/ Technology Hardware
Societal/ structural	There is no specific policy and regulation on CFDM. However, it can relate to ODF and waste management regulation. Some of the participants in both locations are living near the river/ stream. Location is on tropical zone, with rainy and dry seasons every year. Using single use diapers is more frequently during rainy season.	Local authorities' leadership are strong in both locations, they are willing to improve community well-being and to support CFDM through local policy and activities. Faith leaders in Sekadau, health workers in both locations are considered trusted resource in giving information.	CFDM products (nappy, diaper, potty, toilet seat) are easy to access in Simokerto, with various types, prices, materials and volumes. In Sekadau, only nappy and diaper are accessible. Only single use diaper promotion is found massively in TV and social media. There is no specific regulation on child friendly toilet or other CFDM product.

Community	More than 90% of the participants have access to latrines and water. Some villages in Sekadau have been verified ODF.	Community in Sekadau has communal activities regularly, has working group and taking care of each one especially child, and everyone knows each other in the village. Community in Simokerto is more individual, has strong ethnicity bond that also known with bad stigma.	Limited number of cloth napkins and diapers are available in the small shops in the village, only in district and sub district capitals, while potty and toilet seat are not found in Sekadau. Various types, models, materials of CFDM products are available in the local market and modern store that accessible by the community in Simokerto.
Interpersonal/ Household	Mothers are the ones who in charge for taking care of children, husbands and other family members sometimes help when they are available but not in disposing child feces. More than 90% latrines are flush squat toilet type.	Child can defecate around the house because it is not safe to use toilet. Cleaning child feces is mother's responsibility.	There is no potty available and ever used by the participants in both contexts. Sharing cloth nappies and demonstrating how to clean baby nappy and diaper in the family are happened in both contexts.
Individual	Most of the mothers are finished primary and high school and full-time housewives, with 1 child U5 y.o. Child is trained to use toilet averagely after 3 y.o, or after the child can walk properly.	Clean house and neighborhood free from feces is considered very important for the health of the child and family members. Participants can relate to diarrhea from feces that stick on the fly feet. Fathers help in disposing diapers but not in separating feces from diaper.	Mothers concern about the price, quality and model of single use diaper. Some prefer water proof reusable cloth pants and nappy. Some prefers traditional technology, affordable options to help child defecating in the toilet.
Habitual	Traditional way that similar to potty training is learned from elders. Safe environment for children is required.	Mothers are always washing or cleaning the child and the feces around the house as soon as possible. Mothers hope that child can independently and safely defecate in the toilet.	Changing and cleaning nappy and diaper are considered easy and part of the daily job. Separating feces from diaper and potty is considered doable. None of the participants have had potty training before and receiving CFDM information and are desired to have them accessible.

DISCUSSION

A strong association between diarrhea and unsafe disposal of child feces among children aged below 24 months (OR: 1.46; 95% CI: 1.18–1.82, p = 0.001) is found in Indonesia, yet there is no related intervention and policy in place (Cronin AA, Sebayang SK, Torlesse H, Nandy R.). National sanitation program as regulated by Ministry of Health (MoH) is Community Based Total Sanitation (CBTS) that targeting 1) stop open defecation, 2) hand washing with soap, 3) safe drinking water, 4) managing solid waste and 5) managing waste water. However, there is no a clear strategy to intervene child feces disposal in stop open defecation activities. CFDM is considered neglected in WASH intervention (SNV, 2022) despite the issue being recognized as a key risk, even when latrines are available (Cronin AA, 2016). WVI monitors CFDM periodically through outcome monitoring, program review and baseline. The recent baseline shows that 87.9% of caregivers in 13 Area Programs (AP) in 15 districts are unsafely disposing child feces. However, there is no intervention has been carried out systematically due to lack of understanding on proper model of intervention and activities that are ready to use in the WASH Program.

IBM WASH analysis shows that Simokerto, as an urban context, has more access to a variety of CFDM tools and supplies, such as reusable waterproof baby and napkin, reusable waterproof pants, baby potty, child toilet seat than those of the rural, yet lack of Social Behavior Change (SBC) activities and materials on CFDM including potty training are found in both Sekadau and Simokerto areas. Exploring local equipment and technology to support proper CFDM in Sekadau as a rural context is needed. Child safety, child health and saving money are considered the highest motivators to improve child feces management practices. Thus, promoting traditional knowledge in helping child U5 transition from open defecation to using toilets safely is necessary. Perceptions that driving the CFDM behavior is not significantly different in urban and rural

context, however, the social norms interventions may work better in Sekadau than in Simokerto because the community bond is higher in Sekadau. A high gap is found at structural level in both contexts where none of the institutions have existing programs or activities related to child feces management. It is recommended to include CFDM not only in the existing national sanitation program, Community Based Total Sanitation, in all three components: Demand, Supply and Enabling Environment, but also in the Mother and Child Health program.

CONCLUSION AND RECOMMENDATION

Conclusion that is developed from this study are:

Caregiver's behavior in managing child feces disposal is not significantly different in Sekadau (rural) and Simokerto (urban). Child safety, child health and comfort; and saving money are the highest motivators to improve child feces disposal management.

Based on IBM WASH analysis, the highest gaps found in SBC activities and CFDM materials. Participants in urban have more access to variety of CFDM tools and supplies such as reusable waterproof baby napkin, reusable waterproof pants, baby potty, child toilet seat than them of rural. Yet lack of, and unavailability of SBC materials on CFDM including potty training are found in both areas.

It is necessary to explore local material and technology to support proper CFDM in rural context where access to potties and child toilet seat are very limited, in collaboration with local artisans or sanitation entrepreneurs may increase the acceleration of product accessibility.

Mothers and caregivers are not aware of child feces disposal management due to lack of access to SBC activities and materials that expected to be provided by the local sectoral authorities such as health workers and community volunteers.

Addressing CFDM in the existing sanitation program at national level with national WASH stakeholders as described below.

Tabel 2. Strategic Programming Intervention Recommendation

Component	National Level (WASH network and national ministries)
Demand creation	To include/focus on CFDM on world toilet day campaign, world environment day campaign, national stunting reduction campaign, and national children day. To develop generic SBC materials on CFDM
Supply creation	Promote child friendly toilet Develop alternative options for child friendly toilet Develop alternative options for reusable diapers and affordable baby potties
Enabling environment	To develop or adjust STBM Stunting module to have a section on child feces disposal management To develop CFDM training module To include CFDM in STBM regulation To provide training for midwives on CFDM

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ACKNOWLEDGE: all reviewers

KEY WORDS: child feces, child feces disposal, child feces management, IBM WASH, open defecation

Pro-poor Policy in Community-Based Drinking Water and Sanitation Program in Gunungkidul Regency

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BACKGROUND

Placing government at the front and center of the development agenda has proven to be important for encouraging a more just and peaceful society and the formulation of pro-poor policies (Beegle, 2019). Not only in developing countries, the broader issue of defining and measuring the affordability of the water and sanitation sector is also still at the forefront of policy in the United States (National Academy of Public Administration, 2017). In Tanzania, the implementation of rural water supply and sanitation programs demonstrated policy incoherence, technical deficiencies, and political influence such that only a small proportion of funds reached underserved areas (de Palencia, 2011). In Indonesia, Nugroho (2019) pointed out the importance of the capacity of informal and semi-formal Microfinance Institutions in reaching the poor in microfinance policies to develop an inclusive financial system.

In India, pro-poor policies have been successful in reducing maternal mortality and existing supply-side disparities in the Indian health care system (Bhatia et al., 2021). Gunungkidul Regency is one of the regencies in the Special Region of Yogyakarta that is most prone to drought. This can affect food security and can even increase poverty. The Community-Based Water Supply and Sanitation Program (PAMSIMNAS) is aimed at increasing access of rural communities to clean water and proper sanitation. Policies with a pro-poor approach are considered quite effective by the government because they emphasize the involvement of the poor as a policy target. The governance process for designing and implementing policy must underpin every aspect of how the state and its institution's function. However, governance processes often fail to deliver results, especially for the poor. This study aims to gain a comprehensive understanding

of pro-poor policies in the PAMSIMNAS Program in Gunungkidul Regency and the factors that hinder them.

METHODOLOGY

This study uses a qualitative descriptive research method. This research was conducted for 6 months, from March 2022 to August 2022. Data was obtained through in-depth interviews with purposively determined informants, namely parties related to understanding and involvement in the program. Researcher also collected data through observation and literature search to collect documents relevant to this study. Qualitative data analysis in this study was carried out interactively and continuously until completion. The data obtained were analyzed using data analysis techniques consisting of activity flow including data reduction, data presentation, conclusion drawing, and verification.

RESULT

The PAMSIMNAS program has been implemented in Wareng Village since 2017. It is in accordance with the provisions in the guideline as an area that is difficult to access clean water, has a continuous source of water and is outside the reach of the regional drinking company network. So far, it cannot reach all areas in Gunungkidul because the location of each region has a different topography. It is also due to the company's orientation to profits. As stated by the District Project Management Unit that the supply of drinking water is carried out through several chains such as a network of drinking water companies, raw water supply systems for rural drinking water, and individuals (building wells or buying water tanks). The first phase of the program failed to provide access and was unable to reach all areas in Wareng Village. In the next stage, in 2021, Pamsimas in Wareng Village has been used by residents in Dusun Singkar 1 and Singkar 2 with a total number served until September 2021, namely 75 House Connections (SR) or around 700 people. However, this result has not reached the target number, namely 240 SR. For the SR fee, it consists of a 1-meter package and 20 m of pipe, which is IDR 750,000 and a water bill of IDR 2,500/m3 with a charge for electricity of IDR 10,000/month. However, in practice there are still obstacles to the limited ability of the poor to access connections. In practice, the PAMSIMNAS program does not only target the poor, but can be accessed by all residents who need it.

DISCUSSION

The term pro-poor generally refers to an understanding of policies that directly target the poor or are intended to reduce poverty. In practice, policies should provide opportunities for the poor to be directly involved, or lead to outcomes which are pro-poor. The Civil Society Partnership emphasizes that the goals of pro-poor policies must be able to increase the assets and capabilities of the poor (ODI, 2004). One of the government policies within a pro-poor framework can include the direct provision of goods or services (Pettinger, 2019). However Thus Bird and Busse (2006) also put forward several challenges, focus and pro-poor policy sequences. One of them is whether the policy is only considered pro-poor if it directly benefits the poor, or also for other people who are not poor. Or it could be a policy categorized as benefiting everyone, but generate greater benefits for the poor. The PAMSIMNAS program has involved various stakeholders and the poor in its management. The Wareng Village government and the community have formed a Community Self-Help Group and Implementation Unit as a program implementing unit to ensure that the poor have access to safe drinking water and sanitation. However, there are still problems related to limited coordination and communication between various stakeholders and the community. This causes the program has not been implemented optimally. The lack of personnel turnover in the Implementing Unit needs to be addressed, one of which is by providing adequate incentives so that people are encouraged to participate. Apart from that, to overcome the problem of water that is often cloudy, it is necessary to improve infrastructure, such as providing water filters to overcome water turbidity when the rainy season arrives.

CONCLUSION

The Community-Based Water and Sanitation Program in Gunungkidul has not yet shown the realization of pro-poor policies. This is because the program's targeting has not specifically targeted the poor. In its implementation, the program still targets all elements of society regardless of their economic capacity. Several obstacles were also encountered, such as the poor quality of water sources during the rainy season and limited human resources in program management. However, the program has been able to increase people's access to clean water at an affordable cost. Various stakeholders have also demonstrated their roles and participation in program implementation.

KEYWORDS : Policy, pro-poor program, community-based, clean water, sanitation supply

Tata Kelola Sanitasi Lingkungan Pasar Rakyat Menuju Pasar Sehat Era New Normal di Kota Yogyakarta

*Morrin Choirunnisa Thohira[1], Faisol Rahman[2]**

BACKGROUND: Pasar sehat adalah kondisi pasar rakyat yang bersih, aman, nyaman, dan sehat melalui pemenuhan standar baku mutu kesehatan lingkungan, persyaratan kesehatan, serta sarana dan prasarana penunjang dengan mengutamakan kemandirian komunitas pasar. Pasar yang memiliki pengelolaan sanitasi lingkungan yang buruk akan berdampak pada kesehatan masyarakat. Sanitasi pasar rakyat yang baik dapat mewujudkan barang yang dijual bersih dan meminimalkan terjadinya penyebaran penyakit. Salah satu usaha untuk mencegah penyebaran penyakit yang dapat terjadi di pasar adalah diperlukan pelaksanaan tata kelola sanitasi lingkungan pasar yang baik terutama di era *new normal*. Penelitian ini bertujuan untuk menganalisis tata kelola sanitasi lingkungan pasar rakyat era *new normal* pada pasar rakyat di kota Yogyakarta berdasarakan Permenkes No. 17 Tahun 2020 dan Keputusan Menteri Kesehatan melalui KMK No. HK.01.07-MENKES-382-2020.

METHODOLOGY: Penelitian ini merupakan penelitian deskriptif observasional dengan penentuan sampel dalam penelitian menggunakan stratified random sampling, yaitu dipilih berdasarkan kualifikasi pasar rakyat kelas I hingga kelas V yang berada di Kota Yogyakarta dan dibawah pengawasan Dinas Perdagangan Kota Yogyakarta. Pada kelas I direpresentasikan dengan Pasar Beringharjo (bagian timur), kelas II Pasar Giwangan, kelas III Pasar Demangan, kelas IV Pasar Legi Patangpuluhan dan kelas V Pasar Gedong Kuning. Pengambilan data tata kelola sanitasi lingkungan pasar dilakukan pada bulan September – Oktober 2021. Informasi mengenai mekanisme tata kelola sanitasi lingkungan pasar dan deskripsi setiap pasar rakyat dilakukan wawancara dengan pengelola pasar. Penilaian kondisi sanitasi lingkungan pasar rakyat era new normal dilakukan dengan observasi peneliti mengunakan instrument. Kriteria sanitasi lingkungan pasar rakyat di era new normal dikategorikan pasar sehat apabila skor yang didapat mencapai ≥70% dan dikategorikan pasar tidak sehat apabila skor yang didapat yakni <70%.

RESULT: Hasil penelitian ini adalah terdapat tiga pasar yang memiliki kondisi sanitasi yang sesuai dengan Permenkes mengenai Pasar Sehat dan telah menerapkan protokol kesehatan (Pasar Beringharjo, Pasar Legi Patangpuluhan dan Pasar Gedong Kuning). Namun masih terdapat dua pasar yang masih dalam kategori pasat tidak sehat (Pasar Giwangan dan Pasar Demangan). Selanjutnya terdapat beberapa variabel yang telah diterapkan cukup baik, yaitu air untuk kebutuhan higiene sanitasi, kamar mandi dan toilet pengelolaan sampah, saluran pembuangan air limbah, tempat cuci tangan, kualitas makanan dan bahan pangan, desinfeksi pasar serta kebersihan pasar, sedangkan tata kelola mengenai pengendalian vektor dan binatang pembawa penyakit serta pengadaan IPAL perlu dilakukan peningkatan untuk mendukung mewujudkan pasar sehat di era *new normal*.

DISCUSSION: Pada masa pandemi Covid-19, keberadaan air bersih sangat penting untuk menerapkan protokol kesehatan Covid-19 seperti mencuci tangan, BAK dan BAB, sehingga perlu diperhatikannya kuantitas maupun kualitas air bersih yang tersedia di Pasar. Selanjutnya, untuk fasilitas cuci tangan di area toilet dan kamar mandi, hanya tersedia di Pasar Legi Patangpuluhan. Adanya fasilitas cuci tangan di area toilet dan kamar mandi merupakan salah satu upaya yang dapat dilakukan untuk mencegah pasar menjadi lokasi transmisi virus Covid-19. Kebersihan kamar mandi dan toilet juga perlu diperhatikan saat pandemi Covid-19, seperti kebersihan pada gayung dan gangang pintu. Hal ini dikarenakan pada permukaan yang berbahan plastik dan besi tahan karat virus dapat bertahan hingga 72 jam. Adanya IPAL di pasar rakyat bertujuan untuk mencegah terjadinya pencemaran lingkungan sehingga limbah cair yang dihasilkan dari kegiatan pasar ketika disalurkan ke badan air tidak menimbulkan gangguan ekosistem lingkungan. Selanjutnya berdasarkan hasil wawancara peneliti dengan pengelola pasar, fasilitas tempat cuci tangan baru diadakan saat pandemi Covid-19, sebelumnya hanya Pasar Bringhajo Timur yang telah menyediakan fasilitas tempat cuci tangan walaupun dengan jumlah yang terbatas. Pihak pengelola pasar juga belum melakukan upaya pengendalian vektor dan binatang penular penyakit, sehingga tindakan pengendalian hanya sebatas inisiatif dari pedagang yang merasa terganggu dengan keberadaan vektor dan binatang tersebut sehingga membutuhkan upaya pembasmian. Kegiatan desinfeksi dapat mencegahan penularan Covid-19 di area pasar, namun perlu diperhatikan bahwa dalam melakukan kegiatan desinfeksi pasar, petugas kebersihan harus menggunakan APD yang lengkap untuk menghindari paparan bahan kimia ke tubuh serta dilakukan ketika kegiatan pasar sudah tidak beroperasi untuk mengurangi kontak bahan kimia ke warga pasar. Adanya penerapan protokol kesehatan di lingkungan pasar memiliki hubungan dalam peningkatan tata kelola sanitasi di pasar, sehingga hal ini dapat berjalan secara beriringan. Tata Kelola sanitasi yang baik dapat berkontribusi terhadap pencegahan penyebaran Covid-19 di area pasar. Selain rekomendasi untuk mengadakan program pengendalian vektor dan binatang pembawa penyakit serta pengadaan IPAL di pasar rakyat, sosialisasi mengenai PHBS dan penerapan protokol kesehatan untuk mencegah terjadinya Covid-19 di lingkungan pasar perlu dilakukan secara rutin untuk menciptakan pasar sehat di era *new normal*.

CONCLUSION: Kesimpulan dari penelitian ini adalah terdapat tiga pasar yang memiliki kondisi sanitasi sesuai dengan Permenkes mengenai Pasar Sehat dan telah menerapkan protokol kesehatan. Namun masih terdapat dua pasar yang masih dalam kategori pasat tidak sehat. Kategori sanitasi pasar rakyat yang perlu ditingkatkan untuk mendukung mewujudkan pasar sehat di era new normal adalah tata kelola mengenai pengendalian vektor dan binatang pembawa penyakit serta pengadaan IPAL. Penerapan protokol kesehatan di lingkungan pasar memiliki hubungan dalam peningkatan tata kelola sanitasi di pasar, sehingga hal ini dapat berjalan secara beriringan. Tata kelola sanitasi yang baik dapat berkontribusi terhadap pencegahan penyebaran Covid-19 di area pasar.

Environmental Health Risk Assessment in Settlement Area in Batang Arau River Watersheds, Padang West Sumatera Indonesia

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INTRODUCTION

The Batang Arau River is one of the largest rivers in West Sumatra with a length of 30.9 km2. The quality of the Batang Arau River has been declining over the past few years, as shown by a 5- fold increase in pollution load, from 4.2 mg BOD/L in 2013 to 21.78 mg BOD/L in 2015 (Work Unit of the Sumatra River Region Office V, 2016). Populated areas and industrial activities along the river are the main causes of this pollution. Seberang Padang Village, one of the communities in the Batang Arau Watershed (DAS) region, has a total area of roughly 154 hectares (BPS Kota Padang, 2016). Seberang Kelurahan is a flood-prone area in the Batang Arau watershed that is densely populated (47.89 people/ha) and has a population that is more than 40% below the poverty line. In terms of environmental health issues, this subdistrict is located in a high-risk area. In Seberang Padang Village, 64.97% of residents dump waste and excrement into the river, yards, and drainage areas.

It is necessary to conduct a study in order to evaluate the Seberang Padang Village's current sanitary and environmental health conditions. The Environmental Health Risk Assessment (EHRA) Study is one of the studies that can describe sanitation conditions and behavior with regard to public health at the sub-district, district, and city levels. In a village/kelurahan, district, or city, this study describes the presence of sanitation facilities and behavior that risks public health. Sanitation aspects evaluated include water sources, sewerage, latrines, garbage disposal services, and environmental drainage. Meanwhile, aspects of public health behavior include hand washing with soap (CTPS), waste handling and segregation, drinking water treatment, and open defecation (BABS). The aim of the study was to analyze the condition of sanitation facilities and public health behavior in the Seberang Padang Village and obtain the Sanitation Risk Index (IRS) in the Seberang Padang Village.

Building Community Resilient with Water Saving Program Preferences

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BACKGROUND

Green building is a concept of developing environmentally friendly, energy efficient, water efficient, and minimizing the use of existing natural resources while maintaining the function of the building [1]. Applying green buildings can reduce the impact of new buildings on the environment and human health. This concept has many aspects, one of which is water conservation. Water conservation aims to reduce the use of clean water for daily needs and reduce the generation of wastewater produced [2]. Aspects studied in water conservation include using a water meter to determine water use reduction and landscaping water use efficiency. All parties must start implementing the concept of saving water for all purposes, domestic, non-domestic, industrial, and agricultural, to become more resilient.

Community resilience is one dimension of vulnerability to various causes of stress and shock, such as disasters and natural hazards [3]. This impact is partly due to the inherent characteristics of social interactions, institutions, and cultural value systems. The Covid-19 pandemic that has hit since the beginning of 2020 can also be interpreted as a cause of social stress in society. People who have been free to move around are currently experiencing limitations caused by the Covid-19 outbreak.

Seeing the potential risk of vulnerability to water that arises, especially during the current Covid-19 pandemic, it is deemed necessary for a community movement regarding water security. In addition to being effective in water utilization, it also reduces routine costs incurred every month to meet water needs. Therefore, one of the strategies to provide education to increase water security in the post-pandemic Covid-19 era is to provide alternatives according to their preferences regarding increasing water security through three dimensions of community resilience: action, learning, and resource [4] management. Unfortunately, only a few studies use a resilient community framework, making our study a new finding that can help the efforts of the pillars of sustainable development goal (SDG). Therefore, this study aims to determine the community's preferences in saving water, especially within a resilient community framework.

METHODOLOGY

In this study, we used a random sampling method carried out online. The respondents used was 500 respondents from Java and Bali. Where the data analysis method used is importance and performance analysis (IPA). IPA is a procedure for showing the relative importance of various attributes and the performance of an organization in determining the underlying attributes. IPA combines measurements on the dimensions of expectations and interests into two grids. Then the two dimensions are plotted onto the importance value as the vertical axis while the expectation value is the diagonal axis. Then use the average value contained in the dimensions of interest and expectations as the centre of the line cutting. Where the question items in this study can be seen in Table 1. In this study, the probit and logit models also carried out the willingness to participate (WTP) in the water-saving campaign program.

Table 1. Indicators for Water-Saving Resilient

Attribute	Indicator	Source
Action	Using a shower instead of a dipper/bath (AC1)	[5], [6]clothes washing, bathing/showering, and cleaning
	Use a bucket instead of a hose to water plants/wash dishes (AC2)	[7]
Learning and awareness	Learn to make sure all taps are closed when not in use (LA1)	[8]Johannesburg dam levels were also been affirmed as low affecting some parts of Johannesburg areas. At the time of famine, other cities including Johannesburg contributed water through various projects to the residents of Cape Town. South Africa being one of the water strained countries is worsened by the growing inequality among the poor and the rich with the former having the feeling that the later are treated better. The study was piloted in Johannesburg within Johannesburg Metropolitan Municipality (JMM
	Learn to make sure there are no leaks at home (LA2)	[9]
Resources management	Do not throw wastewater carelessly (RM1)	[10]
	Making use of rainwater (RM2)	[11]

RESULT

The results of community preferences in efforts to save water for community resilience can be seen in Figure 1. Again, increasing learning and awareness is the highest community preference, accompanied by not dumping wastewater into water bodies carelessly.

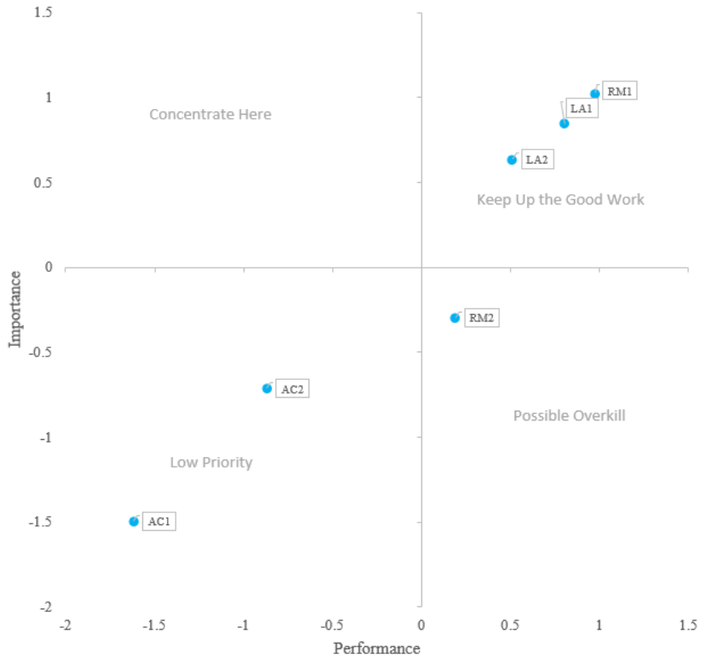

Figure 1. Result of IPA Analysis Quadrant

Based on the logit and probit models, it is found that people's attitudes toward using tap water and using rainwater have a significant effect on WTP. While demographic conditions also affect WTP (Table 2).

Table 2. WTP to Water Saving Program

Variable	Logit Model		Probit Model	
	Model 1	Model 2	Model 3	Model 4
Constant	-4.18865***	-4.08978***	-2.28380***	-2.22447***
Tap water customer (Yes=1, otherwise=0)	0.59460*	0.54467*	0.29652*	0.27743
Utilize rainwater (Yes=1, otherwise=0)	1.75701***	1.85095***	0.90117***	0.94535***
Gender (Male=1, otherwise=0)	0.97655***	0.98938***	0.51063***	0.52780***
Income (> Rp.2.500.000=1, otherwise=0)	-0.53661	-0.58306	-0.21287	-0.24121
Education (>senior high school=1, otherwise=0)	1.35999***	1.43299***	0.72613***	0.76520***
Age (> 29 year=1, otherwise=0)	0.75179**	0.75763**	0.41891**	0.42170**
Marital status (Single=1, otherwise=0)	-0.61697*	-0.60377*	-0.34865*	-0.33756
Mean IP	0.99504***	-	0.56202***	-
Mean PR	-	0.99285***	-	0.55720***
LLR	-167.91034	-166.6473	-167.91243	-166.68422
AIC	353.8	351.3	353.8	351.4
AIC/N	0.709	0.704	0.709	0.704
x2 (0.01, 8) = 20.090				

***,**,**: significance at 1% ,5% and 10% levels, respectively.

POLICY IMPLICATIONS

Since the declaration of sustainable development goals, also known as the SDGs, most countries in the world, including Indonesia, have followed up with various environmentally friendly development policies. In addition, it significantly increases the efficiency of water use in all sectors, ensures the use and supply of fresh water sustainable way to address water scarcity, and significantly reduces the number of people suffering from water scarcity. The efforts can support these steps based on their preferences to achieve water security by integrating WTP in quadrant one improvements.

CONCLUSION

Community choices for saving water for community resilience include raising learning and awareness and not carelessly discharging wastewater. In addition, the community's attitudes about utilizing tap water and rainfall affect WTP, as do demographic factors.

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. With the appointment of Nusantara as Indonesia's new capital through Law No. 3 Year 2022, concerns regarding water availability and aquifer crisis arise especially as Nusantara is located on top of medium- to low-productivity aquifers. Before Nusantara was elected to become the new capital's location, the local government of East Kalimantan has also been exposed issues such as water availability and access to clean water. The shift of capital would entail the utilization of groundwater resources in Nusantara, which pose huge aquifer crisis risks. In contrast, Singapore, a city-state with limited aquifers, does not have problems with water availability and aquifer crisis due to its water management policy that could accommodate its citizens' water demands. In this paper, the authors conducted a comparative analysis on Singapore's water management policies to provide recommendations on the shift of Indonesia's capital to ensure the fulfillment of water demands and mitigate aquifer crisis. Using a normative legal method, 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. The authors argue that the Indonesian government must improve its policies and regulations, keeping in mind lessons that can be learned from Singapore, to ensure water availability whilst preventing the possibility of damaging groundwater resources.

KEYWORDS: *Nusantara, Water Availability, Management Management, Groundwater, Aquifer Crisis*

Themes: Water, sanitation, and hygiene (WASH) behavior/practice in the society or Water Risk Assessment and Management **OR** Regulation Policies and Institutions

INTRODUCTION

Law No. 3 Year 2022 on New Capital marks Indonesia's decision to move its capital from Jakarta to Nusantara, Kalimantan.[16] From urban science perspective, it seems logical to move Indonesia's capital, which is currently packed. The location seems strategic as Kalimantan has a relatively low seismic activity, making it less prone to earthquakes.[17] However, keeping in mind the existing problems in Nusantara's location which affects its aquifer resources, i.e., deforestation and peat problems,[18] the following question arises: Will the shift of Indonesia's capital harm Nusantara's aquifer resources?

Despite Mahakam River in East Kalimantan being resourceful with its ability to discharge 5000 liters of water per second for 2.88 million people,[19] Nusantara's location does not have plenty water[20] nor aquifer resources.[21] Contrastingly, Singapore, a city-state 175 times smaller than the size of East Kalimantan, also face challenges in ensuring water availability due to its densely populated area and limited aquifers.[22] If Singapore is unable to prevent groundwater exploitation, 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.

By observing measures adopted by Singapore in ensuring water availability and reducing aquifer resources exploitation, this paper aims to provide solutions to the possible aquifer crisis from the shift of Indonesia's capital. The authors aim to answer two main research questions: How will Nusantara pose threats related to aquifer crisis? What lessons can be taken from Singapore to reduce aquifer crisis risks?

16 Law No. 3 Year 2022 on New Capital.
17 Tim Pusat Studi Gempa Nasional. (2017). *Peta Sumber dan Bahaya Gempa Indonesia Tahun 2017*. Badan Penelitian dan Pengembangan Kementerian Pekerjaan Umum dan Perumahan Rakyat. ISBN: 978-602-5489-01-3.
18 Theresia, Sihombing, R. M., Simanungkalit, F. (2020). The Impact of Indonesia Capital Relocation to Kalimantan Peatland Restoration. *Sociae Polites, 21(2)*, 234-244. https://doi.org/10.33541/sp.v21i3.2262
19 Van, C. P., Brye, B., Deleersnijder, E., Hoitink, A. J. F., Sassi, M., Spinewine, B., Hidayat, H., Soarez-Frazão, S.. (2016). Simulations of the flow in the Mahakam river–lake–delta system, Indonesia. *Environmental Fluid Mechanics, 16*, 603-663. https://doi.org/10.1007/s10652-016-9445-4
20 Mariwany, M. & Ware, G. (2022, April 14). *A tale of two cities: why Indonesia is planning a new capital on Borneo – and abandoning Jakarta. Podcast*. The Conversation. https://theconversation.com/a-tale-of-two-cities-why-indonesia-is-planning-a-new-capital-on-borneo-and-abandoning-jakarta-podcast-181134; Souisa, H. & Salim, N. (2022, January 30). *Nusantara is set to be the new capital of Indonesia, but what will happen to Jakarta?*. ABC. https://www.abc.net.au/news/2022-01-30/what-will-happen-to-jakarta-when-indonesia-builds-a-new-capital/100784566
21 Herlambang, A. (2022). 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)*, 1–11.
22 Gordon, J. (2014). On the Road to Independence: The Case of Water Management in Singapore.

METHODOLOGY

This research utilizes normative legal research, involving normative standpoints of policies to provide recommendations, and comparative approach on Singaporean 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.

RESULT

Nusantara is located on top of medium- to low-productivity aquifers.[23] Not only is Nusantara's aquifers limited, the scarce groundwater might not cater the needs of a capital city.[24] 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 aquifer crisis as evidenced by Jakarta's depletion of aquifer resources[25] stemming from the overpumping of groundwater.[26] Such risks raise the potential of land subsidence, sinkholes, and cracks in buildings,[27] and threatens the biodiversity of groundwater-dependent ecosystems.[28]

Acknowledging Singapore's high water demand and limited aquifers, the authors looked into Singapore's water management policies. Singapore updated its legislations to promote water conservation and the Public Utilities Board ("PUB") was given the authority to control Singapore's water management.[29] The city-state also focused on the following measures,[30] collectively contributing in minimizing the risk of endangering Singapore's aquifer resources:

Water Pricing

Singapore introduced incentive-based water billings, taxes,[31] and water price revisions. The PUB invests on the water meter installations in households to

23 Herlambang, A., supra n. 6.
24 *Ibid.*
25 Agustin, A., Zulkhoiri, A., Putra, R. D., Irawan, D. E.. (2016, September 25–29). *A Review of Groundwater Issues in Jakarta* [Conference presentation]. 43rd IAH (International Association of Hydrogeologists Congress, Montpellier, France.
26 Onodera, S., Saito, M., Sawano, M., Hosono, T., Taniguchi, M., Shimada, J., Umezawa, Y., Lubis, R. F., Buapeng, S., Delinom, R. (2008). 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)*, 401-410. https://doi.org/10.1016/j.scitotenv.2008.08.003
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28 Brown, J., Wyers, A., Bach, L., Aldous, A. (2009). *Groundwater Dependent Biodiversity and Associated Threats: A statewide screening methodology and spatial assessment of Oregon*. The Nature Conservancy; Devitt, T. J., Wright, A. M., Cannatella, D. C., Hillis, D. M. (2019). Species delimitation in endangered groundwater salamanders: Implications for aquifer management and biodiversity conservation. *Proceedings of the National Academy of Sciences, 116(7)*. https://doi.org/10.1073/pnas.181501411
29 Gordon, J., *supra n.* 7.
30 PricewaterhouseCoopers. *Singapore Water Management Framework* [Presentation]. https://www.gfdrr.org/sites/default/files/D3_CaseStudy14_PwC_WB_Water_Sector_in_Singapore_20160709.original.1531383095.pdf
31 Singapore Goods and Services Tax Act 1993 Rev. Ed. 2020

raise citizens' awareness of water usage.[32] Further, Singapore's water pricing consists of the following components:[33]

Water tariff: Imposed in association with the collection, treatment, and distribution of water

Water conservation tax: Imposed in association with the conservation of water by reflecting the water scarcity value

Waterborne fee: Imposed in association with costs utilized to treat and maintain water

From the above components, the water conservation tax was introduced in the 1990s along with Singapore's major revision of water price. Years after, Singapore 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.[34]

Water Conservation

To conserve water, Singapore conducts rainwater harvesting and utilizes advanced technologies, allowing the PUB to look into desalination and water recycling technologies,[35] which are currently relied on in ensuring Singapore's water availability. In regards to rainwater harvesting, Singapore has utilized a substantial amount of its land to establish rainwater collection catchments by creating a network of canals, which creates water supply whilst controlling floods.[36]

Singapore's prominent water recycling technology is known as NEWater, where the technology essentially converts water from urban sewage treatment plants to high-grade clean reclaimed water.[37] Commonly, clean water from NEWater is used for industrial purposes by various industries and for the purpose of air conditioning cooling in commercial buildings.[38] Such technology undoubtedly plays a major role in conserving water, understanding that industries and commercial buildings entail a huge demand of water. In attaining the final results of NEWater, the technology utilizes a 3-step purification process consisting of microfiltration, reverse osmosis, and ultraviolet disinfection.[39]

Public Education

Understanding the importance of water conservation, the government conducted numerous campaigns to increase public awareness.[40] Such measures were successful as reflected by Singapore's NEWater winning the UN-Water Best Practices Award in 2014 for raising citizens' awareness.[41] 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.[42]

DISCUSSION

Several measures implemented in Singapore have been implemented in Indonesia. Incentive-based water billings and investment on water meters has been implemented by the Indonesian government, which is under the obligation to replace water meters at least once every 4 years.[43] Furthermore, Indonesia has imposed taxes to both groundwater and clean water provided by the state-owned water utility (Perusahaan Daerah Air Minum/PDAM) Indonesia can still refine such efforts as resort to water resources provided by PDAM is still not at its maximum potential.[44]

Water conservation practices are also available, 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. Advanced technologies can certainly become an alternative to the usage of groundwater, minimizing aquifer crisis risks. However, such technologies can be energy consuming[45] 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.[46]

Aside from the previous measures, Singapore relies on the following sources to ensure water availability: water imported from Johor, Malaysia; rainwater

32 Singapore Public Utilities Act (Chapter 261, Section 72) G.N. No. S 584/2002 Rev. Ed. 2004.
33 C. Sanlath & N.M. Masila. (2020). Water demand management: What lessons can be learned from Singapore's water conservation policy?. *Water Utility Journal, 26*, 1–8. https://doi.org/10.13140/RG.2.2.22088.24325
34 PricewaterhouseCoopers, *supra n.* 15.
35 Gordon, J., *supra n.* 7.
36 Hindiyeh, M. Y., Matouq, M., Eslaiman, S. (2020). Rainwater Harvesting Policy Issues in the MENA Region: *Lessons Learned, Challenges, and Sustainable Recommendations* in *Handbook of Water Harvesting and Conseservation*. John Wiley & Sons, Inc. ISBN: 978-111-9478-95-39.
37 Bai, Y., et. al. (2020). 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*. https://doi.org/10.1016/j.watcyc.2020.09.001.
38 Hong Kong Research Office Legislative Council Secretariat (2016). NEWater in Singapore Fact Sheet. https://www.legco.gov.hk/research-publications/english/1516fsc22-newater-in-singapore-20160226-e.pdf.
39 Bai, Y., et. al., *supra n.* 22.
40 C. Tortajada, Y.K. Joshi. (2013). Water Demand Management in Singapore: Involving the Public. *Water Resources Management, 27(8)*. https://doi.org/10.1007/s11269-013-0312-5.
41 United Nations Department of Economic and Social Affairs (UNDESA). (2014). *'Water for Life' UN-Water Best Practices Award*. United Nations. https://www.un.org/waterforlifedecade/winners2014.shtml
42 PricewaterhouseCoopers, *supra n.* 15.
43 Regulation of Pontianak No. 4 Year 2009 on PDAM Tirta Khatulistiwa; Regulation of Bitung No. 9 Year 2012 on PDAM Duasudara Bitung; Regulation of Mojokerto No. 11 Year 2013 on PDAM Maja Tirta Mojokerto.
44 Saparuddin. (2005). Rintisan Menuju Kemandirian Air Minum Masyarakat Desa di Sulawesi Tengah. *Jurnal SMARTek, 3(3)*, 199–208.
45 Lafforgue, M. & Lenouvel, V. (2015). Closing the urban water loop: lessons from Singapore and Windhoek. *Environmental Science Water Research & Technology, 1(5)*, 622–631. https://doi.org/10.1039/c5ew00056d
46 Teo, E. Q (2019). *'Singapore's Solution to Water Scarcity: NEWater'*. Save The Water. https://savethewater.org/singapores-solution-to-water-scarcity-newater/#:~:text=What%20are%20some%20problems%20with,US%24125%20million%20to%20build.

harvesting; reclaimed water; and seawater desalination.[47] Several issues from the above sources include that first, it is Singapore's goal to avoid being dependent on external water sources such as from Malaysia.[48] Second, depending on reclaimed water and seawater desalination entail high energy consumption.[49]

CONCLUSION

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,[50] due diligence on the construction of the new capital needs to be conducted to avoid aquifer resources depletion. The measures in Singapore minimizes aquifer crisis risks by reducing water demands and searching for alternatives to groundwater. Regardless, Singapore is still exposed to numerous challenges spanning from its dependence on water imported from Malaysia, as well as its huge energy consumption linked to the usage of advanced technologies.[51] Accordingly, if Singapore's water management policy were to be adopted, Indonesia must take into account the challenges that may arise through such adoption. Notwithstanding the existence of several measures above in Indonesia, there are still numerous ways to improve the existing Indonesian water management system, i.e., improving the quality and availability of PDAM water, investing on water conservation technologies, and conducting campaigns to increase public awareness on water usage.

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47 *Ibid*; Octastefani, T. & Kusuma, B. M. A.. (2016). Water Governance of Singapore in Achieving Sustainable Water Security. *Jurnal Pembangunan dan Alam Lestari, 7(1)*, 1-10.

48 Lafforgue, M., *supra n.* 30.

49 *Ibid*.

50 Herlambang, A., *supra n.* 6.

51 Gordon, J., *supra n.* 7.

- C. Sanlath & N.M. Masila. (2020). Water demand management: What lessons can be learned from Singapore's water conservation policy?. *Water Utility Journal, 26*, 1–8. https://doi.org/10.13140/RG.2.2.22088.24325
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Prediksi Pengembangan Sistem Pengelolaan Air Limbah Domestik (SPALD) di Pulau Sumatera Tahun 2030 dengan Pendekatan Spasial

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PENDAHULUAN

Pulau Sumatera merupakan salah satu pulau dengan kepadatan penduduk terbesar kedua di Indonesia setelah Pulau Jawa, tentunya akan sangat berpengaruh dalam proses percepatan pembangunan di Indonesia. Hal ini terlihat dengan kontribusi Pulau Sumatera dalam Produk Domestik Bruto (PDB) pada capaian kumulatif 2015-2018 sebesar 21,58% diurutan kedua setelah Pulau Jawa dengan besarnya 58,49% (Kementerian PPN/Bappenas, 2019). Dari segi lingkungan dan sanitasi Pulau Sumatera memiliki akses terhadap layanan sanitasi layak pada tahun 2020 dengan rata-rata 78,1% lebih rendah dibanding Pulau Jawa sebesar 82,88% (Badan Pusat Statistik, 2021). Artinya Pulau Sumatera masih tertinggal dibanding Pulau Jawa yang notabene menjadi pusat perekonomian di Indonesia berdasarkan data di atas. Sementara target 2030 dalam percepatan *Sustainable Development Goals* (SDGs) adalah 100% akses sanitasi layak dan 53,71% sanitasi aman (Kementerian PPN/Bappenas, 2018). Pemilihan Pulau Sumatera sebagai wilayah studi tidak terlepas terhadap potensi yang dimiliki masing-masing daerah jika dapat diintegrasikan satu dengan yang lainnya, maka dapat mendorong percepatan pembangunan nasional demi tercapainya pembangunan yang berkelanjutan.

Studi ini bertujuan mengidentifikasi dan manganalisis sistem sanitasi (pengeloaan air limbah domestik) dengan menganalisis potensi sanitasi melalui pemetaan proyeksi persebaran penduduk berdasarkan tata guna lahan untuk mendapatkan kepadatan penduduk yang nantinya digunakan untuk memperoleh prediksi persebaran sanitasi setiap kabupaten/kota nya dalam mencapai target pembangunan berkelanjutan (SDGs) tahun 2030 di Pulau Sumatera. Ini tentunya mampu menjadi bahan pertimbangan kepada pemerintah dalam mengambil kebijakan untuk mengimplementasikan target rencana pengelolaan air limbah domestik guna mempercepat pembangunan daerah yang berkelanjutan.

METODOLOGI

Dalam melakukan pendekatan, dasar pemilihan, asumsi dan perhitungan, maupun prosedur atau langkah-langkah didasarkan pada referensi maupun studi terdahulu, dokumen-dokumen terkait acuan populasi dan proyeksi penduduk, akses dan kondisi sanitasi, data spasial meliputi data tata guna lahan, jalan, dan peta dasar Pulau Sumatera, serta kebijakan dan regulasi yang merujuk kepada arah dan target Rencana Pembangunan Jangka Menengah Nasional (RPJMN) serta pembangunan yang berkelanjutan (SDGs).

Analisis Statistik dan Spasial

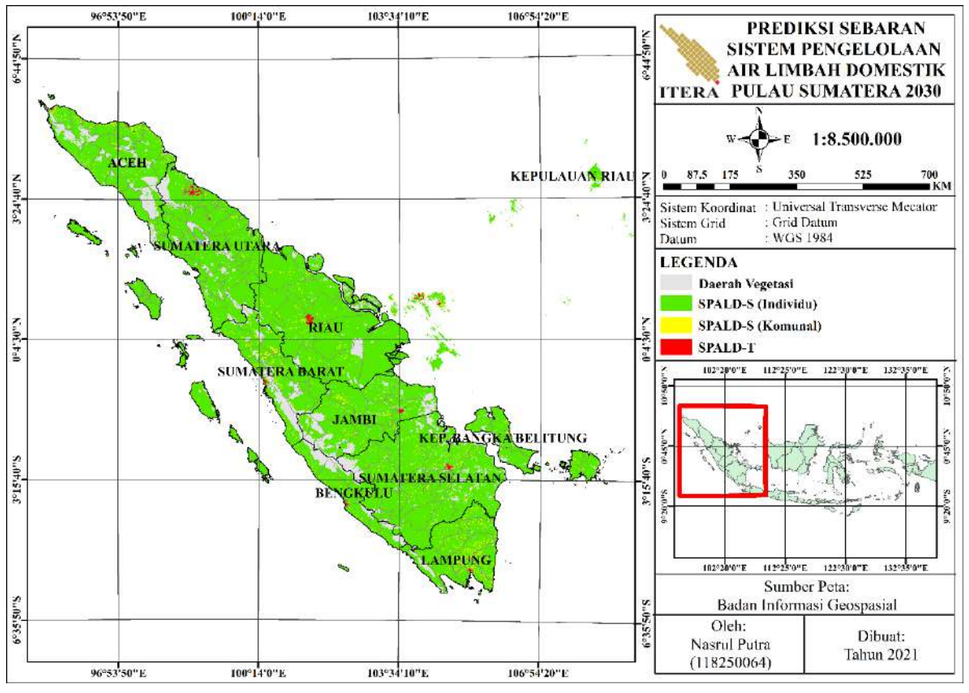
Penentuan sistem sanitasi (SPALD) berdasarkan kepadatan penduduk sesuai dengan penelitian terdahulu oleh Kersten dkk (2015 dan 2016) dan Permen PUPR No 04/PRT/M/017 Tahun 2017 dengan kepadatan penduduk sebagai kategori utama penentuan SPALD. Maka, perlu menghitung proyeksi penduduk untuk target prediksi tahun 2030 dalam upaya percepatan SDGs yang dianalisis persebarannya berdasarkan tata guna lahan menggunakan pembobotan kelas lahan untuk penggambaran potensi penduduk pada setiap lahan dengan pendekatan spasial pada Sistem Informasi Geografis (SIG). Pembobotan ini berdasarkan nilai selisih dari fungsi sosial dan ekonomi (Fawaid, 2018), sehingga akan diperoleh persebaran penduduk pada wilayah permukiman dan non permukiman (daerah persawahan, pertambangan, perkebunan, tambak, hutan, dan sejenisnya) untuk mendapatkan kepadatan penduduk yang nantinya akan digunakan dalam menentukan kategori sistem sanitasi yang direncanakan.

Dasar Pemilihan Sistem Pengeloaan Air Limbah Domestik (SPALD)

Dasar pemilihan SPALD yang didasarkan pada pendekatan kepadatan penduduk suatu wilayah yang dikategorikan menjadi SPALD-Setempat skala individu (SPALD-S individu) dengan kepadatan penduduk <10.000 orang/km^2 (wilayah non permukiman), SPALD-Setempat skala komunal (SPALD-S komunal) dengan kepadatan penduduk >10.000 orang/km^2 (wilayah non permukiman) dan < 15.000 (wilayah permukiman), serta SPALD-Terpusat (SPALD-T) dengan kepadatan penduduk >15.000 (wilayah permukiman).

HASIL DAN PEMBAHASAN

Hasil yang diperoleh berdasarkan pertimbangan kepadatan penduduk pada masing-masing kabupaten/kota yang dianalisis dengan pendekatan spasial. Di mana penduduk Pulau Sumatera tersebar di wilayah permukiman dengan kepadatan penduduk rata-rata 1.633,02 orang/km^2 (93,53%) dan non permukiman dengan kepadatan penduduk rata-rata 113,05 orang/km^2 (6,47%). Dari hasil tersebut menjadi patokan untuk menentukan sistem sanitasi (SPALD) yang tepat untuk setiap kabupaten/kota yang kemudian diselaraskan dengan program pemerintah dalam Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2020-2024 terhadap daerah prioritas untuk pembangunan SPALD-T. Didapatkan hasil pada tahun 2030 untuk mencapai akses sanitasi layak 100% di Pulau Sumatera diperoleh komposisi dengan target SPALD-S individu sebesar 69,07%, SPALD-S komunal sebesar 16,56%, dan SPALD-T sebesar 14,37% yang diperoleh berdasarkan total jumlah pengguna pada setiap jenis SPALD nya. Secara visual dapat dilihat pada **Gambar 1.**



Gambar 1. Peta prediksi sebaran SPALD Pulau Sumatera 2030

Melihat dari hasil tersebut, beberapa wilayah kabupaten/kota di Pulau Sumatera sudah mulai melakukan upaya dalam rangka peningkatan akses sanitasi layak, diantaranya seperti di Kota Pekanbaru dengan adanya pembangunan Instalasi Pengolahan Air Limbah (IPAL) domestik terpusat dari program *Metropolitan Sanitation Management Investment Project* (MSMIP) pada November 2018 yang diperkirakan rampung pada tahun 2022 (Annisa, 2021). Kemudian juga adanya pembangunan IPAL di Kota Palembang dengan kapasitas 20.300 m^3/hari yang melayani 21.700 sambungan rumah (SR) melalui program *Palembang City Sewerage Project* (PCSP) pada akhir tahun 2020 dan diperkirakan rampung pada tahun 2022 (Kementerian PUPR, 2020). Namun, hal ini tentunya masih belum mencukupi kebutuhan target tahun 2030 dari segi kapasitas dan cakupan pelayanan serta aspek lainnya. Maka dari itu, dari hasil yang sudah diperoleh terkait prediksi target capaian untuk setiap jenis SPALD, dapat menjadi bahan pertimbangan dan acuan yang terarah oleh pemerintah setempat dalam upaya melakukan percepatan peningkatan akses sanitasi. Sehingga dapat mengukur sudah sejauh mana pelayanan yang sudah dicapai dari program-program yang ada serta seberapa besar target yang perlu diupayakan pemerintah untuk mencapai target pada tahun 2030.

KESIMPULAN

Sistem Pengelolaan Air Limbah Domestik (SPALD) di Pulau Sumatera pada tahun 2030 merupakan 100% sanitasi layak dengan percepatan berdasarkan capaian rata-rata sanitasi layak di Pulau Sumatera pada tahun 2020 sebesar 78,1% dengan pengelolaan air limbah domestik minimal adalah pengolahan di tempat (SPALD-S) baik skala individu maupun komunal. Berdasarkan skenario perhitungan sistem sanitasi (SPALD) yang direkomendasikan pada wilayah kabupaten/kota setiap provinsi di Pulau Sumatera masih sebatas SPALD-S individu dan SPALD-S komunal untuk mencapai target SDGs sanitasi layak 100% di tahun 2030. Namun, diselaraskan dengan program pemerintah dalam RPJMN 2020-2024 terhadap daerah prioritas untuk pembangunan SPALD-T, sehingga komposisi capaian 100% akses sanitasi layak tahun 2030 adalah dengan SPALD-S individu sebesar 69,07%, SPALD-S komunal 16,56%, dan SPALD-T sebesar 14,37% berdasarkan total jumlah pengguna setiap jenis SPALD nya.

Status Mutu Air Tanah di Kawasan Kumuh Kota Bima dengan Menggunakan Metode Indeks Pencemaran sebagai Upaya Pemantauan Kualitas Air Baku untuk Kebutuhan Higiene dan Sanitasi

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PENDAHULUAN

Peningkatan pertumbuhan penduduk di Indonesia yang tidak diiringi dengan ketersediaan sarana dan prasarna yang layak dapat memicu munculnya kawasan kumuh (Harisun, dkk., 2019). Kota Bima merupakan salah satu wilayah di Indonesia yang memiliki banyak kawasan kumuh termasuk di dalamnya Kelurahan Paruga dan Sarae yang merupakan daerah yang masuk dalam program KOTAKU, PUPR Kota Bima. Masyarakat Kelurahan Paruga dan Sarae masih menggunakan air tanah sebagai air baku kegiatan higiene dan sanitasi. Namun, pada kedua kelurahan tersebut memiliki sistem pengolahan air limbah domestik yang masih buruk dimana sebagian air limbah langsung dibuang tanpa dilakukan pengolahan langsung ke tanah dan ke badan air dan masih banyak tangki septik yang tidak sesuai SNI dan jarak air tanah sebagai air bersih <10 m dengan pembuangan air limbah atau dengan kata lain tidak memiliki akses aman (PUPR Kota Bima, 2020). Permasalahan tersebut dapat berpotensi mencemari air tanah. Dekatnya kedua lokasi penelitian dengan laut juga dapat menyebabkan pencemaran air akibat pencemar lain. Penelitian ini bertujuan untuk mengetahui kualitas serta status mutu air tanah di kawasan kumuh Kota Bima sebagai air baku kegiatan higiene dan sanitasi menggunakan metode indeks pencemaran berdasarkan Permenkes RI Nomor 32 Tahun 2017 dan KepMenLH Nomor 115 Tahun 2003.

METODOLOGI

Lokasi penelitian yaitu RT 9 dan RT 12 Kelurahan Paruga serta RT 2, 3, dan 4 Kelurahan Sarae, Kecamatan Rasanae Barat, Kota Bima. Penentuan lokasi pengambilan sampel dilakukan dengan metode *purposive sampling* yaitu dengan pertimbangan untuk melihat adanya pengaruh kawasan kumuh terhadap kualitas air tanah. Sampel air tanah adalah air sumur bor dan air sumur gali yang terdiri dari 9 stasiun, yaitu 6 stasiun (3 stasiun di RT 9 dan 3 stasiun di RT 12 Kelurahan Paruga) dan 3 stasiun (masing-masing 1 stasiun pada RT 2,3, dan 4 Kelurahan Sarae). Pengambilan sampel dilakukan secara *grab sampling* dengan prosedur pengambilan serta perlakuan sampel mengacu SNI 6989.58:2008.

Sampel air tanah kemudian dilakukan pengujian yang terdiri dari parameter temperatur, pH, TDS, warna, kekeruhan, kesadahan, mangan, nitrat, sulfat, dan zat organik. Pengujian dilakukan secara *in-situ* (pH, suhu, TDS) dan di laboratorium. Metode pengujian kualitas air di laboratorium terdiri dari APHA-2120-B, APHA-2130-B, APHA-2340-C, APHA-3500-Mn-B, APHA-4500-NO_3-B, APHA-4500-SO_4-E, dan SNI 06-6989-22-2004. Analisis kualitas air tanah dilakukan dengan membandingkan hasil pengujian dengan baku mutu air untuk kegiatan higiene sanitasi Permenkes RI Nomor 32 Tahun 2017. Penentuan status mutu air dilakukan menggunakan metode indeks pencemaran (IP) berdasarkan KepMenLH Nomor 115 Tahun 2003.

HASIL

Kualitas air tanah yang dianalisis terdiri dari 10 parameter. Hasil pengujian dibandingkan dengan baku mutu pada Permenkes RI No.32 Th.2017 dengan hasil perhitungan nilai IP serta status mutu air tanah terdapat pada **Tabel 1**.

Tabel 1 Hasil uji kualitas dan status mutu air tanah

No	Parameter	Baku Mutu	Hasil Pengujian Stasiun								
			1 (bor)	2 (gali)	3 (bor)	4 (bor)	5 (gali)	6 (gali)	7 (gali)	8 (bor)	9 (bor)
1	TDS	1000 mg/L	779	833	895	1000	1060	1000	1130	3350	733
2	Warna	50 Pt.Co	5	5	5	5	5	5	7	5	5
3	Kekeruhan	25 NTU	3,63	11,1	5,3	1,45	1,1	5,5	14,9	10,4	4,57
4	Temperatur	Suhu Udara ± 3°C	32	33	29	29	29	28	29	29	30
5	Kesadahan	500 mg/L	335	566	323	400	541	517	457	2509	259
6	Mangan	0,5mg/L	0,159	1,42	0,193	0,374	0,422	<0,025	0,285	1,11	0,159
7	Nitrat(NO_3)	10mg/L	1,16	3,87	1,33	4,67	2,41	4,02	1,61	2,61	0,871
8	pH	6,5-8,5	6,86	6,7	7,02	6,89	6,62	6,7	7,02	7,02	7,26
9	Sulfat	400 mg/L	<4	33,3	<4	59,8	118	94	71	328	45,2
10	Zat Organik	10mg/L	1,96	8,67	9,23	5,03	3,36	5,31	5,03	13,7	5,31
Nilai IP			0,598	2,395	0,717	0,788	0,918	0,834	0,792	3,385	0,564
Status Mutu Air			MB	CR	MB	MB	MB	MB	MB	CR	MB

Keterangan:

: Tidak memenuhi baku mutu

MB : Memenuhi baku mutu

CR : Cemar ringan

PEMBAHASAN

Berdasarkan hasil pengujian kualitas air tanah pada lokasi studi yang dimanfaatkan untuk kegiatan higiene dan sanitasi, parameter-parameter yang memiliki konsentrasi pencemaran dapat disebabkan oleh pencemaran air limbah domestik karena tidak terdapat aktivitas pertanian, peternakan, maupun industri di sekitar lokasi pengambilan sampel. Kontaminasi dapat terjadi karena dekatnya air bersih dengan saluran buangan air limbah *grey water* dan pembuangan air limbah kakus atau *black water* yang langsung ke tanah tanpa pengolahan seperti penggunaan tangki septik. Dengan kedalaman sumur air bor hanya berkisar 5-12 meter dan air sumur gali 3-6 meter, maka dapat berakibat pencemaran akibat resapan air limbah domestik dengan beberapa karakteristik yaitu zat organik, nitrogen, ammonia, sulfat, kesadahan (Metcalf & Eddy, 2014). Lebih lanjut, pada beberapa parameter terjadi fluktuasi dengan konsentrasi lebih tinggi pada beberapa stasiun akibat karakteristik tanah dan batuan untuk parameter kesadahan dan mangan, untuk parameter TDS karena intrusi air laut (R Afrianata, dkk, 2017) dan tingginya kesadahan (Nugraha, 2016).

Status mutu air tanah yang dilakukan menggunakan metode indeks pencemaran berdasarkan KepMenLH Nomor 115 Tahun 2003. Perolehan nilai IP bergantung pada konsentrasi tertinggi dan konsentrasi rata-rata tiap sampel yang berbeda antar stasiun satu dan lainnya dengan nilai IP tertinggi adalah

Stasiun2 dan Stasiun8 (cemar ringan). Pada nilai indeks pencemaran sampel air sumur gali relatif lebih tinggi dibanding air sumur bor, kecuali sampel Stasiun8, yang artinya tingkat pencemaran pada air sumur gali lebih tinggi dibandingkan air sumur bor. Hal tersebut dapat terjadi karena tidak terdapat penutup pada bagian atas sumur gali sehingga menyebabkan mudahnya bahan pencemar masuk ke dalam air (Souisa&Janwarin, 2018).

KESIMPULAN

Kualitas air tanah sebagai air baku untuk kegiatan higiene dan sanitasi yang terdiri dari air sumur bor dan sumur gali yang diuji dari 10 parameter, untuk parameter TDS, kesadahan, mangan, dan zat organik tidak memenuhi baku mutu berdasarkan Permenkes RI Nomor 32 Tahun 2017. Status mutu air tanah yang dihitung berdasarkan KepMenLH Nomor 115 Tahun 2003 pada 9 stasiun adalah 7 stasiun memenuhi baku mutu serta 2 stasiun lainnya cemar ringan.

Eksplorasi Pola Konsumsi Air Domestik Rumah Tangga pada Masyarakat Kawasan Kumuh di Kota Bima, Indonesia

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PENDAHULUAN

Standar konsumsi air domestik yang terbagi berdasarkan kategori perkotaan dan masih berlaku di Indonesia masih belum cukup menggambarkan kebutuhan air bersih masyarakat yang tinggal di kawasan kumuh perkotaan. Walaupun tinggal di perkotaan, masyarakat dengan karakteristik rendah kesejahteraan ini berbeda signifikan dengan karakteristik masyarakat kota yang biasa tergambarkan pada umumnya. Salah satu kota di Indonesia yang mayoritas kelurahannya merupakan kategori kawasan kumuh adalah Kota Bima. Terbatasnya penelitian yang membahas konsumsi air domestik masyarakat kawasan kumuh perkotaan di Indonesia mendorong peneliti untuk melakukan studi lebih lanjut pada masyarakat kawasan kumuh Kota Bima dalam mengidentifikasi rata-rata jumlah konsumsi air domestik dan menganalisis pola konsumsi air domestik berdasarkan jenis kegiatandomestik.

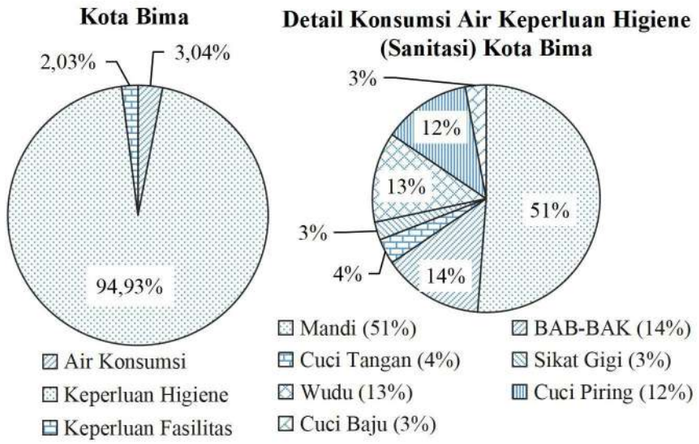
METODOLOGI

Artikel ini menyajikan studi *cross-sectional* kuantitatif yang mengeksplorasi pola konsumsi air domestik masyarakat kumuh di Kota Bima. Dengan metode *purposive sampling*, Kelurahan Paruga dan Kelurahan Sarae dipilih karena memiliki tipologi permukiman kumuh di tepi air sekaligus di daerah rawan bencana banjir. Probabilitas sampel acak sederhana secara proporsional dengan tingkat kepercayaan 90% diterapkan dalam memperoleh jumlah sampel pada lokasi studi. Sehingga didapatkan 88 perwakilan keluarga sebagai responden survei.

Terdapat 3 kelompok kegiatan konsumsi air domestik secara garis besar, yaitu air konsumsi (air minum dan air keperluan memasak), keperluan higiene atau sanitasi(mandi, toilet, cuci tangan, sikat gigi, wudu, cuci piring, dan cuci baju), dan keperluan fasilitas (cuci kendaraan, siram tanaman, dan pel lantai). Kedua belas pola kegiatan konsumsi air tersebut ditetapkan pada studi ini untuk memperoleh jumlah sekaligus pola konsumsi air domestik masyarakat. Sebagai mempermudah pemahaman responden, sebanyak 34 pertanyaan parametrik terkait pola konsumsi air secara statistik terbukti valid (nilai $r > 0,3$) dan sangat reliabel ($0,8 < r11 < 1,0$) setelah dilakukan uji pilot sebanyak dua kali pada lokasi yang juga merupakan masyarakat kawasan kumuh.

HASIL

Gambaran umum pola konsumsi air domestik masyarakat kawasan kumuh KotaBima (n = 88) pada periode pengambilan sampel diilustrasikan pada Gambar 1.



Gambar 1. Persentase kebutuhan air domestik per orang per hari berdasarkan pola konsumsi.

Secara garis besar, terdapat 3 kelompok kegiatan konsumsi air domestik padapembahasan studi ini.

1. Air konsumsi merupakan kelompok kegiatan penggunaan air untuk minumdan air untuk memasak.
2. Keperluan higiene (sanitasi) merupakan kelompok kegiatan penggunaan air dalam kegiatan kebersihan diri, seperti mandi, buang air kecil (BAK) maupunbuang air besar (BAB), cuci tangan, sikat gigi, wudu, cuci piring, dan cuci baju.

3. Keperluan fasilitas merupakan kelompok kegiatan penggunaan air pada kegiatan yang bukan utama dalam kegiatan domestik, seperti cuci kendaraan,siram tanaman, dan pel lantai.

Kemudian, statistik deskriptif dari jumlah konsumsi air domestik pada masyarakat kumuh lokasi sampel disajikan dalam Tabel 2. Kebutuhan air domestik yang telah diukur disajikan dalam satuan liter per orang per hari (l/o/h).

Tabel 2. Statistik deskriptif pola konsumsi air domestik.

Kegiatan Domestik	n	Rata-Rata ± Std. Deviasi	Minimum	Maksimum
		(L/O/H)	(L/O/H)	(L/O/H)
Air konsumsi				
Minum	81	3,2 ± 1,59	0,75	6
Masak	83	2,9 ± 1,53	0,75	6,25
Keperluan Higiene (Sanitasi)				
Mandi	88	94,1 ± 49,11	22,5	202,5
BAB-BAK	82	27,9 ± 9,32	12,5	55,0
wudu	77	26,5 ± 14,00	7,75	60
Cuci piring	83	24,1 ± 12,07	2,4	52,8
Cuci tangan	84	7,0 ± 3,66	1,25	15
Cuci baju	87	5,5 ± 3,95	0,63	15,43
Sikat gigi	81	5,1 ± 2,39	1,75	10,5
Keperluan Fasilitas				
Cuci kendaraan	58	1,4 ± 1,31	0,1	4,4
Siram tanaman	30	4,2 ± 2,86	0,3	10,5
Pel lantai	72	1,8 ± 1,22	0,39	4,50
Rata-Rata Jumlah Konsumsi Air		**193,50 ± 61,97**	**70,38**	**351,28**

PEMBAHASAN

Konsumsi air domestik masyarakat kawasan kumuh pada lokasi sampel menunjukkan rata-rata jumlah kebutuhan air yang lebih tinggi (193,50 l/o/h) daripada standar yang telah ditetapkan oleh SNI 6728-1-2015 pada tipologi Kota Bima (kota sedang: 100-125 l/o/h) dan sebagai kebutuhan dasar manusia berdasarkan yang telah ditetapkan dalam skala nasional (60 l/o/h[1]) dan skala internasional (70 l/o/h[2]). Bahkan, nilai konsumsi air domestik Kota Bima berbeda secara pengamatan dengan penelitian yang telah memetakan jumlah konsumsi air rata-rata pada kawasan kumuh perkotaan di negara berkembang

seperti di Jaipur, India (13,3 l/o/h)[3], di Kathmandu, Nepal (56 l/o/h)[4], dan di Bandung, Indonesia (134 l/o/h)[5]. Hasil analisis memberikan bukti empiris yang menunjukkan bahwa rata-rata suhu pada periode penelitian (32 °C)[6], mendorong masyarakat untuk melakukan kebersihan diri (higiene; sanitasi) menjadi lebih intens. Kondisi ini sama halnya pada penelitian yang dilakukan di Bandar Lampung, yang mana air tetap melimpah walaupun dalam musim kemarau[7]. Meskipun lokasi studi berstatus kawasan kumuh, terpenuhinya konsumsi air masyarakat dapat dikaitkan dengan adanya kelimpahan air yang diakibatkan lokasi penelitian secara topografi berpotensi mengalami intrusi air laut pada sumber air tanah masyarakat. Walaupun belum ada studi yang ditemukan mengenai kualitas air tanah pada kawasan kumuh Kota Bima, masyarakat setempat yakin bahwa air tersebut bersifat payau akibat intrusi dari air laut.Sehingga hal ini menjadikan masyarakat meremehkan penggunaan air atau memiliki sikap rendah dalam perilaku konservasi air.

PENUTUP

Konsumsi air domestik masyarakat di kawasan kumuh perkotaan memiliki rata- rata jumlah konsumsi air domestik masyarakat sampel adalah 193,50 liter per orang per hari. Dari 12 pola kegiatan domestik, 4 diantaranya merupakan konsumsi terbesar masyarakat yang merupakan bagian dari kegiatan masyarakat dalam menjaga kebersihan diri, yaitu mandi (51,3%), toilet (14,3%), wudu

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• (12,9%), dan cuci piring (12,4%). Dengan demikian, tingginya volume kebutuhan air domestik hasil studi berbeda dari SNI 6728-1-2015 dan kebutuhan minimal manusia memerlukan pembaharuan kebijakan dalam pemenuhan air domestik masyarakat kawasan kumuh perkotaan. Disamping itu, dapat diterapkan inovasi teknologi ataupun kebijakan pada hasil buangan air domestik terbesar yang memiliki potensi dapat dimanfaatkan berdasarkan kelas air yang akan dihasilkan. Terakhir, dapat juga dilakukan penyadaran kepada masyarakat kawasan kumuh dalam konservasi air agar air dapat digunakan berkelanjutan.

KATA KUNCI: pola, konsumsi air domestik, kumuh perkotaan

Upgrading the Wastewater Sanitation System for Urban Area, Johar Baru District, Central Jakarta

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As the center of government and the center of the economy, Jakarta has various problems from the high flow of urbanization to this city. One of the problems that occurs is the high population density in several areas in Jakarta. This density tends to lead to social, economic, environmental and so forth inequality problems. The densely populated locations selected were Johar Baru District, Central Jakarta and the Tanah Tinggi subdistrict was selected as a pilot project as an example of planning for other sub-districts. Tanah Tinggi sub-district was chosen because it has the highest open defecation progress compared to other sub-districts, namely 25.13% and has the highest dengue hemorrhagic fever sufferer rate, namely 0.24%. The purpose of this plan is to find solutions in the sanitation sector that are appropriate to the problems in the related sub-districts and to recommend the right technology to improve health rates. The data collection method is carried out by surveying and seeking data from relevant agencies as well as the governments. After getting some initial data such as population density figures and health figures, it is necessary to collect data taken from questionnaires.

The questionnaire was made to find problems that occur in the community so that in making it, it is necessary to determine important points. These points concern the ownership of a septic tank as a simple wastewater treatment in the house, the type of water used and the use of the water, the cleanliness of the use of the bathroom and the economic level of the community seen from the type of building occupied. Determination of the questionnaire sample using the Slovin formula and purposive sampling technique. Questionnaire data collection was carried out directly using the mWater application to facilitate data retrieval. The mWater application also makes it easy to do geotagging so mapping can be done more quickly. The questionnaire was distributed to 11 RWs with the criteria of high population density and poor access to sanitation. Divided into 82 respondents with 1 house for each respondent. Data collection was carried

out for approximately 1 week. After collecting data using the questionnaire method, followed by data analysis. The result is that in 1 house, the average family member in 1 house is between 3 - 6 members with a house area that varies with an average of 3 - 24 m^2. The type of house building that shows the economic level of the community shows that the average yield of residential buildings in Tanah Tinggi sub-district is semi-permanent with a value of 55% and is comparable to PDAM costs per month with the highest score of 31.5%, which is between 75000 - 130000.

The community in Kelurahan Tanah Tinggi owns 62% of the septic tank but when asked further the existing septic tank has never been emptied, indicating that there is a leak in the septic tank. As for sanitation disease itself, people rarely experience it because 55% people of the sample use PDAM water that has been tested. Each RW has advantages and disadvantages in finding the right sanitation solution in terms of topography, available sanitation infrastructure, and the community's economic level. The solution that can be offered is to find vacant land to be used as a communal WWTP in the form of a shared septic tank for 5 – 10 houses. If there is a larger plot of land, a package WWTP can be built that can function for 10-20 houses. Communal WWTP or shared septic tanks can be charged by the community for future management and processing. If the community's residence already has a septic tank, then the septic tank can be relocated if the land in the house is still sufficient.

Every areas in Tanah Tinggi sub-district has sewerage network that link to each other so it is easier to plan a shared septic tank or wastewater treatment plant but it has its very own problems. The densely populated areas make the most area is full of building that also has very narrow street and areas. In the north side of Tanah Tinggi sub-district, RW 01, 03, 014, and 011, the topography in the area tends to decrease towards the south so that it can be planned on the available vacant land or below the streets for the development of simple wastewater treatment plant. Any other RWs has connect its sewerage into main river on the eastern side of Tanah Tinggi sub-district, so its topography also tend to decrease. On the banks of the river, there is still vacant land where a package WWTP can be built which is sufficient for around 10 houses, and it is for RW 08, 09, 010, 012, 013. For RW 06 and 07, the option for its problem is to build shared septic tank because the areas is far from the river. RW 06 is still sufficient for its house to build or expand their septic tank because the house area is tend to wide.

Constructing Boundary Work: Unpack the Multi-Discipline Collaboration Research in WASH Project

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BACKGROUND

The dominant studies on boundary work seek to emphasize the importance of hybrid forums among different actors to build new values and understandings (Horn, 2023; Callon, et.al., 2007).Guston (1999, 2001) provides another emphasis on the importance of boundary organizations, whose has job to ensure collaboration between different knowledges so that they can be realized. However, this study offers a different narrative by showing that the boundary work in research collaborations between science (global north and global south) and policy (stakeholders) are the result of social construction based on the presence of boundaries of text, objects, and people framework.

This study uses the case of the Water, Sanitation, and Hygiene (WASH) project, which is a collaborative research project between Gadjah Mada University (UGM), Indonesia, and Monash University, Australia. The WASH project seeks to comprehend local government actions regarding water and sanitation during the COVID-19 pandemic. The climate crisis has affected urban lives. It can be seen from sea level rises that have given an impact a tidal flood in coastal areas, especially in the part of North of Java. One of the cities in Indonesia, named Semarang, experiences tidal flooding every week. This process has implications for residents in accessing clean water, sanitation, land subsidence and more importantly in the women's health (re: reproduction). This study analyzes by looking at the construction of interactions between science and policy in WASH project. This collaboration raises the question: 1) how did WASH project members negotiate science and policy boundaries within this multi-disciplin collaboration? 2) how does WASH project members in Semarang manage shared knowledge about water hygiene?

This article has academic and practical goals. At the academic level, studies to reconstruct the relationship between science and policy in multi-disciplinary collaboration tend to be taken for granted. This study adds new insights about

how the relationship between science and policy canbe communicated through three mediums, namely text, object, and person. At a practical level, this study can be a basis for policymakers to design appropriate science-based policies. So far, science-based policies have only been slogans. This study then provides a point of awareness thatif the government want to encourage science-based policies, government need prior understandingof each actor involved.

METHODOLOGY

This article uses a qualitative method with a historiographical variant. The primary data for this article is a call for papers on "The Impact of COVID-19 on Indonesia's Economy and Society" with a sub-focus on health; meeting notes from September 2020 to November 2020; research proposal; research agreement documents from the Australia Indonesia Center (AIC) and the Australian Department of Foreign Affairs and Trade; proposal acceptance letter; transcripts of interviews with 25 female residents in Tambak Lorok, Semarang; nine stakeholders; two FGDs notes with stakeholders; and research instruments. Furthermore, this article takes the sociology of scientific knowledge (SSK) as the methodology. SSK is an approach popularized by Science and Technology Studies (STS) scholars that emphasizes that all scientific and technological phenomena are the result of social construction (Shapin 1995; Bijker 2001).

RESULT

Halffman (2003) argues if the one medium in the TOP model is missing, thus it gives an impact on the failure of the interaction of science and policy (Halffman, 2003; Halffman & Hoppe, 2005). Halffman (2003) divides boundary work into three mediums that could 'form' boundaries but also bridge their interactions. In the first medium, the type of text is characterised by rhetoric, language and literary tools (Halffman, 2003, p.60). Furthermore, it refers to the social nature (habits, socialnetworks), language (protocols, concepts), or even material objects (measurement networks, testing equipment, buildings) (Hoppe & Halffman, 2005). Our findings show that "Small Rapid Research Grants' document from The Partnerships for Australia-Indonesia Research (PAIR) dan The Australia-Indonesia Center (AIC) contribute to the establishment of science and policy boundaries. The document contains a specific requirement, for instance, a list of universities and sub-topics.

In the second medium, the object becomes a material boundary device that is used to be a landmark of the boundary (Halffman, 2003, p. 60). This idea explains objects that are understood differently between both actors so that it has implications for differences in activities between them, but they still refer to these objects as the basis of their activities. We find research reports become theboundary object. The research reports separate practices between scientific and policy activities. The person as the last medium describes the agency that stands between the two social worlds,which can play a role and move by being a representative of the relationship between science and policy (Halffman, 2003, p.61). These positions are identified differently as gatekeepers or knowledge brokers. In this WASH project, the role of the boundary person is missing which has been proven by demarcation from small rapid research grants from PAIR-AIC.

DISCUSSION

The study argues the relationship between science and policy in the WASH project has unconsciously formed a boundaries. A study from Imawan, AP (2022), shows the same symptom by showing that the presence of shifting boundary people has resulted in a failure of knowledge integration in consortium settings. Furthermore, the reflections show that the dominance of knowledge from the Global North (re: Netherlands) has contributed to the setting of research collaboration (Imawan, AP, 2022). On that basis, the need to develop science-based policies in Indonesia still requires much more effort.

CONCLUSION

Multi-discipline research collaboration is a form of knowledge co-creation that is currently popular in Indonesia. The spirit of linking science and policy is also voiced by the current authorities. Nevertheless, the case of the WASH project shows that the loss of boundary people results in thefailure of science-based policy creation.Science and policy have not interacted with each other because the absent of boundary person operating between them. The research collaboration was not entirely successful and resulted in a failure to manage shared knowledge about water hygieneand sanitation.

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Analisis Pengaruh Residual Klorin Terhadap Kualitas Mikrobiologi pada Jaringan Distribusi Air Bersih

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ABSTRACT

Desinfeksi merupakan salah satu tahapan proses pengolahan air yang bertujuan untuk membunuh mikroorganisme dalam air. Konsentrasi klor di sepanjang jaringan distribusi harus memenuhi baku mutu air minum Permenkes no. 492/MENKES/IV/2010 tentang Persyaratan Kualitas Air Minum yaitu 5 mg/L. Air pada jaringan distribusi dapat mengalami kontaminasi diakibatkan kebocoran pipa. Hal tersebut merupakan celah mikroorganisme masuk ke dalam jaringan pipa distribusi. Penelitian ini bertujuan untuk mengetahui kualitas air dalam jaringan distribusi dan menganalisis penurunan klor dalam pipa jaringan distribusi. Parameter kualitas air yang diukur yaitu pH, suhu, kekeruhan, residu klor, bakteri koliform, dan *E. coli*. Sampel air diambil pada reservoir, titik terdekat dengan reservoir, titik median jaringan distribusi, dan titik terjauh jaringan distribusi. Penurunan konsentrasi klor dianalisis menggunakan EPANET. Dari penelitian didapatkan bahwa telah ditemukan kondisi air positif tercemar bakteri koliform pada jarak 0,5 km dari reservoar dan meningkat sepanjang aliran pipa. Pada jarak yang sama klor mengalami penurunan dengan penambahan jaraknya dari reservoir, hal tersebut disebabkan oleh terjadinya penurunan nilai elevasi sepanjang jalur distribusi dan dinding pipa. Sepanjang jalur distribusi terjadi peningkatan suhu hingga pada titik terjauh distribusi melewati baku mutu yang berlaku. Peningkatan bakteri koliform pada jaringan distribusi air minum berkaitan dengan penurunan konsentrasi klor dengan nilai determinan koefisien 0,965.

KEYWORDS

Coliform, Desinfeksi, Jarak, Jaringan Distribusi, dan Klor

LATAR BELAKANG

Desinfeksi merupakan salah satu tahapan dalam sistem pengolahan air yang bertujuan untuk menghilangkan mikroorganisme patogen. Klor merupakan salah satu senyawa kimia yang digunakan dalam proses disinfeksi. Menurut Permenkes no. 492/Menkes/IV/2010 tentang Persyaratan Kualitas Air Minum, Keberadaan klor dalam air minum dibatasi pada konsentrasi 5 mg/L (1). Disinfektan klorin dapat menekan pertumbuhan *Staphylococcus aureus* dan *Klebsiella pneumoniae* (2). Semakin tinggi dosis klorin dapat menurunkan nilai total koliform (3).

Kualitas air pada UPTD. Pengelola Air Bersih Kota Pariaman pada tahun 2019 menunjukkan rata-rata nilai sisa klor pada jaringan distribusi air masih dibawah baku mutu air minum. Konsentrasi klor dapat mengalami penurunan seiring dengan pertambahan jarak distribusinya (4–7). Penurunan konsentrasi klor akan meningkat pada saat terjadi peningkatan laju aliran (8). EPANET dapat digunakan untuk menilai tingkat penurunan konsentrasi klor akibat *bulk reaction* dan *wall reaction* (7). Penurunan konsentrasi klor yang dapat mempengaruhi nilai total koliform menyebabkan perlunya mengetahui kualitas air di sepanjang jaringan distribusi dan menganalisis penurunan klor pada sepanjang jaringan distribusi.

METODE

Penelitian ini menggunakan analisis kuantitatif dengan pendekatan *cross sectional* yaitu melakukan pengukuran sisa klor & bakteri koliform dan menganalisis hubungan antar variabel. Pada penelitian ini dilakukan pula analisis deskriptif untuk menggambarkan kualitas air di sepanjang jalur distribusi air minum. Penelitian ini dilaksanakan pada Bulan Juli-Desember 2020. Sampel air diambil pada lima titik di sepanjang jalur distribusi UPTD. Pengelola Air Bersih Kota Pariaman berdasarkan SNI 6989.57:2008 dan SNI 7828:2012. Pengujian sampel air, yaitu klor (APHA 1992) dan mikrobiologi (APHA 9221 ABC:2017) dilakukan di Laboratorium Lingkungan Kota Pariaman. EPANET digunakan untuk menganalisis kondisi eksisting perpipaan jalur distribusi dan menentukan besaran penurunan klor yang berasal dari *Bulk coefficient* dan *Wall reaction*.

HASIL DAN PEMBAHASAN

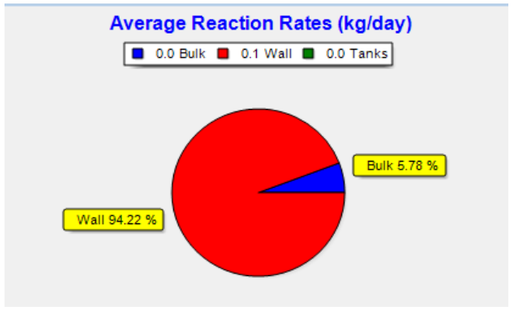
Hasil

Pengukuran kualitas dilakukan pada lima titik disepanjang pipa distribusi dengan titik lima titik terjauh dari reservoir. Secara fisik sampai dengan titik terjauh kualitas air minum masih dibawah Persyaratan Kualitas Air Minum. Konsentrasi klor mengalami penurunan sepanjang jaringan distribusi pada konsentrasi yang aman untuk air minum. Namun, semakin jauh titik sampling dari reservoir terjadi kenaikan dua parameter mikrobiologi. Secara lengkap kualitas air minum di jaringan distribusi UPTD. Pengelola Air bersih Kota Pariaman dapat dilihat pada **Tabel 1.**

Tabel 1. Kualitas Air Bersih Jaringan Distribusi UPTD. Pengelola Air Bersih Kota Pariaman

Parameter	Titik Sampling					Permenkes No. 492/MENKES/IV/2010
	1	2	3	4	5	
pH	8,3	7,08	7	7,28	6,8	6,5-8,5
Suhu	27,2	26	29	30,5	31,5	25^{0}C ± 3
Kekeruhan	0,67	0,46	0,56	0,85	2,68	5 NTU
Klor	0,43	0,4	0,36	0,33	0,08	5 mg/L
Total Bakteri Koliform	0	0	4	94	110	0
E. coli	0	0	4	14	63	0

Penurunan klor dapat disebabkan oleh *Bulk coefficient* dan *Wall reaction* yang didapatkan melalui simulasi pada EPANET. Berdasarkan analisis melalui EPANET penurunan sisa klor yang disebabkan oleh *bulk coefficient* yaitu 5, 78%. Sedangkan penurunan sisa klor yang disebabkan oleh *wall reaction* yaitu 94, 22%. Berdasarkan analisis EPANET didapatkan penyebab utama terjadinya penurunan sisa klor di jaringan distribusi UPTD. Pengelola Air Bersih Kota Pariaman adalah dinding perpiaannya. Secara lebih jelas hasil analisis pada EPANET dapat dilihat pada **Gambar 1.**



Gambar 1. Reaction report

PEMBAHASAN

Penurunan nilai klor merupakan temuan yang dapat ditemukan pada lokasi atau wilayan lain (9,10). Nilai klor yang semakin menurun dengan bertambahnya jarak titik sampling dapat berkaitan dengan pertumbuhan mikroorganisme. Kondisi yang sama ditemukan pula di lokasi yang berbeda (11). Kenaikan parameter mikrobiologi pada penelitian ini dapat mengindikasikan terjadinya penurunan kualitas air minum dan berbahaya bagi masyarakat yang memanfaatkannya. Cemaran mikroorganisme terjadi pada titik 3 dengan jarak distribusi 1 Km yaitu 4 sel/100 mL sampel.

Berdasarkan analisis menggunakan EPANET faktor penurunan oleh faktor reaksi klor dengan zat organik rendah dan masih dalam tahap yang aman. Semakin lambat kecepatan air dalam pipa jaringan maka sisa klor juga akan semakin mengalami penurunan. Penurunan sisa klor secara dominan dapat diakibatkan oleh kebocoran dan bongkar pasang pipa yang dilakukan oleh pihak UPTD. Pengelola Air bersih Kota Pariaman dalam rangka penambahan jaringan Sambungan Rumah (SR) ke sejumlah wilayah di sekitar penelitian ini. Aktivitas bongkar pasang dapat menjadi celah masuknya mikroorganisme ke dalam jaringan pipa dan mempengaruhi sisa klor yang ada.

KESIMPULAN

Kualitas air yang didistribusikan UPTD. Pengelola Air Bersih Kota Pariaman mengalami penurunan untuk pelanggan yang memiliki jarak lebih jauh dari reservoir. Penurunan kualitas terutama dilihat dari parameter mikrobiologi. Salah satu penyebab penurunan kualitas tersebut dapat diakibatkan oleh penurunan konsentrasi klor pada air yang didistribusikan ke pelanggan. Berdasarkan analisis menggunakan EPANET didapatkan penyebab utama penurunan konsentrasi klor dapat diakibatkan oleh kebocoran pada jaringan perpipaan atau aktivitas bongkar pasang.

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Identifying Properties And Indicators Of The Resilience Of Drinking Water Supply Systems Against Flood: An Introduction And Overview

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ABSTRACT

From 2011 to 2020, 7574 moderate-to-high intensity flood events were recorded in Indonesia. Urban flood catastrophes can disrupt Drinking Water Supply System (DWSS) infrastructure services and cause substantial damage to its components. These disturbances include pipe breaks, service interruptions, power outages, and a decline in public confidence. Some flood events significantly affect water quality more than even a brief drought. Academics and practitioners are currently focusing on resilience management to manage crises and mitigate the effects of natural disasters.

Measuring the resilience of DWSS in Indonesia presents specific difficulties. These obstacles include resilience being a novel concept in DWSS disaster management in Indonesia, the difficulty of obtaining reliable quantitative data, the interdependence of multiple factors, and the need to understand the assessment variables better. Experts' judgment makes the qualitative method more adaptable for catastrophic to highly uncertain applications.

This paper provides an overview of the Fuzzy Delphi Method (FDM) for identifying the properties and indicators of DWSS flooding resilience. As with

conventional Delphi methods, the FDM employs a fuzzy membership system response instead of a single-choice response system. The FDM permits experts to express ambiguity when responding to survey questions. The proposed stage for determining the properties and indicators of DWSS flooding resilience in this study consists of determining the hypothesis variables and the instrument variables for DWSS resilience via FDM. A literature review, evaluation, and testing constitute the determination of the hypothesis variable. A three-round Delphi survey is utilized for the FDM variable determination procedure. The results of the expert evaluation (during the initial assessment process and the FDM process) apply to evaluating the content validity of instruments in future research.

KEYWORDS:

Drinking Water Supply System (DWSS), Fuzzy Delphi Method (FDM), Resilience properties, Indicators, floods

INTRODUCTION

From 2011 to 2020, Indonesia experienced 7,574 floods with moderate intensity (Directorate of Risk Mapping and Evaluation of BNPB, 2022). The intake of the drinking water supply system (DWSS) of the Drinking Water Regional Public Company (Perumda AM), Padang City, was damaged on August 18, 2021, due to flooding in Padang City. The floods caused the water supply to be cut off to approximately 45,000 customers in three subdistricts. The networks, water treatment plants (WTP), and intakes in the Solok Selatan District were damaged by flash floods on November 21, 2019. Disruption of any subsystem of a community's critical infrastructure can have a domino effect on the economy, health, security, social welfare, and the efficient operation of government, among others (Tierney, 1995). Building DWSS resilience to disasters is necessary because resilience is the key to expanding access to assured drinking water (Murray, 2015).

Critical infrastructure requires system resilience management (Cantelmi & Patriarca, 2021). Numerous studies have examined the resilience of DWSSs, but few have examined the multidimensional management of DWSSs' resilience to flooding. The essential dimensions for assessing the resilience of critical infrastructure are the technical, organizational, economic, and social dimensions, with the technical and organizational dimensions being the most frequently studied (Guo, Shan, and Owusu, 2021). According to the research of Sweya et al. (2021), technical, organizational, and environmental dimensions are the most influential.

Current research on DWSS resilience management is quantitative and focuses on the technical aspects of DWSS distribution networks, reservoirs, and water treatment plants. Yazdani et al. are investigating an expansion strategy to increase the resilience of drinking water distribution systems using a network theory approach (2011). In order to avoid succumbing to reductionism and oversimplified linear modeling techniques, the development of DWSS resilience management requires reevaluating existing resilience management methods and models. (Ameyaw et al., 2016). Due to the interdependence of multiple factors (Ouyang & Wang, 2015; Shin et al., 2018) and the need for a better understanding of valuation variables, measuring resilience is difficult (Hughes & Healy, 2014). According to research findings, the qualitative method permits greater application flexibility from the study of large disasters to those with high uncertainty (Münzberg, Wiens, and Schultmann, 2016). Difficulties in acquiring reliable quantitative data have also prompted qualitative investigation (Cantelmi & Patriarca, 2021). It implies that future research is necessary to enhance the DWSS resilience assessment instrument that can provide solutions to these issues.

In the last two decades, numerous researchers in Engineering and Construction Management have employed the Delphi method as their primary research technique (Ameyaw et al., 2016). Due to the inappropriate design and implementation of the Delphi study, such as a lack of survey instruments, poor choice of experts, weak bias control, unreliable analysis, and limited feedback during the study, the findings obtained from the Delphi study can occasionally generate controversy (Hohmann et al., 2018). However, the Delphi method remains a superior alternative in circumstances where objective data cannot be obtained, empirical evidence needs to be improved, or experimental research is impractical or unethical (Ameyaw et al., 2016). Several researchers have led to using the Fuzzy Delphi Method (FDM). One of these studies is Tseng et al(2022)'s investigation into identifying the resilience indicators development of indigenous peoples in terms of economic, social, cultural, environmental, and policy dimensions. The FDM application is more consistent and better at making decisions than the conventional Delphi method because it can translate human conversational styles. The FDM employs a fuzzy membership response system as opposed to a single-choice response system, allowing experts to respond to survey questions with ambiguity (Habibi, Firouzi, and Sarafrazi, 2015; Ameyaw et al., 2016). Nevertheless, the DWSS flood resilience development instrument using FDM and the research on inter-cycle indicator links in resilience management have yet to be discovered. This paper will provide an overview of the Fuzzy Delphi method (FDM) for identifying the characteristics and indicators

of DWWS flooding resilience. The primary objective of this paper is to propose FDM in developing indicators that affect DWSS resilience that is suitable for assessing DWSS resilience in Indonesia and West Sumatra Province, specifically. The second objective is to explain the relationship between indicators at the different stages of the resilience management process using FDM.

The research is anticipated to advance understanding of the parameters and indicators of DWSS resilience as a tool for assessing its resilience to flooding. In addition, this research aims to support the Sustainable Development Goals Program and the 2045 Water Resilience Program.

RESILIENCE CONCEPT

Recent experiences with floods, droughts, earthquakes, tsunamis, and liquefaction demonstrate that critical infrastructures, such as DWSS, are damaged during these hazardous events, resulting in the system's unreliability (Amarasinghe et al. al., 2017; Shin et al., 2018). Engineers have shifted in recent years towards resilience-based strategies, such as mitigation and adaptation options, that make critical infrastructure systems such as DWSSs adaptively reliable (Shin et al., 2018).

Definition of Resilience

In the context of critical infrastructure, resilience refers to the ability of organizations to provide minimum services during disruptions or disasters and return to operations quickly, as well as responsive, flexible, and timely recovery actions and coordinated sector-wide planning (Labaka, Hernantes, and Sarriegi, 2015; Matthews, 2016). DWSS resilience refers to the management organization's capacity to design, maintain, and operate DWSS infrastructure so that the impact of disasters is limited to the DWSS infrastructure and the served customers and standardized water distribution to customers is maintained (Murray, 2015).

Resilience operates from a systems perspective, defining incidents as complex processes that can occur at the intersection of natural and human processes on multiple scales that evolve and change over time. Such complexity and variability highlight that threats and disturbances cannot always be predicted. When this occurs, however, threats must be able to provide adaptation lessons. It implies that DWSS must be dependable and tough. Resilience enables quicker recuperation, learning, and adjustment from past errors. Increasing the security of access to potable water requires a focus on hazard resilience (Murray, 2015).

Government officials and DWSS Managers must comprehend crucial aspects of DWSS Resilience. It includes planning in a disaster by anticipating impacts, taking the necessary steps to minimize consequences, and preventing disruption of other infrastructure systems by recognizing and managing critical interdependencies. Matthews, 2016; Matthews, 2016).

Capacities of Resilience

The system resilience approach emphasizes the capacity of infrastructure systems to anticipate and absorb potential disturbances, develop adaptive means to accommodate changes, respond promptly to disturbances, and recover rapidly from potentially disruptive events (Francis & Bekera, 2013). This system's capability is frequently referred to as its characteristic, property, attribute, or nature (Vugrin, Warren, and Ehlen, 2011; Francis & Bekera, 2013; Balaei et al., 2018)

There are three capacities in general: absorptive, adaptive, and restorative (Vugrin, Warren, and Ehlen, 2011; Francis & Bekera, 2013; Labaka, Hernantes, and Sarriegi, 2015; Balaei et al., 2018). Resilience is a quality or characteristic of a system that makes it resistant to disturbances, such as natural disasters (Bruneau et al., 2003; Balaei et al., 2018). Each characteristic has a corresponding success indicator. The achievement of space-defining indicators is constrained by resilience dimensions (Davis, Mostafavi, and Wang, 2018).

RESILIENCE PROPERTIES

According to Davis et al. (2018) and Cimellaro et al. (2016), resilience properties are the actions of a system's resilience. Each property is defined as follows (Bruneau et al., 2003):

Robustness: The capacity of a system to continue generally functioning under adverse conditions.The capacity of a system to withstand pressure without degrading or losing functionality;

Redundancy: the system's ability to be replaced, i.e., to meet functional requirements in the event of a failure or loss of functionality. Provision of replacement parts for alternative operations and maintenance;

Rapidity: The system's ability to meet priorities and achieve goals on time to limit losses and prevent future outages;

Resourcefulness: In the event of a disruption, the system's ability to identify problems, establish priorities, and mobilize resources. Ability to manage resources (financial, physical, technical information, and human) to accomplish objectives and meet priorities.

Existing research on DWSS resilience tends to focus on technical dimensions rather than the five dimensions of the concept of resilience: technical, organizational, socio-economic, and environmental. DWSS is an infrastructure that is interconnected with other infrastructures and dependent on social, economic, organizational, and environmental factors; however, its inability to provide a tiered effect is a deficiency (Shin et al., 2018).

Current research on DWSS resilience is more concerned with the technical aspects of the DWSS distribution network, reservoir, and Processing Installation. A study that focuses on the technical aspect of resilience is the strategy for expanding the resilience of the DWSS distribution system using a network theory approach (Yazdani, Otoo, and Jeffrey, 2011), building a Graph Theory framework to assess the Resilience of the DWSS Distribution Network (Herrera, Abraham, and Stoianov, 2016).

More research is required to examine the resilience of DWSS in the context of multidimensional interactions. Sweya et al. (2020), Balaei et al. (2018), and Zhou et al. (2019) have researched a few of these topics (2022). The difficulty in measuring the resilience of DWSSs is determining how to measure resilience as precisely as possible using data from previous disturbance events (Balaei et al., 2018). It necessitates a conceptual framework encompassing technical, social, organizational, economic, and environmental domains (Davis, Mostafavi, and Wang, 2018).

Resilience is a multidimensional concept that cannot be measured with a single metric because it consists of technical, economic, social, and organizational dimensions, plus environmental factors. Balaei et al (2018). The resilience of DWSS varies according to distinct temporal and spatial conditions (Balaei et al., 2018). Combining technical, environmental, and social dimensions, Cimellaro et al. (2016) developed a new resilience index for urban DWSS distribution networks against earthquakes.

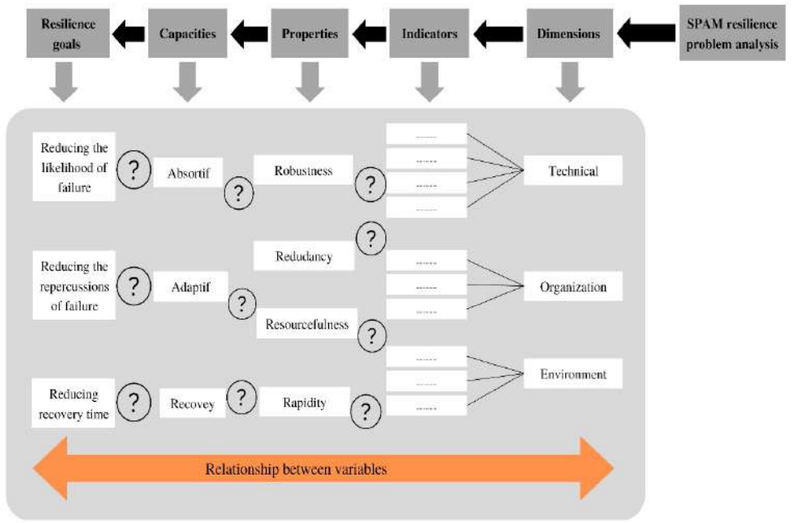
Resilience is a characteristic of the community, organization, or system (Murray, 2015). Resilience describes the performance of a system, not its components. A system consists of interdependent parts that work together to perform a function (Murray, 2015).

The relationship between the dimensions, capacities, properties, and indicators of DWSS flooding resilience is depicted in Figure 1.

Figure 1 Relationship of flood-resilient DWSS dimensions, capacities, properties, and indicators

Qualitative Resilience Assessment Methods

Research on resilience evaluation employs a variety of methodologies, the selection of which depends on system characteristics and measurement needs (Prior and Hagmann, 2014; Hosseini, Barker, and Ramirez-Marquez, 2016). Generally, the procedure for assessing or evaluating system resilience includes qualitative and quantitative components (Hosseini, Barker, and Ramirez-Marquez, 2016).



The qualitative approach consists of a conceptual framework that leads to best practice concepts and a semi-quantitative index that is a method for expert assessment of the qualitative aspects of system robustness. In contrast, this qualitative approach is not quantified (Hosseini, Barker, and Ramirez-Marquez, 2016).

Multidimensional DWSS resilience necessitates the use of qualitative methods (Sweya et al., 2020). The qualitative method provides valuable indicator data for developing and maintaining resilient critical infrastructure like DWSS (Davis, Mostafavi, and Wang, 2018). To assess resilience, selected qualitative approach properties and indicators are grouped into technical, organizational, social, and economic domain dimensions. In addition, the resilience measurement is estimated as the sum of the priority dimensions based on the outcomes of expert evaluations (Davis, Mostafavi, and Wang, 2018).

Hughes and Healy (2014) explain that qualitative methods are more adaptable, have no minimum computational requirements, are simple to implement, can

be applied to complete or incomplete data sets, are more useful in assessing organizational resilience in general, and assist in assessing the physical network assets of DWSS resilience. The benefits of the qualitative method align with the concept of multidimensional DWSS resilience, which incorporates technical, organizational, social, economic, and environmental dimensions. Sweya et al. (2020) describe qualitative methods consistent with the situation in developing nations where data availability is problematic. In developing countries, resilience is still a theoretical concept due to the need for more resilience measurement research; therefore, an easily implementable qualitative method is required (Hughes and Healy, 2010). (2014).

Qualitative methods incorporating a semi-quantitative approach can be used to measure and evaluate the resilience of critical infrastructure. This approach provides an objective operational measure that infrastructure operators can use as benchmarks for further resilience strategies (Clarke et al., 2016). Clarke et al. (2016) note that, unlike the exclusive use of qualitative or quantitative methods, the adoption of hybrid qualitative and semi-quantitative methods allows for the assessment of difficult-to-measure social and organizational dimensions as well as technical or economic dimensions, which have a reciprocal effect on the overall performance of DWSS resilience. As previously explained, a qualitative approach was used to develop the DWSS resilience instrument. Hari et al. (2020) discuss the proposed steps for constructing a conceptual framework in their paper titled Development of Conceptual Framework for Resilience Management of Drinking Water Supply Systems (DWSS) against Floods. In addition, this paper examines a semi-quantitative approach utilizing the Fuzzy Delphi Method (FDM).

Fuzzy Delphi Method (FDM)

The Delphi method is suitable for identifying, evaluating, and forecasting objectives in project planning and design, contracts, labor and personnel issues, and organizational issues in Engineering and Construction Management Research, according to a comprehensive literature review (Ameyaw et al., 2016). Numerous studies employ the Delphi method because it is a widely used and accepted technique for developing consensus regarding real-world knowledge acquired from subject-matter experts (Ameyaw et al., 2016).

The Delphi method has four primary characteristics: anonymity, iteration, controlled feedback, and statistical group responses. Using anonymity to avoid groupthink. The experts who participated in the survey were strangers to one another. Using a series of in-depth questionnaires with controlled feedback, the Delphi method aims to obtain a consensus opinion from a group of experts.

Researchers can identify, categorize, and prioritize problems and develop forecasting frameworks through iteration.

The need for a theoretical framework is the primary drawback of the Delphi method. As a research methodology, Delphi has been utilized in various surveys, studies, procedures, methods, approaches, polls, and engineering, but its application must be consistent (Habibi, Firouzi, and Sarafrazi 2015). **Figure 2** depicts the framework for employing the Delphi method in qualitative decision-making.

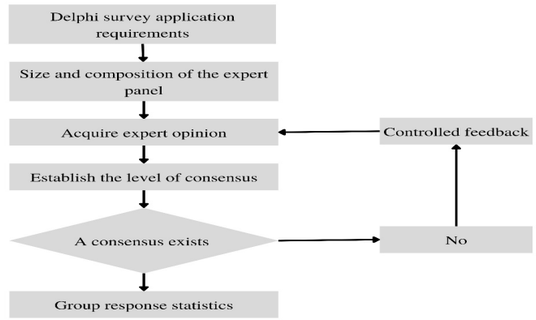


Figure 2 The conceptual structure of the Delphi method in qualitative research (Habibi, Firouzi, and Sarafrazi 2015)

The Delphi method is a multiple-round survey with the following general characteristics (de Hierro et al., 2021; Habibi, Firouzi, and Sarafrazi, 2015):

The process attained by a moderator;

A group of anonymous experts is invited to participate. Invitations are via the mail process or online questionnaire. Experts provide their unbiased opinions anonymously and without the need for a personal meeting.

The first step of the Delphi technique is to select qualified panel members. The validity of the results is contingent upon the expertise and knowledge of the panelists. The optimal number of experts is between six and twelve, and expert panels with various specialization compositions have between five and ten members. Although there is some disagreement regarding the composition and size of Delphi technique panels, a dominant pattern has been identified. It is preferable to use a combination of individuals with specialized knowledge and to select such a snowball sampling technique sample by identifying a small number of knowledgeable and qualified individuals.

The Likert scale is used to collect expert opinions;

The researcher conducts surveys (often more than two, up to three, or repeatedly);

The experts provided their opinion on each proposed indicator via a number or a label and made some suggestions to improve the questionnaire's statements based on their respective perspectives.

Following the conclusion of each round, the researcher provided the expert with a round evaluation report. Taking into account the reports and comments of others, experts are thus able to evaluate their own opinions in an effort to improve consensus.

The researcher can repeat this procedure until a consensus is reached (or after a predetermined number of rounds).

Even though the conventional Delphi method has been widely accepted as an effective technique and applied in a variety of contexts, the issue of ambiguity and uncertainty in expert opinion must still be resolved. The conventional Delphi method has drawbacks in terms of low convergence, high execution costs, and the potential for researchers to filter certain expert opinions (Habibi, Firouzi, and Sarafrazi, 2015; de Hierro et al., 2021). The evaluation of human judgment is viewed as an emotional, complex, perceptual, subjective, and individual phenomenon influenced by a wide range of personal life experiences. Consequently, it isn't easy to obtain a precise numerical value to assess it (de Hierro et al., 2021). Combining fuzzy theory and conventional Delphi methods, FDM is developed to address this issue (de Hierro et al., 2021).

This technique employs verbal expressions to gauge the opinions of respondents. The Crisps/Boolean approach to measuring respondents' opinions generates data that should be more representative (Habibi, Firouzi, and Sarafrazi, 2015). Although the expertise and cognitive abilities of experts are utilized in decision-making, the quantification of expert opinions only partially reflects human thought processes (Habibi, Firouzi, and Sarafrazi, 2015). Fuzzy sets are more consistent with human linguistics and sometimes fuzzy descriptions, and fuzzy numbers are superior for making real-world decisions. Numerous studies have been conducted using FDM. Developing fuzzy spectra, accumulating expert opinions, defuzzification, and reaching a consensus can be accomplished in numerous ways (Habibi, Firouzi, and Sarafrazi, 2015). Two applications of the Delphi method utilized in FDM are the "screening criteria" and "forecasting" methods (Habibi, Firouzi, and Sarafrazi, 2015).

FDM is used to determine the significance of screening criteria and screening of critical criteria. One of the primary advantages of FDM over conventional Delphi techniques is the ability to summarize and sort items using a single loop. Identifying the appropriate spectrum for fuzzification of linguistic expressions, fuzzy aggregation of diffused values, defuzzification, and selection of threshold and filtering criteria are the objectives of the FDM algorithm.Even though the conventional Delphi method has been widely accepted as an effective technique and applied in a variety of contexts, the issue of ambiguity and uncertainty in expert opinion must still be resolved. The conventional Delphi method has drawbacks in terms of low convergence, high execution costs, and the potential for researchers to filter certain expert opinions (Habibi, Firouzi, and Sarafrazi, 2015; de Hierro et al., 2021). The evaluation of human judgment is viewed as an emotional, complex, perceptual, subjective, and individual phenomenon that is influenced by a wide range of personal life experiences. Consequently, it is difficult to obtain a precise numerical value to assess it (de Hierro et al., 2021). Combining fuzzy theory and conventional Delphi methods, FDM is developed to address this issue (de Hierro et al., 2021).

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Following is the FDM procedure for gathering expert opinion using a triangular fuzzy number (TFN):

A fuzzy set is a collection of elements whose membership levels are characterized by a membership function. Similar to the probability distribution, the membership function helps to represent uncertainty by mapping the discourse universe into intervals (0,1). The universe of speakers/discourses represents the set elements and class set intervals. Class consists of fuzzy set membership within the interval (0,1). 0 indicates that the element is not a member of the set, while 1 indicates complete membership. This research employs the trigonometric degree function. In the FDM survey, the experts express their thoughts on the instrument's design. The priority of the instrument variables is determined without participant communication. Then, fuzzy variables, fuzzy sets, the universe of speech, and domains are determined during the fuzzyification phase. Fuzzification converts crisp/crisp system inputs into linguistic/fuzzy variables using membership functions stored in the fuzzy knowledge base. The knowledge base is comprised of fuzzy rules expressed as IF-THEN statements. Assume that experts will evaluate the proposed indicators utilizing the triangular fuzzy membership function and a linguistic scale.

$$\tilde{b}_i^k = (b_{iL}^k, b_{iM}^k, b_{iU}^k) \quad \textbf{(1)}$$

Where *i* is the importance of each measure in the *i* indicator produced by the k-th expert on TFN. Equation (2) is applied to collect the judgments of all K experts.

$$\tilde{b}_i^k = (b_{iL}, b_{iM}, b_{iU,}) = \left(min_k b_{iL}^k, (1/K) \sum_{k-1}^{K} b_{iM}^k, max_k b_{iU}^k\right) \quad \textbf{(2)}$$

Where is the aggregation of TFN.

Calculating the firm score using the average TFN score from the experts with the equation:

$$b_i = \frac{b_{iL} + b_{iM} + b_{iU}}{3} \quad \textbf{(3)}$$

Where *bi* is crips that show the importance of the aggregate measure of each *i* indicator.

Calculate the deviation of the fuzzy mean through the equation:

$$D_1 = F_{avr} - A_i = \left(\frac{1}{n}\sum a_i - a_i, \frac{1}{n}\sum b_i - b_i, \frac{1}{n}\sum c_i - c_i\right) \quad \textbf{(4)}$$

Set the expected value of an acceptance range, so the average *bi* can be judged whether it is within the acceptance range. The threshold value depends on the decision of the preferred decision maker and the local context. This value is taken as 0.52 for this study which is the average of three triangular fuzzy numbers for the moderately important level (0.3+0.5+0.75)/3.

If *bi* < α reject the proposed indicator measure *i* as part of the final indicator measure. If *bi* > α or equal to α accept the proposed indicator measure *i* as part of the final indicator measure.

If a significant deviation is found, the calculated data is returned to the expert and asked to reconsider their opinion. Stages 2 to 4 are repeated for up to 3 rounds until the average TFN given by the experts becomes sufficiently stable. The size of the similarity or dissemblance index between two fuzzy numbers is applied as a criterion for stopping the Delphi round by determining the convergence of the data.

Establish fuzzy logic rules by implementing a Fuzzy Inference System (FIS). FIS converts or fuzzy maps inputs linguistic representations from probability scale indicators to fuzzy outputs by following fuzzy rules (if-then), which contain antecedents and consequents to change fuzzy statements. FIS is used with databases to make inferences with causal methods.

The entire fuzzy inference procedure is implemented using the Matlab software's fuzzy logic toolbox, which provides a Graphical User Interface for constructing fuzzy systems.

Defuzzification transforms the fuzzy output obtained from FIS into a solid value using a membership function identical to the one used in the fuzzification phase. FDM for filtering criteria/indicators in the initial stage can achieve results by defuzzification and threshold value selection.

DISCUSSION

The stage of determining DWSS resilience instrument variables (properties and indicators) against flooding consists of the determination of hypothesis variables through a literature review, assessment, and testing and the determination of DWSS resilience instrument variables through the FDM three-round Delphi survey.

The initial evaluation of the hypothesis variables is conducted by distributing questionnaires to ten specialists. The specialists have expertise and experience in DWSS, disaster management, and/or flooding. There are government elements

(Director General of Natural Resources, Ministry of PUPR in West Sumatra Province, Director General of Cipta Karya, Ministry of PUPR in West Sumatra Province, PUPR Office of West Sumatra Province, BNPB West Sumatra Province, and Environmental Service of West Sumatra Province), operator elements (Perumda AM Padang City and Padang Panjang City), and academic field representatives (DWSS experts and disaster management experts). Regarding the questionnaire-submitted hypothesis variables, the experts evaluated their relevance to the flood resilience of the DWSS in the province of West Sumatra. In addition, the questionnaire completed by the expert is subjected to thematic analysis, one-round FDM, and reliability and validity testing.

The subsequent step is to conduct an initial test of the results of the initial assessment of the instrument variable underlying the hypothesis. The initial test involves interviewing two experts from the Perumda AM element and two from the natural resource-managing ministries and local governments. The initial test's objective is to evaluate the initial implementation of the initial variables and investigate the current issues affecting DWSS resilience. The method for determining the hypothesizing variables is depicted in **Figure 3**.

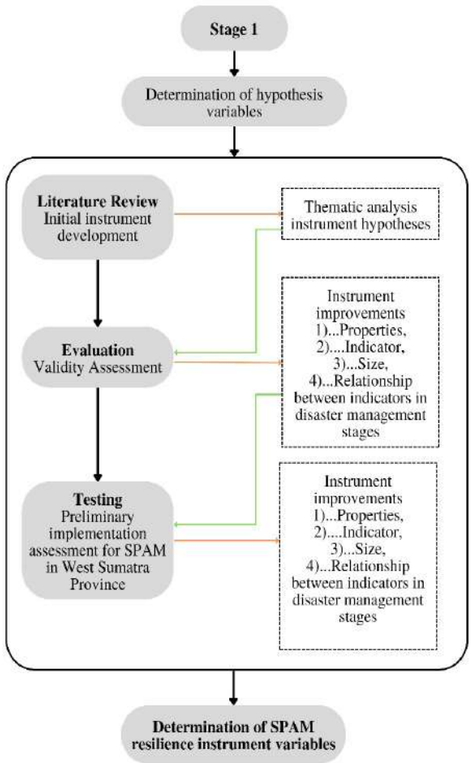

Figure 3. The method for identifying hypothesizing variables

The subsequent step is to determine the variable DWSS resilience instrument using FDM, as depicted in **Figure 4.**

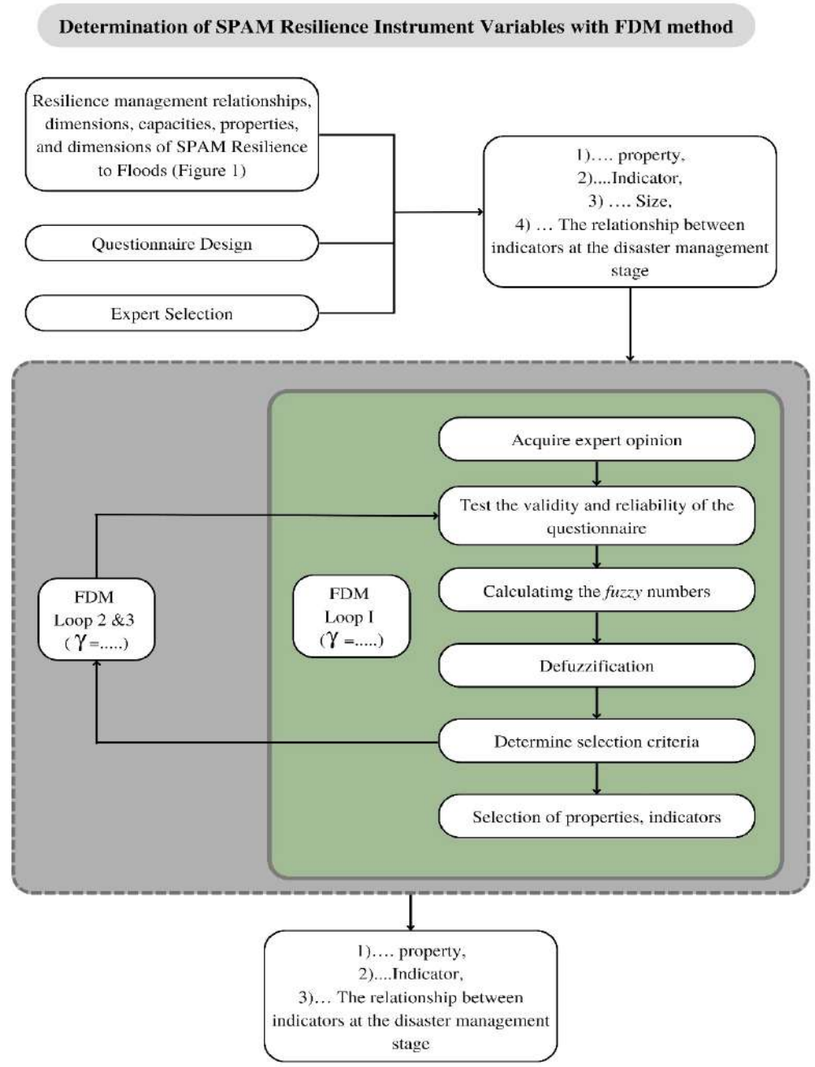

Figure 4 Determination of the instrument variable for DWSS resilience using FDM.

The following are the steps of the proposed Delphi method:

Experts were provided with a research background and asked to evaluate, modify, or add the dimensions, properties, and indicators that affect the DWSS by evaluating the provided questionnaire. ATLAS.ti 8 software will be used to

conduct a thematic analysis on the questionnaire assessment results. In the second round of FDM, the questionnaire is modified based on the results of the analysis of the first round of the Delphi survey and returned to the expert for reevaluation.

Second round. At this point, the experts were asked to use a Likert scale to rank/order the significance of each dimension, property, and indicator/factor, as well as the indicators and the relationship between dimensions and stages of disaster management indicators/factors.

Third round. The questionnaire is modified once more based on the findings of the second round of FDM analysis. On a Likert scale, the experts were asked to rank/order the significance of each dimension, property, and indicator/factor, as well as the indicators and relationships between dimensions and stages of disaster management. Table 1 displays the five-point Likert scale used to evaluate the components of the pre-assessment questionnaire and Delphi survey round.

Untuk menganalisis informasi hasil kuisioner survei pre-assessment dan putaran survei Delphi dilakukan dengan analisis *Fuzzy set theory,* dengan prosedur sebagai berikut:

Proses Triangular Fuzzy number (TFN)

Mengubah skala likert kedalam Triangular Fuzzy number (TFN)

Metode yang digunakan adalah triangular *fuzzy* number (TFN) dengan skala Likert 5 pada kriteria signifikansi. **Tabel 1** menggambarkan skala Likert lima poin dengan nilai bilangan *fuzzy* nya.

Table 1 A five-point Likert scale for evaluating variables on the pre-assessment survey and the Delphi survey round.

Scale	Ekspresi linguistik/ Level penilaian	*Fuzzy number*
1	Sangat Tidak penting	(0, 0, 0,25)
2	Tidak penting	(0, 0.25, 0.5)
3	Moderat penting	(0.25, 0.5, 0,75)
4	Penting	(0.5, 0.75, 1)
5	Sangat penting	(0.75, 1, 1)

Agregasi *fuzzy* dari opini-opini yang diperoleh

Opini setiap pakar ditampilkan sebagai TFN (l. m, u). Metode untuk menghitung rata-rata *fuzzy* opini para pakar, seperti persamaan **(5)**

$$F_{AVE} = \left(\frac{\sum L}{n}, \frac{\sum Lm}{n}, \frac{\sum u}{n}\right) \quad \textbf{(5)}$$

Menghitung nilai ambang batas (d)

Syarat pertama yang harus dipenuhi adalah nilai ambang batas, dapat dihitung dengan rumus **(6)**

$$d\,(m,n) = \sqrt[2]{\frac{1}{3}[(L-l1)^2 + (M-m2)^2 + (U-u3)^2]} \quad \textbf{(6)}$$

Tabel 2 Interprestasi nilai ambang batas (d)

Nilai ambang batas (d)	Interprestasi
d < atau sama dengan 0,2	Indikator/item diterima
d > 0,2	Indikator/item ditolak atau putaran kedua/ ketiga dilakukan terhadap pakar yang tidak sepakat

Menentukan kesepakatan konsensus

Syarat kedua adalah persentase kesepakatan ekspert berdasarkan nilai kesepakatan Shubashini, et al. (2015) yaitu lebih atau sama dengan 67 %.

Proses evaluasi fuzzy

Syarat ketiga adalah nilai skor fuzzy (A) dari rata-rata fuzzy number harus lebih besar atau sama dengan nilai a median fuzzy number (0,1) yaitu 0,5 (Hsu, dkk., 2010; Tang dan Wu, 2010). Nilai skor fuzzy biasa disebut defuzzifikasi dapat dihitung berdasarkan persamaan **(3.3)**

$$if\ \bar{F} = (L, M, U)\ Then\ F = \frac{L+M+U}{3} \quad \textbf{(7)}$$

Pada tahap FDM ini akan diperoleh dimensi, properti, indikator, dan hubungan indikator antar dimensi dan antar tahapan manajemen bencana berdasarkan konsensus dari para eksper. Ketiga syarat harus terpenuhi untuk mencapai kesimpulan konsensus para ekspert. Setelah itu tahap berikutnya adalah memvalidasi konten instrumen yang dilaksanakan pada tahap 3.

In the second and third rounds of the Delphi survey, indicators are ranked based on six primary criteria. Relevance, affordability, availability, dependability, straightforwardness, and transparency are the research criteria (Sweya et al., 2020). The literature uses these six criteria as general guidelines to evaluate the significance of an indicator. Table 2 provides guidelines for evaluating indicators according to key criteria. Each variable for each criterion is scored on a five-point Likert scale ranging from 1 (very unimportant) to 5 (very important), with 1 representing very unimportant and 5 representing very important. Moreover, this variable applies to the development of a DWSS flood resilience instrument.

Table 3 Keys criteria in assessing the validity of indicators

Key Criteria	Description	Reference
Relevance	The extent to which indicators are consistent with research.	(Balaei *et al.*, 2018)
Affordability	Data can be accessed or generated with minimal effort or expense.	(Sweya et al. 2020)
Availability	Simple to gather and measure	(Sweya et al. 2020)
Reliability	Constantly consistent	(Sweya et al. 2020)
Simplicity	Simple to comprehend for decision makers	(Sweya et al. 2020); (Cutter, Ash and Emrich, 2014)yet the extant literature is still mired in definitional debates, epistemological orientations of researchers, and differences in basic approaches to measurement. As a consequence, there is little integration across domains and disciplines on community resilience assessment, its driving forces, and geographic variability. Using US counties as the study unit, this paper creates an empirically-based resilience metric called the Baseline Resilience Indicators for Communities (BRIC
Transparency	Data are reproducible and verifiable	(Sweya et al. 2020); (Cutter, Ash and Emrich, 2014)yet the extant literature is still mired in definitional debates, epistemological orientations of researchers, and differences in basic approaches to measurement. As a consequence, there is little integration across domains and disciplines on community resilience assessment, its driving forces, and geographic variability. Using US counties as the study unit, this paper creates an empirically-based resilience metric called the Baseline Resilience Indicators for Communities (BRIC

CONCLUSION

The intensity and frequency of national and global flood disasters have increased and tend to be unpredictable. DWSS is a critical infrastructure that includes hydrological infrastructure, with some of its subsystems located in the flood-prone upper reaches of the river. Recent extreme floods, have demonstrated, however, that the level of preparedness and response of the affected systems is relatively low. Additionally, the recovery process is lengthy and costly (Rus, K,ilar, and Koren, 2018). The condition mandates that future research investigate aspects of resilience management (Rus, Kilar, and Koren, 2018). The provision of potable water is ensured by enhancing the resilience management of DWSS.

This paper presents FDM's proposal for identifying flood-resilient DWSS characteristics and indicators. The stage of determining the characteristics and indicators of the DWSS's resilience to the proposed flooding is the determination of the hypothesis variables and instrument variables for the DWSS's resilience via FDM. A literature review, evaluation, and testing comprise the determination of the hypothesis variable. A three-round Delphi survey is used to determine the FDM that applies. According to several research opinions, the FDM methodology is suitable for developing nations where data on DWSS resilience instruments is still scarce. The author believes this study will serve as a stepping stone for future research on developing DWSS flood resilience.

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Policy Strategy Context of Human Right Discourse as a Tool to Accelerate Water and Sanitation Access in Indonesia

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INTRODUCTION

Countries have only seven years left to achieve SDG 6, which is to provide water and sanitation for all, fulfilling their obligation to provide their citizens with the Human Right to Water and Sanitation (HRtWS). One approach to achieving HRtWS is through the adoption of a Human Rights-Based Approach (HRBA) based on key principles, including non-discrimination, equality, transparency, participation, accountability, and sustainability. In this paper, we use human rights discourse to explain the utilization of HRBA as an approach and HRtWS as a target that must be achieved[1].

While the usefulness of human rights discourse has been debated, some argue it should be implemented alongside other development frameworks, such as system strengthening frameworks in the water and sanitation sector[2]–[4]. Several essential points need to be considered regarding the correlation between human rights discourse and system strengthening. First, caution must be exercised in utilizing human rights discourse in private financing, but this paper will not focus on it[5], [6]. Thus, this paper instead focuses on human rights discourse's impact on raising awareness of W&S issues and providing vital support for vulnerable and marginalized groups, which is crucial for achieving universal access[7], [8]. Secondly, HRtWS alone is insufficient, and HRBA is necessary to support the attempt to achieve it. HRBA principles, such as accountability and participation, can encourage real government action and promote meaningful local interpretations of HRtWS [4], [7], [9]. Human rights discourse is advised to be used in a context-specific manner[10], [11].

This paper explores the opportunities and challenges involved in utilizing human rights discourse in the water and sanitation sector of Indonesia, based on an analysis of existing government regulations, strategies, and progress towards achieving HRtWS in the country, with specific focus on People with Disabilities' (PwDs). This paper also provides insights into the lessons learned from Plan Indonesia's experience in operationalizing participation as an HRBA

principle to increase PwDs' access to HRtWS. By examining the existing policies and strategies in Indonesia, this paper aims to provide a better understanding of the potential of human rights discourse as an acceleration tool to achieve SDG 6, while also acknowledging the operational implications and challenges that need to be addressed to ensure successful implementation.

METHOD_

To provide the necessary context of Indonesian policy and strategy related to human rights discourse in the W&S sector, this study will analyze government regulations, strategy documents, and progress. The progress will be assessed using data from the Indonesia Central Bureau of Statistics. In addition, the case study will be based on the Mid-Term and End-Line Evaluation report of the Water for Women Project of Plan Indonesia.

DISCUSSION

Through an examination of existing regulations and progress in the W&S sector, below are the opportunities and challenges related to the utilization of human rights discourse in the Indonesian context.

Opportunities	Challenges
Indonesian regulations provide strong and detailed support for the right to water. HRBA principles are clearly identified as guiding principles to achieve the right to water, while community participation and non-discrimination principles, which are part of HRBA, are highlighted for reaching sanitation access. The government, community, and private sector are the implementing actors of the effort to achieve HRtWS. Sanitation is recognized as a basic need and minimum service that citizens are entitled to receive from the government. The Indonesian government has set targets for both water and sanitation access and has made progress in achieving HRtWS	Sanitation is not recognized as a human right within Indonesian regulations. There is a greater gap in achieving SDG 6 for sanitation compared to water access in Indonesia by 2023. The existing monitoring system by the Indonesian Central Bureau of Statistics does not fully measure HRtWS components, and the data is not disaggregated enough to provide a clearer picture of inequality. There is no specific W&S regulation that support the intersectionality of HRtWS for women, children and PwDs Inequality of access to HRtWS still persists in Indonesia.

Plan Indonesia's experience in supporting the participation of marginalized groups in W&S decision-making has shown that it is a long and complex process, despite local government regulations and strategies specifically supporting their participation. The project's main strategies are creating enabling environments and targeted activities for PwDs to address power imbalance[12]–[14]. After four years of implementation, the project resulted in a shift in understanding W&S from a "need-based" to a "right-based" approach among government and community leaders. However, only 40% of PwDs participated in community meetings, despite their increased attitude towards their leadership ability. Changing stakeholder attitudes, including PwDs themselves, is a key enabler for meaningful participation in government decision-making, but it is a slower process than creating supporting local regulations. Nonetheless, around 69% of PwDs still face difficulties in using household toilets. Plan Indonesia's experience illustrates the time and complexity required to operationalize participation as one of the HRBA principles to achieve HRtWS.

CONCLUSION

Utilizing human rights discourse in the water and sanitation sector of Indonesia faces both opportunities and challenges presented by existing policies and strategies. Plan Indonesia's experience highlights the importance of recognizing the time and complexity required to operationalize human rights discourse in W&S projects. Thus, to use human rights discourse as an acceleration tool to achieve SDGs 6, it is essential to consider the opportunities, challenges, and operational implications involved.

LIMITATION

This study explores the use of human rights discourse in the context of water and sanitation in Indonesia. The study only focuses on the community level and does not cover other aspects such as access in institutions, hand hygiene, and menstrual hygiene management. The findings are limited in scope and should not be used as an implementation guide due to the exploratory nature of the study. Further research is necessary to fully understand the role of human rights discourse as a potential acceleration tool for SDG 6 in Indonesia.

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Vulnerability of on-site Sanitation Service Chain and Adaptation Response toward Climate Hazards in Four Areas in Indonesia

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ABSTRACT

The increasing damage and imminent threat of climate change to sanitation service chain is often overlooked, even though its health impact is already evident. This study aims to analyze the vulnerability of the on-site sanitation service chain, from toilet to sludge treatment plant, towards climate hazard and also identify the current adaptation response in the household level of 4 areas in Indonesia, East Lombok, Makassar, Palu and Bekasi through household surveys (n=412), six FGD (male, female) and 8 in-depth interviews. Drought has caused lack of access to toilets of around 50% of the respondents, with many experiencing it multiple times per week. Lack of access to toilet due to flood and high sea level are felt by around 10% of respondents each during which floodwater/seawater covered the toilet, toilet access was physically difficult and/or toilet overflowed. Reactive adaptation included using alternative toilets including secondary household, neighbour/family/friend, communal and public toilet. However, up to 71% of East Lombok respondent who experienced inaccessible toilet reverted to open defecation, both during drought and flood. Resilient sanitation must be prioritized to vulnerable population with limited alternative toilets to decrease the risk of slippage to open defecation.

KEYWORD: Climate Hazard, Impact, Risk, Low and Middle Income Countries (LMIC), Resilience

Systematic Review of the Community Sanitation Program to Achieve SDG's Targets in Bogor City, Indonesia

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EXTENDED ABSTRACT

Background*:* The handling of environmental sanitation by the government has so far faced many obstacles, such as the lack of knowledge of the environment and environmental sanitation, income level, attitudes, and healthy living behaviors in the community. Problems are becoming increasingly complex along with urban demographic conditions with increasing urbanization flows that cause irregularities in settlement infrastructure. Some of the programs that have been implemented by the Bogor City government include Pamsimas. Another program that has existed before is Community-Based Sanitation (Sanimas). Sanimas is a program to provide wastewater infrastructure for communities in urban dense slums.

The purpose of conducting a systematic review of various government programs in Bogor City is to see the effectiveness and sustainability of the program.

METHODOLOGY

The method used is to evaluate the program through a systematic review using the Community-Driven Development approach (Dongier *et al*., 2003). Some of the principles of CDD are climate and institutional policy, investment as needed, participation mechanisms, participation by gender and social status, investment in capacity building of community-based organizations, community facilitation for information, simple rules, and strong incentives/rewards, flexible work design, scaling up, and exit strategy.

RESULT

In the systematic review of The Sanimas Program, several problems arose in the performance of the program in Bogor City in the 114 KSM that were evaluated, namely the Non-governmental Groups (KSM) that had been formed so that it affected the performance of the program in terms of several aspects, including technical, utilization, financial, institutional and social aspects.

Based on the Sanitation Award assessment of Sanimas in Bogor City (the year 2019) is that most (51%) have sufficient categories, there are only 1% have excellent categories and 10% with good categories, and the remaining 38% with bad categories. The potential for domestic wastewater development, especially in Sanimas Bogor City of the 114 Sanimas surveyed, 54% has the potential to be developed both for gallon business, the addition of house connections (SR), the addition of MCK users, development, and use of land to become productive gardens. As much as 35% of the conditions of the Sanimas are optimal, and 11% are not working.

The problem of domestic wastewater management, especially in Sanimas Bogor City, is that there is no Regional Regulation that regulates the management of Domestic Wastewater; there is a Sanimas development program within the RTRW but has not revised the City Sanitation Strategy-SSK; the service capacity of communal and MCK has not been optimal; less competent managers, fewer operators, and manpower; no operational records of Sanimas were carried out; monthly finance minus; and various other weaknesses.

Climate and Institutional Policy

Policy analysis is directed to develop indications of SPALD-T development activities for the short term and develop financing and institutional management plans and develop strategies and programs for the development of domestic wastewater services and their maintenance, taking into account new domestic wastewater management plans and existing developments.

Investment as Needed

Some of the programs that have been implemented by the Bogor City government include Pamsimas and Sanimas Programs. Sanimas is a program to provide wastewater infrastructure for people in urban dense slums, therefore, needs an investment.

Participation Mechanisms

To make these various programs successful, various partnerships are needed, especially Public-Private Partnerships (PPP).

Participation by Gender and Social Status

The Sanimas program also targets women as agents of change in the PHBS program. Historically, water and sanitation programs have focused on women's instrumental value in improving conditions and behavior.

Investment in capacity building of community-based organizations.

This sanitation program policy requires community participation. The role of society in this case can depend on the readiness of human resources and the economic growth of its territory. Therefore, capacity-building activities have also been carried out at the level of Non-Governmental Groups.

Community Facilitation for Information

There are no facilities or information systems that are easily accessible to Sanimas stakeholders including KSM.

Simple Rules

The Bogor City Government has prepared regulatory instruments that can be referred to by the community, namely: Bogor City Regional Regulation Number 4 of 2007 concerning Environmental Management and Decree of the Mayor of Bogor Number 9 of 2004 concerning Liquid Waste Development Permits.

Strong Incentives/Rewards

The sustainability of Community-Based Sanitation Facilities (Sanimas) is greatly determined by the involvement of the user community, the hard work, and the concern of the Community Self-Help Group (KSM). Hence the provision of incentives or rewards through government award programs is indispensable.

Flexible Work Design

The shift in development focus from a Communal wastewater treatment plant to SPALD-T shows flexibility in managing urban sanitation more centrally.

Scaling Up

The Indonesian government has committed to increasing resources through the replication and scaling up of community-based decentralized sanitation through the Sanimas program.

Exit Strategy

Optimization and strengthening of the Sanimas Program in 114 locations need to be carried out through the formulation and development of a Centralized Wastewater Management System (SPALD-T).

DISCUSSION/POLICY IMPLICATION

The specific purpose of this Award event is to monitor the sustainability of Sanimas in the city of Bogor through direct observation in the field, identifying problems faced by KSM, both regarding technical, financial, and institutional aspects to support the sustainability of Sanimas. To support Sustainability and Program Effectiveness, CDD supports investment decisions, as 10 principles have been identified to guide policy formulation and program design in improving the effectiveness and sustainability of this Sanitation Program.

CONCLUSION

1. Generally, The Sanimas program has not been optimal in its operationalization so it is still far from reaching the target of achieving SDG No. 6.
2. To give appreciation as well as motivation and encouragement to KSM who have operated Sanimas on an ongoing basis, it is necessary to give an award called Sanimas Award.

The Public Willingness to Participate in The Management Of Domestic Wastewater In Banda Aceh

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ABSTRACT

One solution that has begun to be implemented in Banda Aceh to address the problem of domestic wastewater is the operation of a Communal WWTP (Wastewater Treatment Plant), namely an on-site (local) wastewater treatment plant that treats non-toilet wastewater and toilet waste. In Banda Aceh, more than twenty Communal WWTPs have been built, which are expected to prevent environmental pollution. So far, this program has been running well but not as smoothly as expected, for example, due to an error in the connection from the distribution line to Home Connection, blockages, rejection by some residents, etc. This Communal WWTP in Banda Aceh was built in *gampongs* (the smallest administration unit), classified as slums (according to the Decree of the Mayor of Banda Aceh). All houses and buildings that produce waste must ensure the pollutant level before discharging waste into water bodies. It is hoped that this WWTP can be adapted more broadly to connect all houses and buildings to the WWTP.

In addition to domestic wastewater generated by domestic activities (households, offices, dormitories, schools, etc.), it is also necessary to pay attention to household and more extensive industrial activities that can potentially contribute to water pollution. More prominent industries should have a special WWTP that is not affiliated with domestic wastewater because the characteristics of the wastewater may be different, requiring a different processing stage from the treatment of domestic wastewater.

Several legal regulations in Indonesia have addressed the problem of pollution (Law no. 32/2009) and control mechanisms (Government Regulation no 22/2021), and also related to community participation (Law no 17/2019, etc.). More detailed regulations (so-called *Qanun* in Aceh) are needed at the regional level, both at the provincial and city/district levels, so that the implementation of wastewater management can run well because the strategy has been reviewed according to conditions in the area and the level of community participation. Several

provinces and cities in Indonesia have regional regulations governing domestic wastewater management, but this is not yet available in Banda Aceh.

This study aims to determine the willingness of the people of Banda Aceh to participate in the management of domestic wastewater and what factors influence this level of willingness so that a strategy for implementing policies on wastewater management can be formulated.

The research method used was a survey using a questionnaire instrument. The questionnaire is divided into three parts. The first part collects data on the characteristics of the respondents, the second part contains questions about people's perceptions of wastewater and pollution, and the third part contains questions about the community's willingness to participate in waste management. Respondents so far numbered 108 people living in Banda Aceh City.

The results showed that the community (business and non-business owners) was highly willing to participate (19.44% *very willing*, 77.78% *willing*). The form of willingness to participate that most respondents chose was "*willing to attend meetings of community members related to wastewater management*" (52%) and "*pay dues*" (18%).

From the results of research and discussion, several conclusions can be drawn. First, the community have a high level of willingness to participate. Second, the form of willingness to participate that most respondents chose was "*willing to attend meetings of community members regarding wastewater management*" and "*pay dues*". Factors influencing willingness to participate are a. Respondents know they are also waste producers and that their liquid waste can pollute the environment and must be treated before being released into it; and b. The community perceives that the government is responsible for providing wastewater treatment facilities.

Several things need to be considered by the government, including the community should be involved in formulating policies or regulations related to wastewater management. Furthermore, the government needs to provide environmental education so that people's insight and knowledge can increase and expand so that the implementation of policies related to liquid waste management can run well. Education related to the environment and liquid waste management must also be carried out so that the community's willingness can be more extensive.

KEYWORDS: public participation; domestic wastewater management; willingness to participate

Characterization of Sewage Sludge as Briquettes Combined with Sawdust

Suci Wulandari

INTRODUCTION

Malang City has succeeded in achieving open defecation-free (ODF) status through the Community-Based Total Sanitation (STBM) program which covers all urban villages so that around 100% of the population has healthy latrines and proper sanitation. On the other hand, the level of collection of sludge at the Sludge Treatment Plant (STP) through scheduled desludging services (SDS) by the government and the private sector is still low, around 11%. In order to encourage the implementation of SDS, the ultimate goal of sludge treatment needs to be redefined so that the processing product is more applicable and of high value so that it can become a resource recovery product. Currently, the use of sludge from STP is limited to organic fertilizer, while sewage sludge has the potential as a biofuel which has been applied in several countries, as a partial substitute for high-emission fuels such as coal for power plants and cement factories. This is one of the solutions related to carbon tax policies and efforts to reduce factory operating costs by using bio-solid fuel from sludge products with lower emissions. This study aims to measure the potential utilization of sludge as bio-solid fuel in the form of non-charcoal briquettes combined with sawdust.

METHOD

The sludge sample was taken from the sludge drying bed at the Supit Urang STP, Malang City, and the sawdust was taken from the nearest furniture craftsman. Sludge samples were taken randomly at 6 points in SDB and composited into one sample of 5 kg. Raw materials are given initial treatment in the form of chopping and grinding using a crusher and grinder. Then homogenized by sieving on a 60 meshes sieve. Briquettes were made on a laboratory scale by mixing sewage sludge and sawdust at a ratio of 75%: 25%, 50%: 50%, and 25%: 75%. In addition to the combination of raw materials, briquettes also use an adhesive in the form of starch with a percentage of 5% of the total weight. The adhesive is dissolved in water in a 1:3 ratio. The briquette material that has been mixed is molded with metal tube that has inner diameter of 29 mm. The briquettes that have been made will be subjected to characterization analysis including

calorific value analysis based on ASTM D 5865-01, proximate analysis based on SNI 06-3730-1995 and SNI 01-6235-2000, sulfur value based on ASTM D3177, and density of briquettes based on SNI 8021-2020. Correlation analysis between the proximate value and the calorific value was carried out using the Spearman rank method so that it can be seen the relationship between the proximate parameters and the calorific value. The characteristics of the briquettes are also compared with the quality standard for the qualification of the fuel used, namely SNI 8021: 2020. The ranking of the best briquettes is carried out using multi-criteria analysis (MCA) adopted from the Sludge Energy Enterprises in Kampala (SEEK) Project.

RESULT & DISCUSSION

The sludge briquette products tested in this study were combined with biomass of sawdust including 75% SS and 25% SD; 50% SS and 50% SD; 25% SS and 75% SD. Characterization of briquette products is carried out by carrying out proximate analysis, and testing the calorific and sulfur values. The results of the characterization of briquette products are shown in **Table 1.**

Tabel 1. Briquttes Characteristic

No	Variasi	Water Content (%)	Volatile Matter (%)	Ash Content (%)	Fixed Carbon (%)	Calorific Value (cal/g)	Sulfur (%)	Density (g/cm³)
1	SS 100%	4,27%	38,75%	51,91%	5,07%	3.921,43	0,64%	0,88 ± 0,12
2	SS 75% SD 25%	3,26%	51,34%	32,97%	12,42%	4.237,78	0,41%	0,68 ± 0,05
3	SS 50% SD 50%	7,09%	48,68%	17,61%	26,62%	4.693,11	0,33%	0,56 ± 0,03
4	SS 25% SD 75%	7,57%	68,97%	12,02%	11,44%	5.158,64	0,23%	0,50 ± 0,09
5	SD 100%	5,33%	72,34%	1,41%	20,91%	5.632,65	0,24%	0,40 ± 0,02

Obtaining the moisture content value of the combination of sludge and sawdust briquettes is in the range of 3.26% - 7.57%, with the lowest water content value being in the variety of 75% SS and 25% SD, while the highest moisture content is in the combination of 25% SS and 75% SD. In general, no linear correlation between the percentage of water content and the percentage of the combination of SS & SD in this study (Figure 1). The value of the water content is also closely related to the density of the briquettes, the lower the density the higher the potential for absorbing water resulting in a high-value water content (Sudrajat, 1983). In Table 1, it can be seen that the density of 100% sludge briquettes is higher than 100% sawdust briquettes, so the trend hypothesis is that the greater the sawdust composition, the higher the water content. This hypothesis is proven by three composition variations, namely SS75% and SD25%, SS50% and SD50%, and SS25% and SD75%. The value of the water content in this study can be influenced by the mixture of water and adhesive when making briquettes, as well as the influence of the drying process carried out.

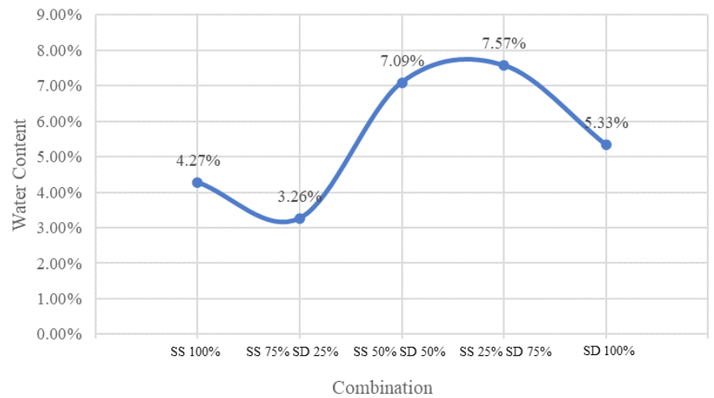

Figure 1. Relationship of Briquette Combination Composition to Moisture Content

The relationship between the composition of the combination of SS and SD briquettes on the value of volatile content can be seen in Figure 2. The value of volatile content ranges from 38.75% - 72.34%. Based on the graph, there is a linear relationship between composition and volatile content. Volatile content will increase with the increasing composition of sawdust combination in sludge briquettes. The lowest volatile content was in the 100% fecal sludge briquette variation, while the highest content was in the 100% sawdust briquette variation.

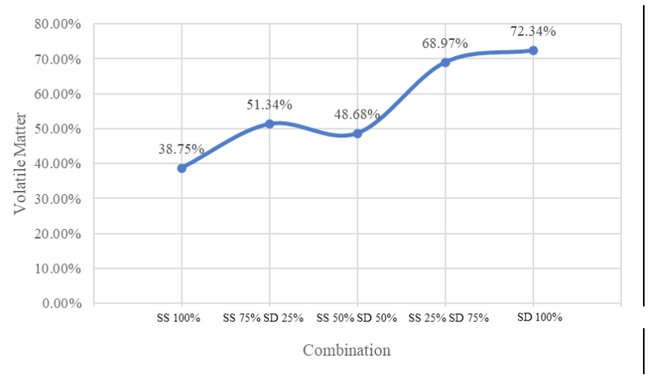

Figure 2. Relationship of Briquette Combination Composition to Volatile Matter

Ash content has a linear relationship to variations in the composition of sludge and sawdust briquettes (Figure 3). The greater the composition of the sludge, the higher the ash content, and vice versa. So that the highest value of ash content is in the 100% fecal sludge variation, which is 51.91%, while the lowest value is in the 100% sawdust variation, which is 1.41%.

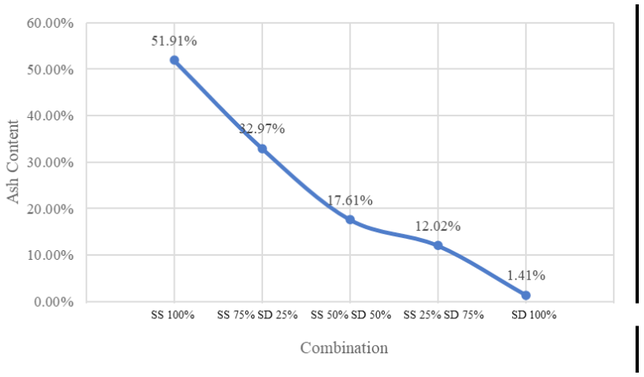

Figure 3. Relationship of Briquette Combination Composition to Ash Content

Fixed Carbon has a quadrant curve relationship to variations in the composition of sludge and sawdust, but does not apply to variations in 100% sawdust (Figure 4). The peak value of Fixed Carbon is at SS50% and SD7% variation, which is 26.62%. While the lowest value of Fixed Carbon is in the 100% SS briquette variation.

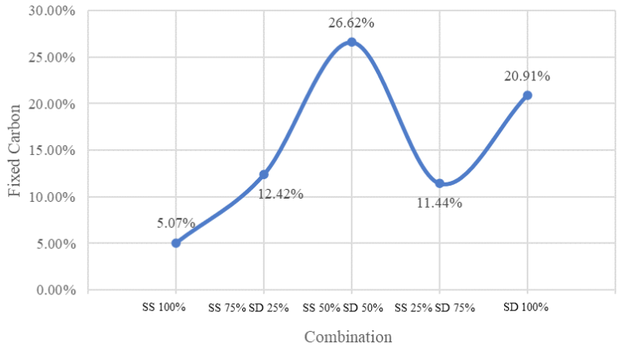

Figure 4. Relationship of Briquette Combination Composition to Fixed Carbon

The calorific value of the combination of sludge and sawdust is 3,921.43 – 5,632.65 cal/g. The relationship between the calorific value obtained is linear to the increase in the composition of sawdust in sludge briquettes (Figure 5). So that the highest and lowest values are, respectively in the variation of SS100% and LL100%.

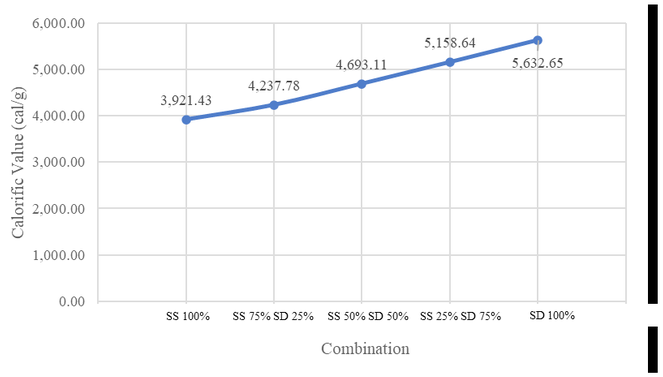

Figure 5. Relationship of Briquette Combination Composition to Calorific Value

The relationship between sulfur values obtained is negatively linear to the increased sawdust composition in sludge briquettes (Figure 6). The sulfur value of the combination of sludge and sawdust is 0.23% – 0.64% cal/g, so the highest and lowest values are, respectively, in the LT100% and SG100% variations.

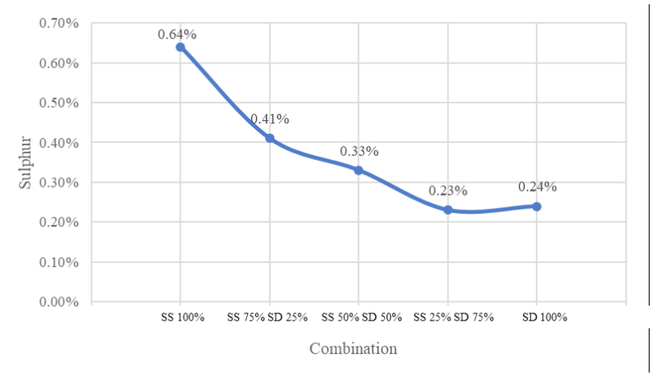

Figure 6. Relationship of Briquette Combination Composition to Sulphur

In the combination of sludge and sawdust, there is no significant correlation between the content of water and fixed carbon on the calorific value. This can be seen from the significance value > □ (Figure 6 – Figure 7). The significance of heat and water content is 0.285, greater than the significance level of 0.05, so the relationship obtained is not significantly correlated. The degree of relationship obtained from heat and water content is 0.600, which means the level of relationship is strong in a positive direction. This means that the calorific value will increase with increasing water content. But still, the relationship between the two is not significant, the correlation can be said to be not absolute.

The significance of heat and bonded carbon was 0.391, higher than the 0.05 significance level. The degree of relationship between heat and bonded carbon is 0.500, so it is a medium relationship with a positive direction. The higher the bonded carbon, the heating value will increase.

Correlations

			Kalor	Kadar Air
Spearman's rho	Kalor	Correlation Coefficient	1,000	,600
		Sig. (2-tailed)	.	,285
		N	5	5
	Kadar Air	Correlation Coefficient	,600	1,000
		Sig. (2-tailed)	,285	.
		N	5	5

Figure 7. Spearman Rank Correlation between Calorific Value and Water Content

Correlations

			Kalor	Fixed Carbon
Spearman's rho	Kalor	Correlation Coefficient	1,000	,500
		Sig. (2-tailed)	.	,391
		N	5	5
	Fixed Carbon	Correlation Coefficient	,500	1,000
		Sig. (2-tailed)	,391	.
		N	5	5

Figure 8. Spearman Rank Correlation between Calorific Value and Fixed Carbon

The relationship between ash content and volatile content on calorific value has a significant correlation. This can be seen from the significance value < □ (Figure 8 – Figure 9). Significance of heat and ash content 0.000 <0.05 (even significantly correlated at a significance level of 0.01); heat and volatile content 0.037 <0.05. The degree of relationship between heat and ash content (-1.000) strongly correlates with a negative direction (or reverse relationship). In contrast, the relationship between heat and volatile content (0.900) is a very strong relationship with a positive direction. This shows that the greater the ash content, the lower the calorific value, and vice versa. For the volatile content, the higher the volatile content, the higher the calorific value.

Correlations

			Kalor	Kadar Abu
Spearman's rho	Kalor	Correlation Coefficient	1,000	-1,000**
		Sig. (2-tailed)	.	.
		N	5	5
	Kadar Abu	Correlation Coefficient	-1,000**	1,000
		Sig. (2-tailed)	.	.
		N	5	5

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 8. Spearman Rank Correlation between Calorific Value and Ash Content

Correlations

			Kalor	Kadar Volatil
Spearman's rho	Kalor	Correlation Coefficient	1,000	,900*
		Sig. (2-tailed)	.	,037
		N	5	5
	Kadar Volatil	Correlation Coefficient	,900*	1,000
		Sig. (2-tailed)	,037	.
		N	5	5

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 8. Spearman Rank Correlation between Calorific Value and Volatil Matter

The SS75% and SD 25% briquettes successfully meet the solid fuel quality criteria according to SNI 8021:2020. The first quality is fulfilled by the parameters of moisture content and volatile content. While the second quality is fulfilled by ash content, heat, sulfur, and density parameters. Table 2 provides comparative information between the characteristics of briquettes compared to SNI 8021:2002.

Table 2. Quality Analysis of Briquettes SS75% and SD25%

Parameter	Result	SNI 8021:2020		Keterangan
		First Quality	Second Quality	
Water Content	3.26%	≤ 8	8 < x ≤ 12	Qualified 1st Quality
Volatile Matter	51.34%	≤ 75	> 75	Qualified 1st Quality
Ash Content	32.97%	≤ 2	> 2	Qualified 2nd Quality
Calorific Value	4,237.78	≥ 4,300	4,000 < x <4,300	Qualified 2nd Quality
Sulphur	0.41%	≤ 0.05	> 0.05	Qualified 2nd Quality
Bulk Density	0.68 ± 0.05	≥ 0.700	0.600 < x ≤ 0.700	Qualified 2nd Quality

Briquettes with a composition of LT50% and SG50% successfully meet the quality criteria of SNI except for density because the value is minimal, namely 0.56 g/cm3. This is due to the characteristics of the raw material for sawdust which is light but has a volume or can be said to have a low density. The other parameters have met the quality criteria for the first quality fuel and the second quality. The first quality is fulfilled by water content, volatile content, and heat, while the ash and sulfur content fulfills the second quality criteria. A comparison between SNI criteria and LT50% and SG50% briquettes can be seen in Table 3 below.

Table 3. Quality Analysis of Briquettes SS50% and SD50%

Parameter	Result	SNI 8021:2020		Keterangan
		First Quality	Second Quality	
Water Content	7.09%	≤ 8	8 < x ≤ 12	Qualified 1st Quality
Volatile Matter	48.68%	≤ 75	> 75	Qualified 1st Quality
Ash Content	17.61%	≤ 2	> 2	Qualified 2nd Quality
Calorific Value	4,693.11	≥ 4,300	4,000 < x <4,300	Qualified 1st Quality
Sulphur	0.33%	≤ 0.05	> 0.05	Qualified 2nd Quality
Bulk Density	0.56 ± 0.03	≥ 0.700	0.600 < x ≤ 0.700	Not Qualified

The quality of the LT25% and SG75% briquettes is the same as the LT50% and SG50% briquettes, that is, only the density criteria are not met. The rest, water content, volatile content, and heat, have completed the first quality criteria. At the same time, the ash and sulfur content meet the second quality criteria. Analysis of the quality of these briquettes can be seen in Table 4 below.

Table 4. Quality Analysis of Briquettes SS25% and SD75%

Parameter	Result	SNI 8021:2020		Keterangan
		First Quality	Second Quality	
Water Content	7.57%	≤ 8	8 < x ≤ 12	Qualified 1st Quality
Volatile Matter	68.97%	≤ 75	> 75	Qualified 1st Quality
Ash Content	12.02%	≤ 2	> 2	Qualified 2nd Quality
Calorific Value	5,158.64	≥ 4,300	4,000 < x <4,300	Qualified 1st Quality
Sulphur	0.23%	≤ 0.05	> 0.05	Qualified 2nd Quality
Bulk Density	0.50 ± 0.09	≥ 0.700	0.600 < x ≤ 0.700	Not Qualified

In addition to comparing the characteristics of the sludge briquette product and the combination of biomass with SNI 8021:2020, the briquette product is also scored and weighted through the Multi-Criteria Analysis (MCA) adopted from the Sludge to Energy Enterprises in Kampala (SEEK) Project. The MCA is used only to assess the physical and chemical content contained in the fuel. It eliminates several criteria not available in this study, such as heavy metals, particle size, and material impurities. The results of scoring and weighting can be seen in **Table 5.**

Table 5. Scoring and weighting of briquette products using MCA

No	Combination	Water Content (%)	Ash Content (%)	Fixed Carbon (%)	Calorific Value (MJ/kg)	Bulk Density (g/cm3)	Total Score	Ranking
1	SS 75% SD 25%	3.26%	32.97%	12.42%	17.74	0,68 ± 0,05	37.00	3
	- Score	5.00	2.00	2.00	5.00	4.00		
	- Weigh	3.00	3.00	1.00	2.00	1.00		
	Score x Weigh	15.00	6.00	2.00	10.00	4.00		
2	LT 50% SG 50%	7.09%	17.61%	26.62%	19.65	0,56 ± 0,03	45.00	1
	- Score	5.00	4.00	5.00	5.00	3.00		
	- Weigh	3.00	3.00	1.00	2.00	1.00		
	Score x Weigh	15.00	12.00	5.00	10.00	3.00		
3	LT 25% SG 75%	7.57%	12.02%	11.44%	21.60	0,50 ± 0,09	42.00	2
	- Score	5.00	4.00	2.00	5.00	3.00		
	- Weigh	3.00	3.00	1.00	2.00	1.00		
	Score x Weigh	15.00	12.00	2.00	10.00	3.00		

The scoring and weighting results are ranked so that a ranking is produced for each variation of briquettes. In this ranking, the top three briquettes were obtained according to the ranking carried out, namely the first rank obtained the SS50% and SD50% variations, the second rank obtained the SS25% and SD75% variations, and the third rank obtained the SS25% and SD25% variations.

CONCLUSION

The calorific value of fecal sludge non-charcoal briquettes was obtained 100% almost meeting the second fuel quality standard based on SNI 8021: 2020 of 3,921.43 cal/g. The addition of sawdust gave a trend of increasing the calorific value of fecal sludge non-charcoal briquettes up to 32%, namely 5,158.64 cal/g. This addition also increases the water content, where the lowest water content is owned by the 75% SS briquette: 25% SD, namely 3.26%. The characteristics of sludge with a high ash content greatly benefit from the combination of sawdust, so that the ash content of mixed briquettes experiences a decreasing trend of

up to 40%. While the content of volatile and bound carbon does not have a linear trend towards the variation of briquettes, i.e. 48.68% - 68.97% and 11.44% - 26.62% respectively. The sulfur value meets the second quality standard of SNI 8021: 2020, which is in the range of 0.23% - 0.41%. According to SNI 8021:2020 only variety briquettes SS 75%:SD 25% only that meets the second quality criterion of buld density. From this study, it was found that sewage sludge in Malang City has the potential to be used as a bio-solid fuel and the use of sawdust as a combined biomass can increase several parameters of the required fuel criteria.

Social Vulnerability Assessment To Clean Water Management, Study Case: Clean Water Crisis In Baleendah And Dayeuhkolot Districts, Bandung Regency

BACKGROUND

Climate change has brought many externalities to the community, one of its notable impactsis closely related to the clean water crisis. With extreme weather happening more frequently,along with low-quality social behavior in managing their water stock, clean water is not optimally managed for fulfilling the basic needs. If this problem is ignored for a long time, it can hinder the improvement of life's quality in the affected area. Considering this urgency, reducing social vulnerability to clean water crises because of climate change is a mandatory task for the involved stakeholders. As a first step to realize this strategy, social vulnerabilityassessment should be conducted as the preliminary study.

METHODOLOGY

The purpose of this study is to conduct a social vulnerability assessment in regards to cleanwater crises. As for the study cases, Baleendah and Dayeuhkolot Districts, Bandung Regency, were selected as the sample because these places have been well-known as high populated areas that are prone to flood and drought when extreme weather occurs.

To operate the assessment, a mixed-method approach between quantitative and qualitative methods would be used at the village level unit to measure the level of social vulnerability as well as to deepen the logical reasons behind the achieved indexes. The quantitative methodmay be functioned for measuring the social vulnerability. Operationally, a composite social vulnerability assessment framework along with its parameters and indicators should act as aguide in the assessment process. To make it more holistic, the index measurement is assisted by the use of Geographical Information Systems so that the index's pattern could be spatiallyidentified.

After finding the social vulnerability indexes for each district, the qualitative approach is conducted to elaborate the root problems behind the indexes and synthesize the resilience

strategy based on the findings. SWOT analysis is intended to be the method to deconstructand map the knowledge from the indexes and form strategic solutions.

RESULT

Based on the analysis, four indicators were measured jointly to produce composite social vulnerability indexes in every village in these two districts: population density, health resiliency, education resiliency, and purchasing power. After calculating the indexes, three kinds of results were obtained: highly vulnerable (5 villages that mostly resided in Dayeuhkolot District), moderately vulnerable (8 villages across the two districts), and lowlyvulnerable (only Baleendah Village).

The major factor for the high vulnerability is the ignorance of the local people to build and maintain their unstructured store. They will open their temporary or permanent tenant right on the watershed and water catchment area for the sake of securing their marketplace. Theyare willing to against the government's relocation plan because they are afraid of losing theconsumers and profit from their current business.

DISCUSSION

From this description, it can be concluded that local people's economic security must be fulfilled first in order to save the vital zone for clean water saving while educating them about how to increase their capacity in managing the clean water crisis from flood and drought disaster is also simultaneously endeavored. Nevertheless, the mentioned strategies to increase social capacity should be accompanied by other aspects, particularly physical resilience so the impact of extreme weather could be completely mitigated.

In addition, the SWOT analysis revealed that the strengths of the community are their high sense of social solidarity and their ability to adapt to the environment. However, their weaknesses lie in their low level of education and their lack of awareness about the importance of water management. The opportunities include the existence of government programs to relocate the community to safer areas and the availability of funds for education and infrastructure development. The threats are the limited availability of land in safer areasand the resistance of the community to relocate due to their economic interests.

CONCLUSION

In conclusion, social vulnerability assessment can be used as a preliminary study in reducingsocial vulnerability to clean water crisis due to climate change. Baleendah and DayeuhkolotDistricts, Bandung Regency were chosen as study cases due to their high population and vulnerability to flood and drought. The composite social vulnerability assessment framework, along with its parameters and indicators, was used to measure the social vulnerability in each village. The study found that there were three levels of vulnerability: highly vulnerable, moderately vulnerable, and lowly vulnerable. The study also found that the major factor for high vulnerability was the local people's ignorance to build and maintaintheir unstructured store.

KEYWORDS

Climate change, clean water crisis, social vulnerability, social resilience, resilience strategy

Strengthening Local Government Policies on the Protection of Groundwater Sources to Obtain Sustainable Water Supply for Regional Drinking Water Companies

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ABSTRACT

The availability of natural resources, especially water, is of great importance as it directly affects the resilience of a nation. Water is a fundamental component of life, and thus, the sustainable and professional management of this resource is essential for preserving its quality and quantity. The right to water is an indispensable human right, essential for living a life with dignity. It is a prerequisite for realizing other human rights, which means that every country has the responsibility of providing clean drinking water and sanitation to all who reside within its borders. Accordingly, without access to water, other human rights cannot be realized. In 2012, UNESCO declared that the basic human right to water is 60 liters per person daily for both consumption and sanitation needs. The National Standardization Agency has stated that the use of water for domestic purposes is determined based on the population in both urban and rural areas. In this regard, it has been stated that urban and rural residents require at least 120 and 60 liters/day/capita, respectively. This means that water needs can be calculated and planned accordingly. Regional Drinking Water Companies manage drinking water at the district or city level, ensuring the provision of safe drinking water for all.

OBJECTIVE

This research aims to analyze the regulation, implementation, and strengthening of Local Government Policies toward protecting groundwater sources, thereby ensuring that Regional Drinking Water Companies Obtain a sustainable water supply.

METHOD

The methodology employed in this research is empirical juridical. Furthermore, both primary, secondary, and tertiary data were analyzed qualitatively. The data was collected by direct observation and interviews, and the research was conducted in Kuningan Regency.

RESULT

The results show that water resources management policies at the central level are regulated in the Indonesia Constitution such as Law Number 23 of 2014 concerning Regional Government, Law Number 30 of 2014 concerning Government Administration, Law Number 37 of 2014 concerning Land and Water Conservation, Law Number 17 of 2019 concerning Water Resources, Indonesia Presidential Regulation Number 59 of 2017 concerning the Implementation of Achieving Sustainable Development Goals, and Environment Minister Regulation Number 12 of 2009 concerning Rainwater Utilization. Accordingly, some local government policies towards the effective management of water resources include Regional Regulation Number 13 of 2007 concerning Water Resources Conservation, Regional Regulation Number 12 of 2011 concerning the Implementation of the Kuningan Botanical Garden, Regional Regulation Number 11 of 2013 concerning Urban Forests, and Regional Regulation of Kuningan Regency Number 2 of 2021 concerning Basic Provisions for Services of the Regional Drinking Water Company Tirta Kamuning Kuningan Regency.

IMPLEMENTATION

Regarding the local government policy on water resource management, Kuningan Regency has 523 springs, 104 reservoirs, 5 urban forests, 1 Kuningan Botanical Garden, and 1 Mount Ciremai National Park. In this regard, Tirta Kamuning Regional Drinking Water Company, a company responsible for the implementation of water resources, works to optimize services by managing 18 springs that are used as raw water sources from the 523 springs in Kuningan district, and this is achieved through its 12 branch offices and dedicated services.

CONCLUSION

To strengthen local government policies in protecting groundwater sources and ensure that regional drinking water companies obtain Water Supply Sustainably, it is recommended to update the regional regulations related to building permits. This includes adding the obligation to plant trees, make infiltration wells, and construct bio pore holes, as well as to maintain the quantity and quality of usable water resources. By implementing these policies, people can access clean water and sanitation, which is appropriate to the Sustainable Development Goals.

RECOMMENDATION

This research highlights the need to strengthen local regulations directed towards optimality in meeting the needs for clean water and the improvement of company performance. These regulations will ultimately lead to the optimal fulfillment of clean water requirements in the region.

KEYWORDS: Policy; Sustainability; Water Resources; Quality

Politics of Decentralisation of Water Governance Reform in West Java, Indonesia

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ABSTRACT

This article focuses on identifying the underlying political barriers of water governance decentralisation in Indonesia, mainly in the context of public service reform. The research question is 'how does decentralisation affect water governance reform in Indonesia?'. The urgency of this question is on the gap of preparedness among regions in Indonesia amidst water governance reform directive, indicated by privatisation and irrigation reform. This article also adds political spectrum of explanation to the current water management perspectives. Moreover, this article focuses on subnational domain, particularly West Java to address the central inquiry more empirically.

West Java province is selected as a case study due to national importance of its water resources potential, as well as its engagements with various water and sanitation projects both from national and international fundings. Politically, close proximity between West Java and Jakarta as the capital city poses particular contention in water allocation politics and regulations. About 3000 manufactures and more than 30 million people depend on West Java's water supply and its hydropower generation.

The online and on-site fieldwork was conducted in March to July 2021 and March to May 2022. They are in the form of interviews with local and national authorities, mainly from related ministries and water institutions. Policymakers from the parliament down to civil society actors were also interviewed, accompanied by Data will be gathered from a qualitative case study of West Java province, examining how local networks operate in the water sector. Focusing on one province will allow for an in-depth examination of institutional decentralisation within a country, due to bureaucratic complexity in decentralised Indonesia. Decentralisation of authority from provincial to village level causes tensions in river basins, water resource ownership, and ODA-related project implementations. For future research, findings from an in-depth case study

can be compared with other provinces in Indonesia, where different models may exist. The purpose of the case study will be instrumental, by bringing new insights into an issue area to advance an existing framework (Baškarada, 2014).

The complexity of decentralisation and the growth of water stakeholders in Indonesia are also evident in the rising number of subnational actors in Indonesia working with donor representatives, development organisations, national executive institutions, and national water institutions. Regional planning boards, provincial water enterprises, private water business, river basin organisations (RBOs), water user associations (WUAs), NGOs as donor partners, and epistemic community also actively engage in water reform processes at the subnational level. These range of actors will be best investigated in a provincial level case study with middle-management entities that can connect the global, national and the smallest units of government.

Decentralised water service provision can be observed in such processes, including desalination, drinking water, reclamation, irrigation water conservation, imported pipe water, rainfall tank, rainstorm harvesting, or groundwater bores (Mankad & Tapsuwan, 2011; Moglia et al., 2011).

The selection basis of the case study is in the critical features of the cases, where they have a strategic importance to the general problems (Flyvbjerg, 2001). Furthermore, institutions are built through the construction of a set of values and norms, linked to standardised behavioural roles of states. However, ambiguity in the norms frequently lead political actors into non-compliance and disintegration (Engelkamp & Glaab, 2015), particularly in the sub-national level. In this article, IWRM and global foreign assistance governance are positioned as networking entities of global knowledge utilisation that involves transnational advocacy networks, global public policy networks, and transnational executive networks (Stone, 2013). This is where case studies are substantial, as localised cases will reflect to what extent those networks of water governance operate across the local level.

Water governance reform in Indonesia during the democratic transition (1998-2004), in the context of sectoral priorities, is characterised by the privatisation of drinking water service and decentralisation of irrigation management. Both of these sectors were directed and funded by The World Bank despite the state of public debt and fragile incentive structure for development. Decentralisation of government was expected to bring a more competitive model of water governance amidst public pressure to evenly distribute access to clean water.

From general decentralisation law to sector-specific regulations, multi-tier laws and regulations were legalised to formalised power-sharing in water governance.

KEYWORDS: decentralisation, water governance, water management, West Java, water politics

Is the “Privatization” Over? Towards a Just Regulatory Framework in Post-Concession Jakarta

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INTRODUCTION

The Indonesian Supreme Court ruled in 2017 that Jakarta’s water concession must cease because it violates some national and local regulations. As reactions, many (human right) activists and anti-privatization groups were jubilant that the 25-year private-concession would finally come to an end and that the Jakarta’s water supply services would return to the public hand. The Governor of Jakarta Province at that time, Anies Baswedan, vowed that he would immediately enforce the Supreme Court’s decision. The Governor formed a team to assist him with the re-municipalization of Jakarta’s water services and improving its governance framework. What follows, unfortunately, is a lot more complicated. In 2019, through a review made by the Ministry of Finance, the Supreme Court annulled its 2017 Decision. As a result, the concession remains untouched – the contract can only lapse in 2023 unless otherwise agreed by the parties (PAM Jaya, Palyja and Aetra). In principle, there is an urgent need to increase the coverage of water service provision within the capital city – and this was part of the political promise of the 2017 elected Governor. The only plausible legal mechanism available at that time was to retake Jakarta’s water services through private means. Following tough negotiations, the concession holders have different positions. Aetra, the private operator in charge of the Eastern half of Jakarta, agreed to relinquish the distribution part of the network it controls but retain parts of the bulk water supply. and this negotiation has been formalized by extending the existing concession contract. On the contrary, Palyja, who controls the Western half refused to adjust and opted for the contract to lapse in 2023.

For Jakartans 2023 is the year of an inflection point in the water sector. There is a need to encourage public debates and find new regulatory models. Although the national legal framework restricts the involvement of private sector in water supply by prohibiting them to manage the distribution networks, there are varying structural and institutional dynamics at the more local scales that

have made diverse forms and degrees of involvement of private actors in place. In this paper, we argue that the national regulatory framework is not effective in securing the public provision system; it hinders for guaranteeing access to water for all, while allowing diverse private actors operating within the under-regulated public domains. In current governance practice, private sector players utilize “blended financing” schemes to go around the regulatory restrictions but with an –end-result of maintaining contractual controls of all the provision chains. We view that it is crucial to differentiate between service provision and service production; it is the basic service provision that the state has to guarantee instead of a particular model of service production. We argue that in addition to the national legal framework, Jakarta should ensure good governance including socially-and-ecologically just service production systems, acknowledgement of different service production schemes.] and ensuring public control by reforming its local regulation on water services. The regulation, which is currently in the drafting process, would be very prone to capture by special interests. Failure to ensure a just regulatory system in Jakarta would mean that the commercialization of water could continue in different ways.

METHODOLOGY:

This paper draws from 4 (four) previous researches undertaken in 2018-2021

We draw conceptual framework from the human right to water movement, based on General Comment-15 and report of the UN Special Rapporteur on Human Right to Water

•Comparative: Comparing Jakarta’s regulatory framework with advanced jurisdictions

•Legal Analysis: Analyze existing national regulation and local water regulation

•Group Discussions: 5 (Five)

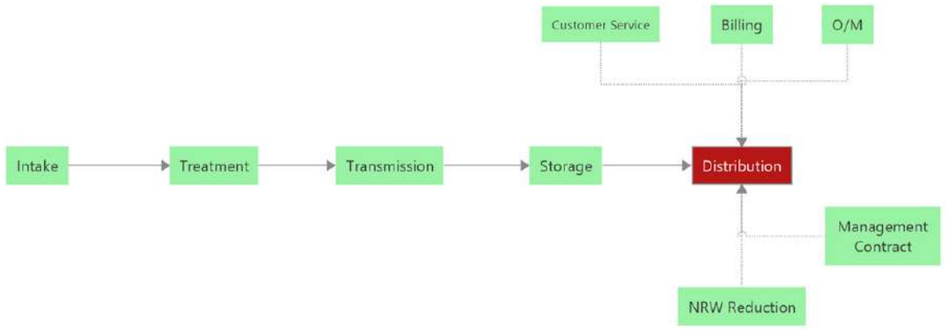
•Interviews: 10

FINDINGS:

Jakarta’s water concession ended on February 1, 2023. However, existing regulatory framework is outdated and missing proper guarantee of access to water.

On October 14, 2022, PAM Jaya signed an agreement with Moya (Aetra’s affiliated company) to produce bulkwater for PAM Jaya. The bundling agreement is meant to cover investment by optimizing existing assets. It was reported that Moya will operate 6 bulkwater treatment plants whereas the remaining 7 WTP remains under PAM Jaya’s control. The exact financial nature (IRR, etc) of the agreement is unknown. Governor regulation 7/2022 limits the contract period to 30 years.

Upon analyzing national and local Jakarta regulation, we find that it is still possible for the private sector to control parts of water supply value chain through contractual arrangements (see figure below) and for the whole contracts to be overseen by a single company or a group of affiliated companies. However, such arrangement could diminish control and as such, may not be constitutionally compliant.



In order to ensure a just access to water, we propose that regulatory framework be reformed so as to include (i) public entity protection, (ii) recognition of service plurality, (iii) connection and disconnection policy, (iv) service standard and compensation policy, (v) free basic water and hardship policy as well as (v) justice and transparency mechanisms across the planning and business cycle.

CONCLUSIONS:

Without appropriate safeguard, there is no guarantee that the end of Jakarta’s concession means the end of “privatization” and commercialization of water services in Jakarta. In fact, our analysis demonstrate that existing legal framework still open holes for the private sector to “control” water value chain through contractual arrangement, although this may not be compatible with the constitution. We argue that the framework as explained above needs to be included as a part of Jakarta’s regulatory reform package in order to ensure a just access to water. As water regulation is prone to capture, this needs to be implemented immediately while the momentum is present.

Mutual Accountability and Multistakeholder Partnerships in Water and Sanitation Sector in Indonesia

Qowamuna, NA, Al'Afghani, MM

BACKGROUND

In line with the Sustainable Development Goal (SDG) 6, the government of Indonesia has set a target to ensure 100% access to improved drinking water, including 15% of safely managed drinking water, and 90% access to improved sanitation facilities, including 15% safely managed sanitation by 2024. Over the past decade, Indonesia has made consistent progress in increasing the coverage of improved drinking water and sanitation. Despite progress, Indonesia continues to face challenges in providing safely managed drinking water and sanitation services to its population. As of 2020, only 11,95% households have access to safely managed drinking water, while 7,6% have access to safely managed sanitation.

PROBLEM STATEMENT

Collaborative efforts from a wide range of actors, including government agencies, civil society, development partners, private sector, as well as research and learning institutions are essential to ensure the achievement of water and sanitation targets. However, multi-stakeholder collaborations may encounter challenges such as lack coordination, lack of trust, as well unclear roles and responsibilities. Such factors can hinder the progress and undermine the effectiveness of multi-stakeholder collaboration.

Mutual accountability is viewed as an essential aspect in enhancing multi-stakeholder collaboration. It is seen as a driving force in fostering collaboration towards a common goal. The concept of mutual accountability enables partners to hold each other accountable for their commitments to achieve the SDG 6. Moreover, mutual accountability is one of the forms of accountability, such as public accountability and horizontal accountability, to name a few. However, in contrast to other forms of accountability, there has been relatively limited research on mutual accountability in the WASH sector.

OBJECTIVE OF PAPER

This paper aims to:

Assess the existing condition of multi-stakeholder collaboration and mutual accountability in the WASH sector in the national level in Indonesia;

Identify enabling factors required for multi-stakeholder collaboration to increase sector progress.

METHODOLOGY

This paper draws on the Indonesia case study as part of the Sanitation and Water for All (SWA) Mutual Accountability Mechanism (MAM) study conducted in 2020 and the SWA MAM Catalytic support conducted in 2022. The data collection includes document review, stakeholder mapping on national level actors that have the potential to drive change in the WASH sector, online survey, key informant interviews, social network analysis (SNA), validation workshop, group discussion, and online webinars. Mutual accountability, according to the SWA, is the mechanism by which partners collaborate to build robust, transparent, and responsive accountability systems, and willingly be held responsible for the commitments made to one another.

RESULTS

The paper identifies different forms of accountability in the national level, such as public accountability and upward accountability. Various forms of multi-stakeholder platforms (MSPs) are also found in the national level. Two platforms with the largest membership and substantial government engagement are Jejaring AMPL (Water and sanitation network) and National Pokja AMPL (PPAS/PKP). Jejaring AMPL has a diverse membership, including government actors, NGOs, donor organizations, and research and learning organization in their personal capacity. National Pokja AMPL (PPAS/PKP) officially consists of government actors, although non-government actors are sometimes invited for discussions. The two main platforms typically serve as communication and coordination platform but have yet to enable mutual accountability.

This paper also assessed three enabling factors that are required to support sector effective collaboration and accountability. Trust, agenda-setting, and shared vision are seen as the driving force for stakeholders to take part in a multi-stakeholder engagement. However, power difference is considered by some as one of the challenges in collaboration between government agencies and CSOs as well as between CSOs themselves.

DISCUSSION

Multi-stakeholder platforms hold an important role in enhancing collaboration between sector stakeholders. They perform varying functions such as information sharing, capacity building, increasing diverse participation of wider stakeholders, as well as influencing sector policy. Moreover, this study found that multi-stakeholder engagement is considered to bring various benefits such as increasing collaboration and participation in policy development. It also supports peer to peer learning between sector actors. Several concrete results of multi-stakeholder engagement in the WASH sector in Indonesia includes providing inputs into national laws and policies.

The existing multi-stakeholder platforms, however, do not yet support mutual accountability between the stakeholders. Even so, well-functioning multi-stakeholder platforms have basis and potential to facilitate the process. In the context of Indonesia, the existing multi-stakeholder platforms (or engagement) can be utilized to enable mutual accountability. However, the rules of engagement should be agreed upon by sector stakeholders.

CONCLUSIONS

It is important to enhance participation and inclusiveness between sector actors by strengthening the multi-stakeholder platform(s) and to enable mutual accountability within the platform as well as opportunity for learning. In the context of Indonesia, further discussion is necessary in terms of the rules of engagement and the level or proceduralization that the actors are willing to adhere. The paper also found that the SWA, a global multi-stakeholder partnership, that works towards collective action in the sector, is seen as neutral ground that can level the playing field between large and small stakeholders.

Effect of Introduction of Water Filters on Hydration of Primary School Students

Ningsih,B.A,. Ramsey,S.S,. Hofwegen, G. van.

BACKGROUND

Academic research supports the notion that dehydration reduces cognitive ability.[1] Only 21 percent of Indonesian schools supply safe drinking water to students. As a result

students either drink potentially contaminated water, purchase sugary drinks, or go to school thirsty. This study seeks to determine the extent to which the provision of water filters to schools improves the fluid intake of children while at school. Congruently, this study also seeks to determine the impact of water filter allocation on absenteeism, sugary drinks consumption, and diarrhea rates.

METHOD

1212 water filters were installed in 150 schools in Lebak Regency, Banten, Province, Indonesia. 34,625 students received a 10 minute lesson on the importance of hydration. A random sample of 1500 students were surveyed about their water drinking habits before and afterwater filters were installed. Digital water meters were installed at 23 randomly chosen filters in order to verify the reported fluid intake. The water quality at the schools were tested before and after the filters were installed.

RESULTS

87 percent of children indicated they drink more water at school than before the waterfilters were installed. Results from water meters attached to the water filters verified that after the filters were installed children drank on average 239ml of water during a 2-hour school day compared with just 3ml before the installation. Total water consumption at schools increased

from an average of 80 ml per child per day before the project to 443ml per child per day after theproject. Before filtration the average e-coli plate count of water at school was 1300 CFU /100ml of e-coli bacteria. After filtration the plate

count was 0 in all instances. No measurable effect wasfound on sugary drink consumption, absenteeism, and diarrhea.

DISCUSSION

For a more profound effect on diarrhea future projects can be combined with efforts to increase drinking water quality at home as well. Results showed that students started bringing more water from home after the filters were installed, suggesting that having drinking water at school also encouraged better drinking habits at home.

CONCLUSION

The results of this study suggest that installing water filters in combination witheducation on hydration are effective in increasing hydration of children in schools. However,further research is needed to determine the effect of water filter allocation on sugary drink consumption, absenteeism, and diarrhea rates. Future studies should also add to the growingbody of research on the impact of hydration on academic performance.

1 Masento, N., Golightly, M., Field, D., Butler, L., & Van Reekum, C. (2014). Effects of hydration status on cognitive performance and mood. *British Journal of Nutrition, 111*(10), 1841-1852. doi:10.1017/S0007114513004455

Systematic Literature Study of Water, Sanitation and Hygiene (WASH) and Biosecurity Intervention as a Determinant of the Danger of Antimicrobial Resistance (AMR) Prevalence in the Livestock Environment

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EXTENDED ABSTRACT

Microbial resistance to antibiotics (AMR) comes from various sources, including agricultural activities, which includes livestock, fishery sector, and plantation sector. The agricultural sector supports adequate food for both developed and developing countries, which is vulnerable to AMR exposure, especially the livestock sector. Until now, the risk factors of AMR are still being comprehensively studied to determine how much influence the factors have in developing a quantitative microbial risk assessment model (QMRA). Risk factors can be determined through fecal/ manure contamination risk factors as pathogens, including hazard factors, pathway factors and indirect factors. Hazard factors, according to World Health Organization (2021), consist of misuse of antibiotics, unavailability of adequate facilities and infrastructure (Water, Sanitation and Hygiene/WASH) and inadequate infection prevention and control (Inadequate Infection Prevention and Control/IPC). Types of animal farms, environmental routes, consumption of antibiotics, and types of livestock are considered as pathway factors, while urbanicity and multi-dimensional wealth index are considered as indirect factors. The One health policy raises the question of whether WASH efforts must also be applied in the livestock sector and other efforts such as Biosecurity and to what extent the availability of WASH influences the opportunities for zoonotic pathogens to arise for workers in the animal farm. This study offers a systematic review of the latest developments in

WASH applications in the livestock sector, the effect of WASH interventions on the risk of exposure to zoonotic pathogens for workers and other hazard factors other than WASH that can build an AMR exposure model as part of the QMRA.

The methodology used in this study is PRISMA 2020, a bibliometric approach and a qualitative approach to determine and assess 58 journals related to WASH interventions in the livestock sector in 2007 – 2022. WASH interventions based on the results of a literature review have increased over the last ten years as cross-sectoral One health policies. Hygiene topics commonly practiced have been integrated with the biosecurity program, and these topics will increase in the future. Only 33% of interventions in the form of improving the quality and quantity of clean water were found in this study. The interventions included disinfection, acidification, and efforts to increase the discharge of water sources. The review was analyzed based on the odds ratio (OR) from 58 works of literature, comparing the intervention's influence on the chance of disease occurring around the livestock area. The OR range for the WASH intervention ranged from 0 - 2, while the WASH-Biosecurity combination intervention was in the range of 0.07 – 18.1. The more complete the types of interventions carried out, the more significant the impact of the risk of disease exposure on workers is reduced. The types of common interventions are medical solid waste management, vaccination programs for livestock, policies limiting the use of antibiotics only for sick animals, the level of knowledge of farmers about the use of antibiotics, management, and cage design.

Only 34% of interventions in the form of improving the quality and quantity of clean water were found in this study. The interventions included disinfection, acidification, and efforts to increase the water supply. The review was analyzed based on the odds ratio (OR) from 50 works of literature, comparing the intervention's influence on the chance of disease occurring around the livestock area. The OR range for the WASH intervention ranged from 0 - 3, while the wash-biosecurity combination intervention was in the range of 0.07 – 24. The more complete the types of interventions carried out, the more significant the impact of the risk of disease exposure on farmers is reduced. The types of common interventions are medical solid waste management, policies limiting the use of antibiotics only for sick animals, the level of knowledge of farmers about the use of antibiotics, management, and safer livestock housing design.

WASH-Biosecurity integration efforts were found in 25% of studies in the form of consistently cleaning the environment around the livestock area, limiting livestock of varied species, separating sick livestock, periodic disinfection of stables, and limiting wild animals to the animal farm. In developing countries where most livestock are smallholders, there are difficulties in implementing biosecurity, so optimizing the application of hygiene and other hazard factors are proposed as the best practice for reducing AMR. Furthermore, through consistent WASH efforts by cooperating with interested parties, the One Health policy will reduce exposure to AMR in the livestock environment.

KEYWORDS: AMR, biosecurity, hazard factors, livestock, odds ratio, WASH

Tanggung Jawab Pengelolaan Sungai untuk Pemenuhan Kebutuhan Air Minum Masyarakat

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ABSTRAK

Air merupakan sumber daya alam yang mendasar bagi kehidupan manusia, sehingga pemenuhannya perlu mendapat perhatian khusus, terutama untuk air minum yang layak konsumsi. Namun demikian, seiring dengan pertambahan jumlah penduduk, pemenuhan kebutuhan air tersebut belum dapat dilaksanakan sepenuhnya sesuai dengan target pencapaian. Hal ini sebagaimana yang terjadi di provinsi Banten, walaupun tiap kabupaten dan kotanya mempunyai Perusahaan Daerah Air Minum (PDAM) sendiri. Dalam praktiknya sumber daya air dari sungai tidak sepenuhnya sesuai dengan standar baku mutu air. Oleh karena itu, sungai yang merupakan sumber air permukakan untuk bahan baku air bagi PDAM perlu dikelola dengan berwawasan lingkungan agar kualitas dan keberlanjutan keberadaannya dapat terjaga.Untuk itu diperlukan dasar pengaturan pemanfaatan sungai dan mengimplementasikannya.

Berdasarkan latar belakang permasalahan tersebut perlu dikaji mengenai; pengaturan terkait dengan pemanfaatan sungai untuk kebutuhan air masyarakat oleh PDAM; dan bagaimana tanggung jawab pengelolaan sungai agar kualitas air baku maupun keberadaan air sungai tetap terjaga. Untuk menjawab permasalahan tersebut akan dikaji berbagai peraturan tentang air, sungai, dan dokumen terkait lainnya, serta informasi dari nara sumber melalui wawancara. Hasil kajian menunjukan pengaturan tentang sungai atau air permukaan belum memadai, yaitu peraturan di tingkat nasional maupun peraturan daerah provinsi Banten dan peraturan Daerah Kabupaten/ Kota-nya. Belum memadainya dilihat dari sisi substansi maupun kelengkapan peraturan yang menjadi dasar pelaksanaan pengelolaan dan pemanfaatan sungai. Tanggung jawab pengelolaan sungai di dalam praktik belum jelas dan tidak terkoordinasi dengan baik antar para pemangku kepentingan. Apabila

kondisi air sungai buruk maka jika dipakai sebagai bahan baku air oleh PDAM akan berdampak pada biaya pengolahan air untuk menjadi air layak konsumsi semakin mahal. Akibatnya akan berdampak pada harga air minum masyarakat yang akan naik pula. Pada akhirnya akan berdampak pada kesejahteraan masyarakat yang menurun.

Kata kunci: sumber Daya Air, sungai, pengaturan air, pengaturan sungai, PDAM, Peraturan Daerah, Provinsi Banten.

A. PENDAHULUAN

Sungai merupakan air permukaan yang salah satunya digunakan sebagai bahan baku air minum masyarakat seharusnya dikelola bersama oleh perusahaan air minum maupun pemangku kepentingan lain yang terkait agar terjaga kualitas maupun kuantitasnya. Untuk itu diperlukan suatu pengaturan atau kebijakan yang memadai mengenai pengelolaan sungai yang apabila diterapkan akan berdampak pada terpenuhinya kebutuhan air masyarakat dan peningkatan kesejahteraannya.

Keberadaan sungai sangat penting karena sungai menyediakan air untuk berbagai kebutuhan hidup manusia. Beberapa manfaat air sungai antara lain untuk irigasi, kebutuhan sehari- hari di rumah tangga, pembangkit tenaga listrik, berbagai industri industri yang membutuhkan air dan berbagai bidang kehidupan manusia lainnya. Oleh karena itu pengelolaan sungai sangat diperlukan mengingat begitu besar manfaatnya sebagai sumber ketahanan air masyarakat sehingga menjadi prioritas kebijakan.[1] Melalui kebijakan atau peraturan yang ada akan menjadi dasar pijakan untuk melakukan berbagai program kegiatan yang berkaitan dengan pengelolaan dan pemanfaatan sungai. Sebagaimana sungai- sungai di provinsi Banten yang airnya dimanfaatkan untuk bahan baku air minum PDAM-nya.

Sejak tahun 2019 provinsi Banten yang mempunyai luas wilayah 9.662,92 km2 itu memiliki sungai- sungai yang dimanfaatkan airnya sebagai bahan baku air minum.[2] Sungai atau wilayah sungai di provinsi Banten, sebagaimana diatur dalam Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Nomor 4/ PRT/M/2015 tentang Kriteria dan Penetapan Wilayah Sungai, memiliki empat wilayah sungai yaitu Cibaliung Cisawarna, Ciliman Cibungur, Cidanau-Ciujung-Cidurian dan Ciliwung-Cisadane. Dari ke empat wilyah sungai tersebut yang menjadi kewenangan Pemerintah Provinsi Banten adalah wilayah sungai Ciliman-Cibungur dan Cibaliung-Cisawarna. Sedangkan 2 wilayah sungai lainnya yaitu Cidanau-Ciujung- Cidurian dan Ciliwung-Cisadane menjadi kewenangan Pemerintah Pusat karena aliran sungainya yang lintas provinsi.

Pemanfaatan air sungai Cisadane oleh PDAM di provinsi Banten bukan saja digunakan oleh masyakat di Daerah Aliran Sungai (DAS) untuk berbagai keperluan rumah tangga, pertanian maupun perikanan, juga digunakan oleh berbagai industri yang membutuhkan air seperti pabrik keramik, pabrik pengolahan makanan, dan terutama juga menjadi sumber bahan baku air minum bagi PDAM. Ada beberapa PDAM di provinsi Banten yang memanfaatkan air sungai sebagai bahan baku air minumnya yaitu Tirta Kerta Raharja PDAM di Kabupaten Tangerang; Tirta Benteng PDAM di Kota Tangerang; Tirta Al Bantani PDAM Kabupaten Serang; Tirta Berkah di Kabupaten Pandeglang; Cilegon Mandiri PDAM di Kota Cilegon; dan Tirta Madani PDAM di Kota Serang.

Kebutuhan air minum masyarakat yang layak minum dari tahun ke tahun semakin tinggi karena jumlah penduduk yang terus meningkat yang tentu mengonsumsi air minum. Jumlah penduduk provinsi Banten pada tahun 2020 sebanyak 11.904.562 orang; tahun 2021 sebanyak 12.061.475 orang; dan di tahun 2022 menjadi 12.251.985 orang. Jumlah kenaikan ini sejalan dengan jumlah kebutuhan air minum yang juga meningkat. Namun untuk memenuhi kebutuhan air tersebut persentase sumber air minum rumah tangga di provinsi Banten pada tahun 2021 persentasenya masih didominasi air dalam kemasan yaitu 56, 14% . Sementara untuk air minum leding yang menggunakan sarana perpipaan ini baru terpenuhi 2, 08%. Kebutuhan air minum lainnya dipenuhi oleh air pompa sebanyaak 26,57 %; Air sumurterlindung 6,38 %; Air sumur tidak terlindung 1,77 %; Mata air terlindung 3,92 %; Mata air tidak terlindung 2,17 %; Air permukaan 0,57 %; Air hujan 0,22 %; dan lainnya 0,17 %.

Dalam praktiknya, penggunaan air sungai ini bukanlah tanpa kendala, berbagai permasalahan sungai terjadi yang berdampak pada masyarakat maupun perusahaan pengguna air sungai. Permasalahan sungai Cisadane yang airnya digunakan untuk bahan baku air minum antara lain adalah berkurangnya jumlah air di musim kemarau dan di musim hujan meskipun jumlah air banyak namun tingkat kekeruhannya tinggi. Hal ini menyebabkan biaya pengenglolaan tinggi, bahkan pernah sebagaimana dialami PDAM Tirta Kerta Raharja kabupaten Tangerang karena tingginya tingkat kekeruhan air menyebabkan terganggunya pengolahan air minumnya. Selain itu masalah limbah pada sungai, seperti limbah sampah ataulimbah buangan dari industri menjadi masalah sungai yang sangat mengganggu dan membahayakan pengguna sungai.

1

2 Peraturan Menteri Dalam Negeri Nomor 72 Tahun 2019 tentang Perubahan atas Permendagri Nomor137 Tahun 2017 tentang Kode dan Data Wilayah Administrasi Pemerintahan Provinsi Banten.

Air minum yang layak untuk dikonsumsi haruslah memenuhi standar yang telah ditentukan. Peraturan Menteri Kesehatan No. 492 Tahun 2010 Tentang Persyaratan Kualitas Air Minum mengemukakan bahwa air minum yang aman bagi kesehatan adalah memenuhi persyaratan fisika, kimiawi dan radioaktif yang dimuat dalam parameter wajib dan parameter tambahan.[3] Untuk kepentingan praktis, dapat dilihat secara visual yaitu sesuai dengan karakteristik kualitas air minum adalah tidak berwarna, tidak berbau dan tidak berasa, maka pengamatan visual bisa menjadi acuan sementara. Sehingga untuk menghasilkan air yang layak konsumsi tersebut memerlukan bahan baku air, salah satunya dari air sungai, yang kualitasnya memenuhi standar air yang memungkinkan untuk diproses menjadi air minum. Namun demikian, pemenuhan kebutuhan air tersebut belum dapat dilaksanakan sepenuhnya sesuai dengan target pencapaian. Hal ini sebagaimana yang terjadi di provinsi Banten, dimana Perusahaan Daerah Air Minum (PDAM) tiap kabupaten dan kotanya sebagian besar menggunakan air permukaan dari sungai.

Dalam praktiknya sumber daya air dari sungai tidak sepenuhnya sesuai dengan standar baku mutu air. Oleh karena itu, sungai yang merupakan sumber air permukakan untuk bahan baku air bagi PDAM perlu dikelola dengan berwawasan lingkungan agar kualitas dan keberlanjutan keberadaannya dapat terus terjaga. Mengingat pentingnya fungsi sungai tersebut maka sungai seyogyanya dikelola bersama secara bersinergi oleh para pemangku kepentingan.Selain itu sungai juga mempunyai permasalahan yang kompleks sehingga untuk menjaga kualitas air maupun keberlanjutan keberadaannya perlu dikelola dari berbagai aspek. Salah satunya adalah sungai Cisadane di provinsi Banten yang menjadi sumber bahan baku air minum Perusahaan Daerah Air Minum (PDAM) dan perusahaan lain yang menggunakan air sungai Cisadane untuk pengolahan usahanya di Kabupaten Tangerang Provinsi Banten.

Berdasarkan uraian yang melatarbelakangi pemanfaatan air sungai untuk air minum tersebut, maka perlu dilakukan penelitian mengenai hal ini. Suatu penelitian mengenai bagaimana pengaturan dalam pengelolaan air sungai yang digunakan untuk bahan baku air minum. Sehingga rumusan permasalahan penelitian ini adalah: 1) Bagaimana pengaturan pemanfaatan sungai untuk kebutuhan air minum masyarakat oleh PDAM?; dan 2) Bagaimana tanggung jawab pengelolaan sungai agar kualitas air baku maupun keberadaan air sungai tetapterjaga?

Untuk menjawab permasalahan tersebut akan dikaji berbagai peraturan tentang air, sungai, dan dokumen terkait lainnya. Peraturan yang ditelaah adalah yang terkait dengan sungai dan pemanfatannya oleh PDAM pada tingkat undang- undang, Perda, Peraturan Pemerintah, Peraturan Menteri, dan peraturan lainnya. Sebagai data pendukung akan dilakukan wawancara dengan nara sumber terkait dan observasi lapangan. Agar penelitian ini lebih mendalam makakajian penelitian akan difokuskan pada pemanfatan air sungai Cisadane pada PDAM Tirta Kerta Raharja di Kabupaten Tangerang.

Sistematika penulisan hasil penelitian ini diawali dengan uraian latar belakang permasalahan yang menjadi alasan urgensi dilakukannya penelitian ini. Selain itu permasalahan yang melatarbelakanginya menjadi dasar perumusan pokok permasalahan yang harus dijawab melalui penelitian yang merupakan tujuan dari penelitian. Jawaban penelitian diperoleh melalui langkah- langkah penelitian atau metode penelitian. Bab pendahuluan diakhiri oleh sistematika penulisan laporan penelitian.

Bab berikutnya merupakan uraian tentang pengaturan sungai dan sistem penyediaan air minum. Uraian memuat pengaturan sungai menurut Undang-Undang, Peraturan Pemerintah, dan Peraturan Daerah. Secara lebih khusus selanjutnya akan dibahas mengenai pengaturan Sistem Penyediaan Air Minum. Setelah pengaturan, pembahasan lebih menguraikan mengenai implementasi dari pemanfaatan air sungai oleh masyarakat dan PDAM di Provinsi Banten. Setelah itu dikaji mengenai tanggung jawab pengelolaan sungai oleh para pemangku kepentingan. Selain tanggung jawab dikaji pula mengenai kendala dan upaya penelolaan sungai yang berkelanjutan. Berdasarkan kajian- kajian tersebut ditarik suatu simpulan dan saran tindaklanjut.

Diharapkan melalui penelitian ini dapat dianalisis tentang pengaturan sungai atau air permukaan yang digunakan untuk bahan baku air minum. Peraturan dimaksud dari sisi substansi maupun kelengkapan peraturan yang menjadi dasar pelaksanaan pengelolaan dan pemanfaatan sungai. Selain itu penelitian ini akan memperjelas tanggung jawab pengelolaan sungai di dalam praktik oleh para pemangku kepentingan. Mengingat apabila kondisi air sungai buruk maka apabila dipakai sebagai bahan baku air oleh PDAM akan berdampak pada biaya pengolahan air layak konsumsi menjadi semakin tinggi. Akibatnya akan berdampak pada harga air minum masyarakat yang akan naik pula. Pada akhirnya akan berdampak pada kesejahteraan masyarakat yang menurun.

[3] Parameter wajib merupakan persyaratan kualitas air minum yang wajib diikuti oleh penyelenggara air minum. Sementara parameter tambahan merupakan kondisi kualitas dari lingkungan daerah masing- masing yang mengacu pada parameter tambahan dalam peraturan ini.Pasal 2 dan Pasal 3 Peraturan Menteri Kesehatan Republik Indonesia No492/ MENKES/PER/IV/2010 Tentang Persyaratan Kualitas Air Minum.

Potential Development of Drinking Water and Sanitation Systems and Technologies in Regions with Marginal Raw Water: Opportunities and Challenges

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ABSTRACT

The use of technology type to process raw water in to clean/drinking water continues to develop in line with advances in technology, innovation and changes in environmental quality The increase in water demand due to the increasing population, especially in big cities, requires drinking water companies to process raw water on a larger scale and in a shorter time. More complex water treatment technologies are being used by combining several processes such ascoagulation, flocculation, settling, and filtering and disinfecting. This concept is known as thebasic technology for processing raw water into clean/drinking water for more than 75 years and is still used today. Innovation and development of the basic concept continues to be carried out in accordance with the demands and developments of the era, which are largely driven by three main factors, namely: the discovery of new contaminants, the establishment of new water quality standards, and costs. The drinking water industry has gradually adapted to new technologies. Several new technologies and innovations have been continuously developed, tested, demonstrated and introduced to the urban water treatment market in the last 30 years including: membrane filtration, UV irradiation, advance doxidation, ion exchange and biological filtration. The use of one type of new technology by industry and other parties ishighly dependent on several things such as cost, suitability and reliability, location as well as operation and maintenance.For example, membrane filtration technology and its combinations can be used to replace conventional filtration for surface water treatment but cost is a majorbarrierto its implementation on a large scale.

Although efforts to improve clean/drinking water services continue to be increased inline with changes in the environment, raw water, demand and technological developments, the level of access to drinking water is still relatively low, especially in rural areas. This requires innovation and breakthroughs to support the accelerated improvement of clean/drinking water services. In line with the sustainable development goals (SDGs 2030) No. 6 namely “Clean water and sanitation for all”, Indonesia needs to strive to achieve this target so that the level of clean water services for the community can reach 100%.Ful filling the need for clean/drinking water in marginal areas of peat, with low raw water quality must be a priority given the low z level of access to clean/drinking waterfor local communities.

KEYWORDS: water treatment, water quality, raw water, technology development

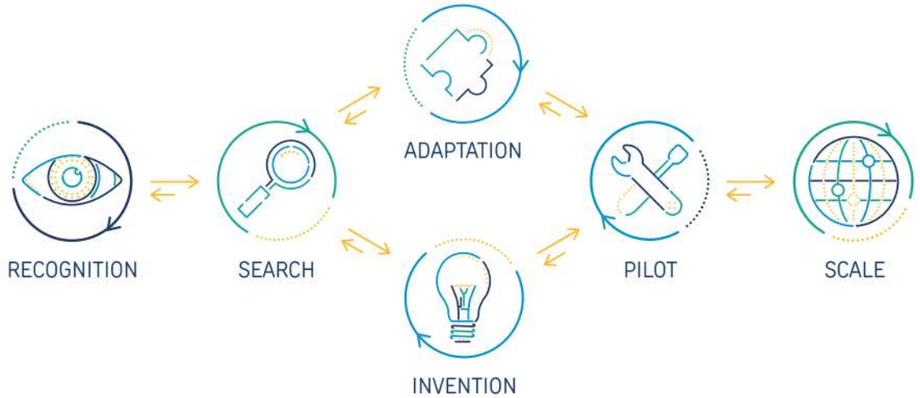

Figure 1. Flowchart of research and innovation in WASH Program [Elrha, 2019]

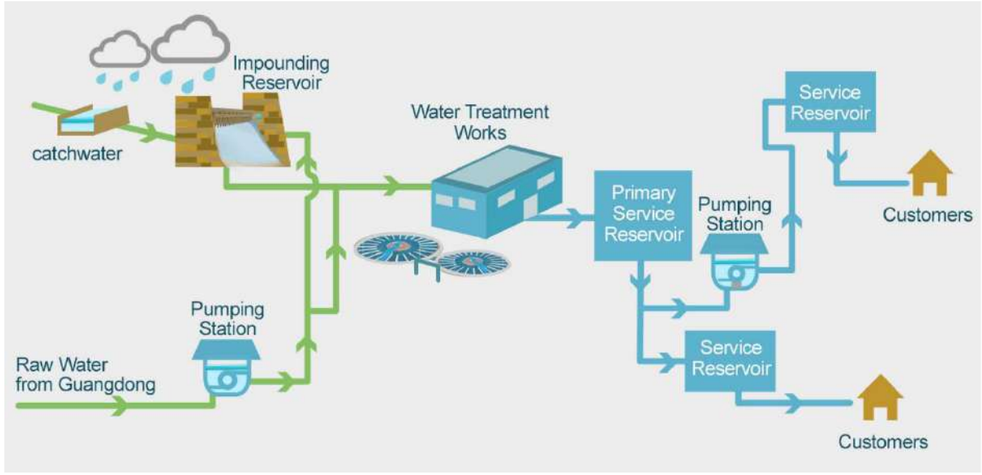

Figure 2. Schematic process from raw water to clean and drinking water [WSD, 2023]

Figure 3. Time frame of development of system and technology for marginal raw water treatment [Sutapa, 2019]