



Volume 4	Issue 2	November (2024)	DOI: 10.47540/ijqr.v4i2.1733	Page: 162 – 171
----------	---------	-----------------	------------------------------	-----------------

## A Systematic Review of Research Trends in Water, Sanitation, and Hygiene (WASH) in Indonesia

Wisnu Prayogo

Department of Building Engineering Education, Universitas Negeri Medan, Indonesia

**Corresponding Author:** Wisnu Prayogo; Email: [wisnuprayogo@unimed.ac.id](mailto:wisnuprayogo@unimed.ac.id)

### ARTICLE INFO

**Keywords:** Research Trends, Water Sanitation and Hygiene (WASH), SDGs, Social Factors.

**Received :** 14 October 2024

**Revised :** 28 November 2024

**Accepted :** 30 November 2024

### ABSTRACT

This study offers a comprehensive review of research trends in WASH in Indonesia from 1975 to April 2021. A total of 272 articles related to Sustainable Development Goals 6.1 and 6.2 were analyzed, sourced from the Web of Science and Scopus databases. The analysis found that water-related research (41%) was more prominent than topics related to sanitation (22%) or hygiene (13%). Social aspects (39%) were the most common focus in literature, particularly studies exploring the factors influencing WASH-related behaviors. However, there was a noticeable lack of studies on the implementation of WASH programs or interventions aimed at changing behavior, highlighting a disconnect between research findings and their application in policy and practice. In contrast, topics on hygiene (14%) and WASH financing (1%) were among the least covered. There was also a significant amount of research that combined multiple topics (6%) and themes (5%), reflecting a growing recognition of the need to address WASH challenges from a holistic, multi-faceted perspective. Geographically, most WASH research was centered in central Indonesia, even though WASH issues, such as inadequate services and poor behavior, tend to be more acute in other areas. This study also identifies several research gaps relating to topic selection, thematic focus, and regional coverage that should be addressed in future WASH studies in Indonesia.

### INTRODUCTION

Access to WASH is a critical issue for public health globally, and its importance is underscored in the SDGs, specifically Goals 6.1 and 6.2. Despite significant progress over the past few decades in expanding access to WASH services, an alarming portion of the global population, approximately two billion people, still lack safely managed drinking water, while 3.6 billion lack access to safe sanitation, and 2.3 billion do not have basic hygiene services. The lack of proper WASH infrastructure not only undermines public health systems and threatens health security, but it also has detrimental economic impacts. Therefore, improving WASH services is vital not only for enhancing public health but also for advancing human rights, promoting economic stability, and fostering resilience in communities. In the context of Indonesia, the fourth most populous country in the world, WASH issues remain particularly pressing, especially as the

country prepares for a demographic boom projected for 2045. Historically, in 2011, the provision of basic WASH services in Indonesia was limited, with only 55% of the population having access to drinking water and 56% to sanitation services. However, by 2020, Indonesia made notable strides, raising access to basic water, sanitation, and hygiene services to 92%, 86%, and 94%, respectively. These improvements align with the national efforts to meet SDG targets and provide safe, equitable access to essential services (Karon et al., 2017; Hanson et al., 2020; Awfa et al., 2023).

Despite these achievements, there is still a significant need for research to accelerate progress toward SDGs 6.1 and 6.2. WASH research plays a critical role in monitoring progress, informing evidence-based policy decisions, and identifying underlying causes of ongoing WASH-related challenges. Given the diversity of Indonesia's regions, the WASH situation varies considerably

across the country, making localized research essential for understanding specific regional needs and challenges. For instance, some areas may face unique sanitation or water accessibility issues, and understanding these localized conditions is crucial for developing targeted interventions. Furthermore, while the topics of water and sanitation are often studied, research on hygiene remains relatively underexplored, which may suggest an overlooked or underestimated area of concern. This imbalance in research may hinder the development of comprehensive solutions to WASH issues across all sectors (Niedfeldt et al., 2021; Wulandari et al., 2022; Ahmed et al., 2023; Upe et al., 2024).

The geographical distribution of WASH research also reveals gaps in certain regions, where research efforts may be limited or nonexistent, despite pressing WASH issues. Addressing these gaps could provide crucial insights into under-researched areas and guide future studies to focus on neglected regions or themes. For example, more research on the financial and social aspects of hygiene services might be necessary to better understand the broader determinants of WASH behavior and identify effective interventions. To date, no study has systematically reviewed the trends and developments in WASH research in Indonesia. This study aims to address this gap by providing a comprehensive analysis of past and current research trends in the field. By doing so, this review will not only highlight existing research priorities but also pinpoint critical knowledge gaps and emerging research needs. It will offer valuable guidance for future studies that can support the achievement of SDGs 6.1 and 6.2 in Indonesia, ensuring that research efforts are aligned with both national needs and global priorities.

## **METHODS**

The systematic review was carried out following the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, ensuring a rigorous and transparent methodology for synthesizing the available evidence. The primary goal of this review was to identify all relevant research related to WASH in Indonesia, published up until April 2021, from the Web of Science and Scopus databases. To ensure comprehensive coverage, a broad search strategy was implemented

using the following keywords: “water” OR “sanitation” OR “hygiene” OR “WASH” AND “Indonesia”. These search terms were carefully selected to capture a wide range of studies focused on various aspects of WASH in Indonesia, ensuring that all relevant research was included. Once the studies were retrieved, the next step involved removing any duplicate entries, which were performed using Mendeley reference management software. This process helped ensure that only unique publications were considered for further analysis (Ahmed et al., 2023; Azizah et al., 2024).

After the removal of duplicates, the titles of the remaining articles were manually reviewed to eliminate studies that did not align with the focus of the review. This stage was essential for maintaining the relevance of the review and ensuring that only studies directly related to WASH were included. The titles were evaluated based on the presence of key WASH-related terms, such as drinking water, sanitation inspection, hand washing, latrines, water access, water quality, water supply, open defecation, wastewater treatment, and social contamination. These keywords were selected because they are recognized as core components of WASH research, and the inclusion of studies featuring these terms was assumed to indicate a direct relevance to the WASH field.

Following the title screening, the abstracts of the selected articles were then reviewed to determine whether they addressed specific aspects of the SDGs, particularly SDG 6.1 (access to water) and SDG 6.2 (access to sanitation and hygiene), which form the focus of this review. Only those articles that met the inclusion criteria were retained for full-text evaluation. The inclusion criteria were as follows: (1) the primary focus of the article must be on WASH, with a particular emphasis on SDGs 6.1 and 6.2; (2) the full text of the article must be accessible for a more detailed eligibility assessment; (3) the article must be written in English; and (4) the research must have been conducted in Indonesia. These criteria were designed to ensure that only relevant and accessible studies were included, facilitating a thorough and precise analysis of the WASH research landscape in Indonesia (Ahmed et al., 2023; Win et al., 2024).

For each study that passed the full-text screening, key data were extracted and recorded in a Microsoft Excel spreadsheet. The extracted data

included: (1) the specific WASH topics covered in the study (e.g., water, sanitation, hygiene, or combinations of these topics); (2) the research themes, categorized as financial, institutional, environmental, technical, social, or a combination of these themes; (3) the year of publication; (4) the keywords used in the article; and (5) the geographical location of the study, usually at the provincial level. This systematic data extraction enabled a detailed examination of the trends and themes within WASH research and provided insight into both the thematic distribution and geographical focus of the studies (Niedfeldt et al., 2021).

Descriptive statistical analysis was conducted to explore the frequency and distribution of WASH topics, research themes, and the geographical spread of studies across Indonesia. This analysis helped identify patterns in the research, such as which areas of WASH were most studied and where research efforts were concentrated geographically. To further explore the relationships between research topics and themes, SPSS Statistics version 23 was used. This allowed for a deeper investigation into how specific WASH topics (e.g., water or sanitation) were associated with research themes (e.g., social, financial or technical issues). Additionally, a word cloud was generated to visually represent the most frequently occurring keywords in the titles and abstracts of the selected articles. This visualization provided a clear depiction of the key topics and themes that dominate the WASH research landscape in Indonesia (Odagiri et al., 2020).

Finally, to assess the geographical distribution of the studies, ArcGIS version 10.8 software was employed. This tool enabled the review team to create visual maps of the study locations across Indonesia, highlighting regions with high concentrations of WASH research as well as areas with limited research activity. By mapping the locations of the studies, the review was able to identify geographical disparities in research, pinpointing areas where WASH challenges might be particularly pressing but where research has been insufficient. This spatial analysis contributed to the identification of research gaps, underscoring the need for more localized studies in regions with fewer research outputs. It also provided valuable insights into the current state of WASH research in Indonesia and highlighted priority areas for future

research endeavors, ensuring that the findings from this review could guide future studies and inform policy decisions in underrepresented regions.

## **RESULTS AND DISCUSSION**

### **Search Results**

The systematic literature review process initially retrieved a total of 8,151 articles from the Scopus and Web of Science databases, encompassing studies published up to April 2021. Following the removal of duplicate entries, 7,981 articles remained for further screening. The next step involved title screening, during which 414 studies were identified as potentially relevant to the topic of water, sanitation, and hygiene (WASH). These articles were then subjected to an abstract screening process, wherein 136 studies were excluded due to their lack of direct relevance to SDGs 6.1 and 6.2, which focus on water and sanitation access. After this initial refinement, the remaining 278 articles proceeded to the full-text review stage. At this stage, a further round of exclusions took place. Six articles were removed from the selection process for the following reasons: two were not written in English, three were not conducted in Indonesia, and one paper could not be accessed despite efforts to obtain it. As a result, a final set of 272 articles was included in the comprehensive review process. These selected studies represent the body of research that was closely aligned with the review's objectives of exploring trends in WASH research in Indonesia. Further details regarding these studies, including the categorization of themes based on the FIETS framework (Financial, Institutional, Environmental, Technical, Social), the types of studies included, and their geographical scope, are provided in the Supplementary Materials. This thorough selection process ensures that the articles analyzed are highly relevant to the research questions and provide a robust foundation for the synthesis of WASH research trends in Indonesia (Fitri et al., 2022; Aji et al., 2024; Sari et al., 2024).

### **Features of WASH Research Based on Topics, Themes, and Publication Year**

The primary focus of WASH research in Indonesia has been on water-related topics, which accounted for 41% of the studies, followed by research on combined topics (23%) and sanitation (22%). A notable trend observed across the studies

was the dominance of social themes, which appeared in 39% of the articles, with a particular emphasis on socioeconomic and behavioral factors influencing access to and practices related to WASH services. These social determinants were frequently highlighted in the context of water, sanitation, and hygiene behaviors, underscoring the importance of understanding the behavioral drivers behind WASH practices. Social themes were especially prevalent in studies addressing hygiene (66%), combined topics (63%), and sanitation (40%). This suggests that social aspects are a central focus of WASH research in Indonesia, particularly in understanding how social conditions and behaviors shape access to water and sanitation services (Yamauchi et al., 2022).

However, research on hygiene represented only 14% of the reviewed studies, and hygiene topics have not received substantial attention in the literature, particularly during the period from 1991 to 2004. The limited focus on hygiene during these years reveals a potential research gap, as hygiene is a critical component of public health. The outbreak of COVID-19 has brought renewed attention to personal hygiene, emphasizing its role in controlling disease transmission. This suggests the need for more focused research on hygiene-related issues, which are particularly relevant in the context of Indonesia's ongoing public health challenges.

In terms of research themes, the technical aspects of WASH were addressed in 18% of the studies, with a higher concentration in water-related research (29%). These studies predominantly focused on water treatment technologies and techniques, highlighting the technical challenges in ensuring safe and accessible water for all. On the other hand, institutional themes, which addressed governance, policy, and organizational aspects of WASH services, were discussed in 13-15% of articles on water, sanitation, and combined topics. However, the institutional theme was only mentioned in 5% of hygiene-related research, with very few studies examining institutional challenges in hygiene practices. Notably, only two studies on hygiene included institutional themes, both of which focused on low-resource settings, such as rural hospitals lacking proper hand hygiene protocols and the evaluation of Indonesia's "Baduta Program" aimed at improving the health of children

under two years old (Salmaddiina & Hanifah, 2022; Aji et al., 2024; Win et al., 2024).

Financial considerations were the least explored theme, appearing in only 6% of the studies. The research that addressed financial issues in water-focused topics often centered around water tariffs, the willingness to pay for water services and affordability. In sanitation, financial themes (7%) revolved around selecting affordable sanitation technologies for local communities. However, there was a clear gap in financial research related to hygiene, with no studies on the financial aspects of hygiene services or facilities. This gap is significant, as hygiene-related infrastructure, such as the cost of soap or handwashing stations, is essential to public health efforts. The GLAAS 2019 report noted that Indonesia has developed cost estimates for water and sanitation services but has not yet addressed the financial aspects of hygiene, indicating a critical area for future research (Sudhiastiningsih et al., 2024; Sari et al., 2024).

The first WASH-related study in Indonesia was published in 1975, although there was a gap in publications between 1981 and 1991. WASH research in the country has been published regularly since 1991, except for a few years, and saw notable growth between 2015 and 2020. Notably, the number of studies on water topics peaked in 2019, with 24 articles published. Research on water dominated early on (1975-1981), but from 1990 to 2000, research on combined topics gained more attention. In contrast, research on sanitation and hygiene showed significant gaps. Sanitation studies did not appear until 2010, likely spurred by the inclusion of sanitation as a key target in Indonesia's 2010-2014 Medium-Term Development Plan (RPJMN), which was a policy driver for increased research focus. Hygiene research, after an initial study in 1991, did not resume until 2004, with a noticeable increase in publications starting in 2016, coinciding with the implementation of the SDGs in Indonesia (Prayogo et al., 2020; Sari et al., 2024).

An analysis of the titles and abstracts of the selected studies revealed the most frequently used keywords in Indonesian WASH research. The top five keywords were "drinking water", "water supplies", "stunting", "diarrhea", and "sustainability". This aligns with the dominance of water-related topics in the research, as drinking water-related issues were consistently highlighted,



including concerns about safe water sources, treatment methods to ensure water quality, and the availability of piped and bottled water. Keywords related to health issues, such as stunting and waterborne diseases like diarrhea, also featured prominently, suggesting an increasing integration of WASH research with broader public health concerns. This trend underscores the growing recognition that WASH services are crucial not only for environmental health but also for addressing critical health challenges in Indonesia (Odagiri et al., 2020; Awfa et al., 2023; Azizah et al., 2024).

### **Spatial Distribution of WASH Research in Indonesia**

The identification of research locations for WASH (Water, Sanitation, and Hygiene) studies in Indonesia was classified into four distinct categories based on the scope and geographical focus of the studies. The first category consists of multi-country studies that include Indonesia as one of the study locations. These studies typically address topics related to sanitation and social issues, often incorporating financial and social themes as prominent areas of focus. Examples of such studies are those that investigate sanitation challenges across multiple Southeast Asian countries, with Indonesia being one of the key countries involved in the analysis. The second category encompasses studies conducted in Indonesia, but without specifying a particular province or location. This group includes 56 articles that primarily discuss combined topics and social themes, reflecting the widespread interest in the social dimensions of WASH issues across the country. These studies often provide an overarching analysis of WASH challenges in Indonesia, without focusing on regional variations (Niedfeldt et al., 2021; Ahmed et al., 2023; Sudhiastiningsih et al., 2024).

The third category involves studies that are conducted across multiple provinces. These studies are typically centered around sanitation topics and social themes and are represented by 10 articles. These studies provide insights into regional differences in sanitation access and WASH-related social factors, examining broader patterns that transcend individual provincial boundaries. The final category, which represents the largest proportion of studies, consists of research conducted in a single specific province. This group includes 203 articles, or 74.5% of the total studies

reviewed, indicating a significant concentration of WASH research in particular provincial contexts. These studies are more localized and focus on issues relevant to specific regions, providing detailed insights into the unique WASH challenges faced by provinces. An analysis of the provincial distribution of WASH research in Indonesia reveals notable geographic inequalities in research coverage. Most WASH studies have been concentrated in provinces located on Java Island, which is home to the most advanced research infrastructure in the country. Among these, West Java leads with 29 studies, followed closely by Jakarta with 28 articles, and Central Java and East Java, each with 27 articles. Research in these provinces is often focused on water-related topics, with East Java primarily addressing sanitation issues. Furthermore, the thematic focus of studies in these regions varies, with West Java and East Java predominantly examining social themes, while Jakarta's research is more likely to combine technical and social aspects, and Central Java's studies are often multidisciplinary, incorporating a range of WASH topics (Torresse et al., 2016).

In contrast, WASH research in other parts of Indonesia is less prevalent. In Central Indonesia, East Nusa Tenggara stands out as the province with the highest number of WASH studies in the region, totaling 15 articles. In Eastern Indonesia, Papua province leads with seven articles. However, several provinces have seen very little WASH-related research. For instance, South Kalimantan and West Kalimantan each have only three articles, while Gorontalo has two. Several provinces, including Bangka Belitung, East Kalimantan, Riau, Riau Archipelago, Central Kalimantan, Southeast Sulawesi, North Sulawesi, and Maluku, have only a single study, highlighting areas where research efforts have been minimal. Additionally, six provinces are Jambi, Bengkulu, North Maluku, and West Papua, have had no recorded WASH research between 1975 and April 2021, indicating substantial gaps in research coverage across the nation. This uneven distribution of WASH research across Indonesia underscores the need for more geographically diverse studies to ensure that all regions receive the attention required to address the local WASH challenges they face. The concentration of research in Java Island, particularly in its more developed provinces, may reflect the

availability of better infrastructure and resources for conducting research, but it also points to a potential underrepresentation of critical WASH issues in less-studied areas of the country. This geographical imbalance in research coverage emphasizes the importance of targeting underrepresented provinces in future studies to foster a more comprehensive understanding of WASH conditions throughout Indonesia (Torlesse et al., 2016; Niedfeldt et al., 2021; Tehupeiry et al., 2023).

### **Geographical Spread of WASH Research Across Indonesia**

This systematic review provides a comprehensive set of recommendations for advancing WASH research in Indonesia, focusing on the identification of key research topics, themes, and regional disparities. A major gap identified in the existing literature is the limited attention given to hygiene-related research across diverse settings, such as schools, healthcare facilities, emergency contexts, and menstrual hygiene management. While much of the current research has been centered around personal and household hygiene, these other critical areas have not been sufficiently explored. Given the heightened global emphasis on hygiene due to the COVID-19 pandemic, there is a timely opportunity to expand research in these under-researched areas. Additionally, the financial aspects of hygiene access, including the affordability of hygiene facilities like handwashing stations in vulnerable areas such as schools, rural communities, and emergency settings, require further investigation (Indarti et al., 2019; Daniel et al., 2021; Satriani et al., 2022; Dwipayanti et al., 2022; Tehupeiry et al., 2023).

Although the social theme has dominated much of the WASH research in Indonesia, particularly studies focused on the determinants of WASH practices, behavior change interventions remain an underexplored area. Our review highlighted that only two studies in Indonesia specifically address behavior change interventions, despite their prominence in many WASH programs run by non-governmental organizations (NGOs). This gap suggests the need for stronger collaborations between WASH NGOs and academic researchers to conduct implementation research that could contribute both to academic literature and inform evidence-based policy and intervention strategies. Such partnerships could involve baseline

studies, intervention designs, and post-intervention evaluations published in peer-reviewed journals, providing critical insights for the broader WASH sector. Research on the financial barriers to accessing WASH services is another area that has been notably underrepresented. There is a clear need for more studies that explore how economic factors limit access to essential WASH services, particularly for marginalized communities. Rural and low-income populations, for example, often face significant challenges in affording basic sanitation infrastructure, such as latrines. Research exploring cost-effective WASH technologies and assessing the willingness of communities to pay for these services could help identify practical solutions to improve access in economically disadvantaged areas. This review also indicates a growing recognition among Indonesian WASH researchers of the interconnectedness of various WASH topics and themes. A notable trend is the increasing focus on combination topics, such as water and sanitation, and the integration of multidimensional themes, including financial, institutional, environmental, technical, and social factors (FIET). This reflects a shift towards a more holistic, interdisciplinary approach to WASH research, which is essential for addressing the complex nature of WASH challenges. Future studies should continue to adopt this multi-faceted approach to explore the interactions between different WASH topics and themes, as this will provide a more comprehensive understanding of WASH conditions and contribute to the design of more effective interventions.

However, the interdisciplinary nature of such research also presents challenges. Researchers from fields like environmental science, public health, and engineering will need to collaborate with experts from other domains, such as economics and psychology, to overcome the barriers of disciplinary silos. This remains a challenge in Indonesian academia, where knowledge production is often structured within traditional disciplinary boundaries. For meaningful interdisciplinary collaboration to occur, researchers must actively engage with multiple fields to create a more nuanced understanding of WASH issues. Another significant issue highlighted by this review is the geographical imbalance in WASH research across Indonesia. Most studies are concentrated on Java Island, where research infrastructure and resources

are more readily available. In contrast, provinces outside Java, particularly those in the eastern and central regions, have seen limited research activity. Between 1975 and 2021, several provinces, such as Jambi, Bengkulu, North Maluku, and West Papua, had no recorded WASH research. Geographical barriers, along with limited resources, contribute to this disparity. To address this issue, the government could provide targeted research grants to support WASH studies in under-researched provinces. Moreover, universities located in Java, with better research facilities, could collaborate with local institutions in other provinces to overcome the challenges of limited human resources. Such efforts would help to ensure that WASH research is more equitably distributed across the country, enabling the effective monitoring of progress towards SDG 6.1 (universal access to water) and SDG 6.2 (universal access to sanitation and hygiene) nationwide (Niedfeldt et al., 2021; Ikhwalı et al., 2022; Handayani et al., 2024).

The review also emphasizes the importance of conducting localized WASH research. WASH conditions, behaviors, and service delivery models are highly context-dependent, and findings from one region cannot always be generalized to another. This underscores the need for tailored interventions that are responsive to local conditions. The findings of this review suggest that much of the research conducted in Indonesia has been focused on addressing local WASH problems, with three-quarters of the studies concentrated in a single province. While this focus is important for solving region-specific challenges, it also highlights the vast potential for further research across a variety of WASH topics in different settings, including urban, rural, and remote areas. A significant gap in the literature pertains to WASH research involving vulnerable communities, such as people with disabilities, indigenous populations, and those living in remote areas. These groups often face greater challenges in accessing WASH services, and their unique needs must be better understood to ensure that they are not left behind in achieving SDGs 6.1 and 6.2. Future research should prioritize these vulnerable communities to understand the barriers they face and develop more inclusive and accessible WASH solutions (Chatterley et al., 2018; Daniel et al., 2021; Handayani et al., 2024).

Furthermore, there is a clear need for more research on WASH services in specific settings, such as schools, healthcare facilities, and emergency contexts. While the SDGs emphasize the importance of universal access to WASH services in all settings, data from 2019 show that basic WASH services in schools and health facilities in Indonesia are still lacking. For example, in 2019, only 72.73% of schools had access to water, 40.40% had sanitation facilities, and 58.86% had hygiene facilities. Similarly, although 80.17% of health facilities had basic WASH services, there remains a significant gap in access. Our review found very few studies focusing on WASH in schools or healthcare facilities, indicating the need for further research in these areas to improve access and hygiene practices, particularly in schools where disease transmission is a concern.

Finally, menstrual hygiene management (MHM) is another emerging area of concern in WASH research in Indonesia. Although some progress has been made, many schools and public facilities still lack appropriate sanitation facilities for menstruating girls. Addressing these gaps could significantly impact the health and educational attainment of young girls, and further research is needed to explore how to improve menstrual hygiene facilities and practices, particularly in schools. Despite the valuable insights provided by this review, there are some limitations. First, the broad scope of the study means that the identification of knowledge gaps could be more specific. Future reviews focusing on narrower topics, such as water-related research, could provide a more in-depth analysis of gaps in specific areas. Additionally, this review did not assess the risk of bias, or the quality of the studies included. Future research should carefully evaluate the quality of existing studies and design new research that builds upon previous findings while addressing potential biases (Chatterley et al., 2018; Salmaddiina & Hanifah, 2022; Handayani et al., 2024).

## CONCLUSION

This review study examines 272 articles on WASH-related research in Indonesia published before April 2021. The analysis reveals that the most frequently discussed topic is water, while the dominant research theme in Indonesia is social issues. In the water topic, technical themes such as

water supply and water treatment are more prevalent, while social themes are more dominant in the sanitation, hygiene, and combined topics. Nearly half of the studies were conducted on Java Island. It was found that there is limited research focused on the implementation of behavioral change interventions in WASH studies in Indonesia. This indicates that most WASH research in Indonesia has been primarily focused on identifying behavioral determinants without leading to tangible changes. Future WASH research in Indonesia should consider topics such as hygiene and its relationship to financial aspects, with a focus on indigenous or remote populations and areas, as well as studies in schools, emergency settings, healthcare facilities, and research on menstrual hygiene. Further exploration of these topics is expected to enrich our understanding of the ongoing WASH situation in Indonesia.

## REFERENCES

- Alfred, R., Garfias Royo, M., Opabola, E., Nurdin, S., Dewi, E., Idris, Y., ... & Parilth, P. (2023). Assessment of WASH infrastructure in school in Central Sulawesi, Indonesia using structured observation and principal interviews. *Journal of Water, Sanitation and Hygiene for Development*, 13(6), 375-390.
- Aji, A. D. S., Suhardono, S., Suryawan, I. W. K., & Prayogo, W. (2024). Impacts of Sanitation Practices on Human Development: A Decade-Long Analysis of the Malang District. *Ekulilibrium: Jurnal Ilmiah Bidang Ilmu Ekonomi*, 19(2), 276-288.
- Awfa, D., Azka, A., Putri, Y., Putra, N., Imami, A. D., Azizah, R. N., & Prayogo, W. (2023). Identification of the Influence of Socio, Demographic, and Economic Factors on Domestic Water Consumption Patterns (A Case Study: Bandar Lampung City, Indonesia). *Jurnal Presipitasi: Media Komunikasi dan Pengembangan Teknik Lingkungan*, 20(2), 365-377.
- Azizah, R. N., Putri, D. M., Imami, A. D., Mutiara, E., Putri, Y., Putra, N., ... & Prayogo, W. (2024). Water Conservation Practices viewed from Community Socio-Psychological Factors (Case Study: Bandar Lampung City, Indonesia). *International Journal of Marine Engineering Innovation and Research*, 9(1).
- Chatterley, C., Slaymaker, T., Badloe, C., Nouvellon, A., Bain, R., & Johnston, R. (2018). Institutional WASH in the SDGs: data gaps and opportunities for national monitoring. *Journal of Water, Sanitation and Hygiene for Development*, 8(4), 595-606.
- Daniel, D., Djohan, D., & Nastiti, A. (2021). Interaction of factors influencing the sustainability of water, sanitation, and hygiene (wash) services in rural Indonesia: evidence from small surveys of wash-related stakeholders in Indonesia. *Water*, 13(3), 314.
- Dwipayanti, N. M. U., Nastiti, A., Johnson, H., Loehr, J., Kowara, M., De Rozari, P., ... & Powell, B. (2022). Inclusive WASH and sustainable tourism in Labuan Bajo, Indonesia: needs and opportunities. *Journal of Water, Sanitation and Hygiene for Development*, 12(5), 417-431.
- Handayani, I. M., & Supriatna, N. (2024, June). Systematic Literature Review: Analysis Implementation of Water, Sanitation, and Hygiene (WASH) Programs in Elementary Schools. In *International Conference on Elementary Education* (Vol. 6, No. 1, pp. 206-214).
- Hanson, C., Allen, E., Fullmer, M., O'Brien, R., Dearden, K., Garn, J., ... & Hall, P. (2020). A National Communication Campaign in Indonesia is associated with improved WASH-related knowledge and behaviors in Indonesian mothers. *International Journal of Environmental Research and Public Health*, 17(10), 3727.
- Ikhwal, M. F., Rau, M. I., Nur, S., Ferijal, T., Prayogo, W., & Saputra, S. F. D. (2022). Application of Soil and Water Assessment Tool in Indonesia—a review and challenges. *Journal of Sustainable Infrastructure*, 1(2), 75-84.
- Nastiti, A., Prayogo, W., Ikhwal, M. F., Manyasa, R., Zulfikar, A. (2022). Study of Water Quality Index of Cilimaya Watershed Before and During The COVID-19 Pandemic. *Journal of Sustainable Infrastructure*, 1(2), 75-84.



- Desalination and Water Treatment*, 277, 105-119.
- Indarti, N., Rostiani, R., Megaw, T., & Willetts, J. (2019). Women's involvement in economic opportunities in water, sanitation and hygiene (WASH) in Indonesia: Examining personal experiences and potential for empowerment. *Development Studies Research*, 6(1), 76-91.
- Karon, A. J., Cronin, A. A., Cronk, R., & Hendrawan, R. (2017). Improving water, sanitation, and hygiene in schools in Indonesia: A cross-sectional assessment on sustaining infrastructural and behavioral interventions. *International Journal of Hygiene and Environmental Health*, 220(3), 539-550.
- Niedfeldt, H. J., Beckstead, E., Chahal, E., Jensen, M., Reher, B., Torres, S., ... & Crookston, B. T. (2021). Use of technology to access health information/services and subsequent association with WASH (water access, sanitation, and hygiene) knowledge and behaviors among women with children under 2 years of age in Indonesia: cross-sectional study. *JMIR Public Health and Surveillance*, 7(1), e19349.
- Odagiri, M., Cronin, A. A., Thomas, A., Kurniawan, M. A., Zainal, M., Setiabudi, W., ... & Pronyk, P. (2020). Achieving the Sustainable Development Goals for water and sanitation in Indonesia—Results from a five-year (2013–2017) large-scale effectiveness evaluation. *International Journal of Hygiene and Environmental Health*, 230, 113584.
- Prayogo, W., Soewondo, P., Zakiyya, N. M., Putri, D. W., & Muntalif, B. S. (2020). The removal of organic materials and nutrients with addition of artificial supporting materials in the water body (A case study of Cikapayang River, Bandung City Hall). In *IOP Conference Series: Earth and Environmental Science* (Vol. 409, No. 1, p. 012007). IOP Publishing.
- Salmaddiina, A., & Hanifah, A. N. (2022). A Cross-sectional Study of Household Characteristic of WASH Facilities in West Java, Indonesia. *Jurnal Presipitasi: Media Komunikasi dan Pengembangan Teknik Lingkungan*, 19(3), 720-728.
- Sari, D. P., Yusuf, S., Andid, R., Darussalam, D., Dimiati, H., & Amna, E. Y. (2024). Water, sanitation, and hygiene (WASH) factors associated with stunting among under-fives: A hospital-based cross-sectional study in Banda Aceh, Indonesia. *AcTion: Aceh Nutrition Journal*, 9(3), 614-622.
- Satriani, S., Ilma, I. S., & Daniel, D. (2022). Trends of water, sanitation, and hygiene (WASH) research in Indonesia: A systematic review. *International Journal of Environmental Research and Public Health*, 19(3), 1617.
- Sudhiastiningsih, N. N. S. N., Agustina, T., & Priadi, C. R. (2024). Analysis of water, sanitation, and hygiene (WASH) implementation based on GEDSI and climate resilience in Kupang City. In *E3S Web of Conferences* (485), 04001. EDP Sciences.
- Supriyati, A., Supriyati, M., Supriyati, L., Supriyati, I. Y., Prayogo, W., Arianingrath, N. N., & Buana, D. M. A. (2023). Sociodemographic determinants of water conservation behavior: A comprehensive analysis. *International Journal of Advanced and Applied Sciences*, 10(9), 124-131.
- Torlesse, H., Cronin, A. A., Sebayang, S. K., & Nandy, R. (2016). Determinants of stunting in Indonesian children: evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC Public Health*, 16, 1-11.
- Upe, A., Hos, J., Arsyad, M., Roslan, S., & Supiyah, R. (2024). Optimizing Village Funds for Sustainable Development: A Technical Guidance Services in Tokowuta Village, Lasolo Sub-district. *Indonesian Journal of Community Services*, 3(1), 76-83.
- Win, C. Z., Daniel, D., Dwipayanti, N. M. U., & Jawjit, W. (2024). Development of integrated assessment tool for water, sanitation and hygiene (WASH) services in non-household

settings under climate change context.  
*Heliyon*, 10(18).

Wulandari, R. A., Azizah, R., Jalaludin, J. B.,  
Sulistiyorini, L., & Diyanah, K. C. (2022).  
Meta-Analysis Factor of Hand Washing  
Habits and Exclusive Breastfeeding with  
Diarrhea Between 2017-2021. *Indonesia.  
Journal of Environmental Health*, 14(3).

Yamauchi, T., Otsuka, Y., & Agestika, L. (2022).  
Influence of water, sanitation, and hygiene  
(WASH) on children's health in an urban  
slum in Indonesia. *The Sanitation Triangle*,  
101.

# Retracted