

# Global Sustainable Infrastructure in Rural Areas: Environmental Impact Analysis of Water, Sanitation, and Hygiene Systems

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## Abstract

This study provides an environmental impact analysis of global sustainable infrastructure in rural areas, specifically focusing on water, sanitation, and hygiene (WASH) systems. The research emphasizes how infrastructure development in rural areas must align with sustainability goals to ensure long-term benefits for communities. The environmental impact of WASH infrastructure is assessed in terms of resource consumption, waste management, and the health outcomes of rural populations. By examining current practices, challenges, and innovations, the study highlights the critical role of sustainable infrastructure in improving living conditions while minimizing environmental degradation. Recommendations for sustainable WASH solutions are discussed, with a focus on how rural communities can adapt to climate change and reduce their environmental footprint.

**Keywords:** water; sanitation; hygiene systems

## Introduction

Sustainable development heavily relies on access to clean water and sanitation facilities. However, in recent years, overuse, pollution, and climate change have contributed to a global shortage of clean water. More than 4.2 billion people worldwide lack access to safely managed sanitation, and over 2.2 billion people do not have access to safe drinking water. Diarrheal diseases such as cholera, typhoid, rotavirus, hepatitis, and worm infestations are directly linked to poor sanitation and inadequate access to clean water. These illnesses can exacerbate malnutrition, particularly in vulnerable populations. In many areas, inadequate sanitation facilities lead to open defecation, with people using fields, forests, open lakes, and other public spaces due to a lack of toilets. Open defecation and poor sanitation infrastructure pose serious health risks, as human waste can spread infectious diseases. Therefore, access to hygienic restroom facilities is essential to prevent the transmission of infections.

According to the WHO/UNICEF Joint Monitoring Program (JMP), a basic sanitation service is defined as a facility that hygienically separates human contact from human excreta and is not shared with other households. Contaminated drinking water, often tainted by human or animal feces, can harbor bacteria, viruses, toxins, and other harmful

substances, posing a significant threat to public health. Safe drinking water is essential for preventing waterborne diseases and ensuring overall well-being. To achieve Sustainable Development Goal (SDG) 6, which aims to provide clean water and sanitation for all, it is crucial to improve water and sanitation infrastructure and eliminate open defecation practices.

The COVID-19 pandemic has further complicated the situation, making it even harder for billions of people to access safe drinking water, sanitation, and hygiene services necessary to prevent the spread of the virus. According to a recent report by the WHO/UNICEF Joint Monitoring Program (JMP), 3.79 million people in Bangladesh lack access to safe drinking water, while 75.4 million people lack access to adequate sanitation facilities, and 68.5 million people do not have access to basic hygiene services. Additionally, 107 million people in Bangladesh lack access to soap and water for handwashing at home. These alarming statistics underscore the urgent need to address gaps in WASH infrastructure and services to protect public health and support sustainable development.

Nearly one-third of the populace of Bangladesh, a developing nation, lives in poverty. We already know that a lack of sanitary facilities and access to clean

drinking water contributes to the rise in a number of diseases. One of the best ways to lower the likelihood of getting an illness is through improved cleanliness [5].

This study attempted to evaluate the current state of a village's water, sanitation, and hygiene system in the Comilla District. The problem has previously been researched numerous times. Multiple Indicator Cluster Survey (MICS) 2019 and the National Hygiene Survey 2018 are recent examples of cluster-based surveys that have been undertaken. With a slight difference between rural and urban homes, we have seen that 98–98.5% of the population has access to a better source of drinking water [7-10]. Only 43% of the population, however, resides in an area with a site-based improved drinking water source. In Bangladesh, access to better sanitation is available to 84–86% of households. But when people choose not to share, the percentage drops to about 60%. In our study, we looked at the water supply, sanitation, and hygiene practices of rural residents as well as school-age children. We also looked at how often people in rural areas share knowledge and are aware of WASH. We also looked at the possibility of drinking water contaminating waste water [11-14]. These aspects weren't taken into account in other investigations, but we did so in this one. Despite the fact that our sample size is quite tiny, the other portion of our study can at least partially confirm or support the earlier results. The goal of this study is to determine the water, sanitation, and hygiene conditions of Bordoil

Uttarpara village, which is part of Comilla's Durgapur North union and Adarsha Sadar Upazila, Bangladesh. The study's particular goals are to:

- Identify the villagers' sources of drinking water
- Determine how often they use the restroom.
- Understand the people' hand-washing habits.
- Learn how the peasants dispose of their trash.

Study about prior efforts to raise villager awareness of the need of leading healthy lifestyles

Water, sanitation, and hygiene situations are generally poor in least developed countries, including Bangladesh. However, Bangladesh has made progress in various sectors, including water and sanitation, in the past decade. To understand the current state, this analysis is crucial, considering existing studies. Larger-scale studies would provide a more accurate picture. Bangladesh's government has initiated policies and projects for rural development, necessitating environmental cleanliness, hygiene provisions, and waste disposal. This study enhances the understanding of water, sanitation, and hygiene for these initiatives.

SDG 2030 emphasizes Goal 6 for clean water and sanitation, aiming to ensure universal access. As Bangladesh aligns with SDGs, accurate data collection becomes vital for planning and investments. [4] Data disaggregation and inclusion of demographic subgroups are integral to leaving no one behind. This study holds significance in shaping policies aligned with these goals.



Figure 1: Location of Bordoil Uttarpara village, Durgapur North Union, Adarsha Sadar Upazila, Comilla.

## Methodology

This study aims to comprehend the water, sanitation, and hygiene conditions among rural residents. Approximately twenty questions will be posed to Bordoil Uttarpara villagers. The questions will cover topics such as drinking water sources, latrine types, waste disposal, distance between water source and latrine, hygiene practices post-defecation, pre-meals, and food prep, waste and child feces disposal sites, villagers' hygiene motivation, and past initiatives promoting sanitation, hygiene, and safe water practices.

Though the study includes both qualitative and quantitative data it can be identified as a quantitative analysis. Twenty villagers of Bordoil Uttarpara village, Durgapur North Union, Adarsha Sadar Upazila, Comilla were selected during the survey. To gain an idea of the current situation of water, sanitation and hygiene of the households and to perform the field

study, some of the specific sources of ideas for the study include books, journal articles, unpublished papers, government reports, organizational, and private web pages. After studying the research papers or journals a structured questionnaire containing 20 questions has been prepared where all questions have been presented in the form of multiple-choices.

To conduct the survey primary data was obtained through field study, in-depth discussions with people living at the village. The survey was conducted by simple random survey method. The survey took place in October 26, 2022. By the carried-out survey, any conclusion actually cannot be drawn as the sample size consisted only a group of 20. Twenty household heads were asked during the survey. Moreover, the socio-economic condition of that group of people may not match those aspects of common people of Bangladesh. During the survey, some photographs were taken which are shown in Figure 2.



**Figure 2:** Survey Conducted by asking question at Bordoil Uttarpara village, Durgapur North Union, Adarsha Sadar Upazila, Comilla

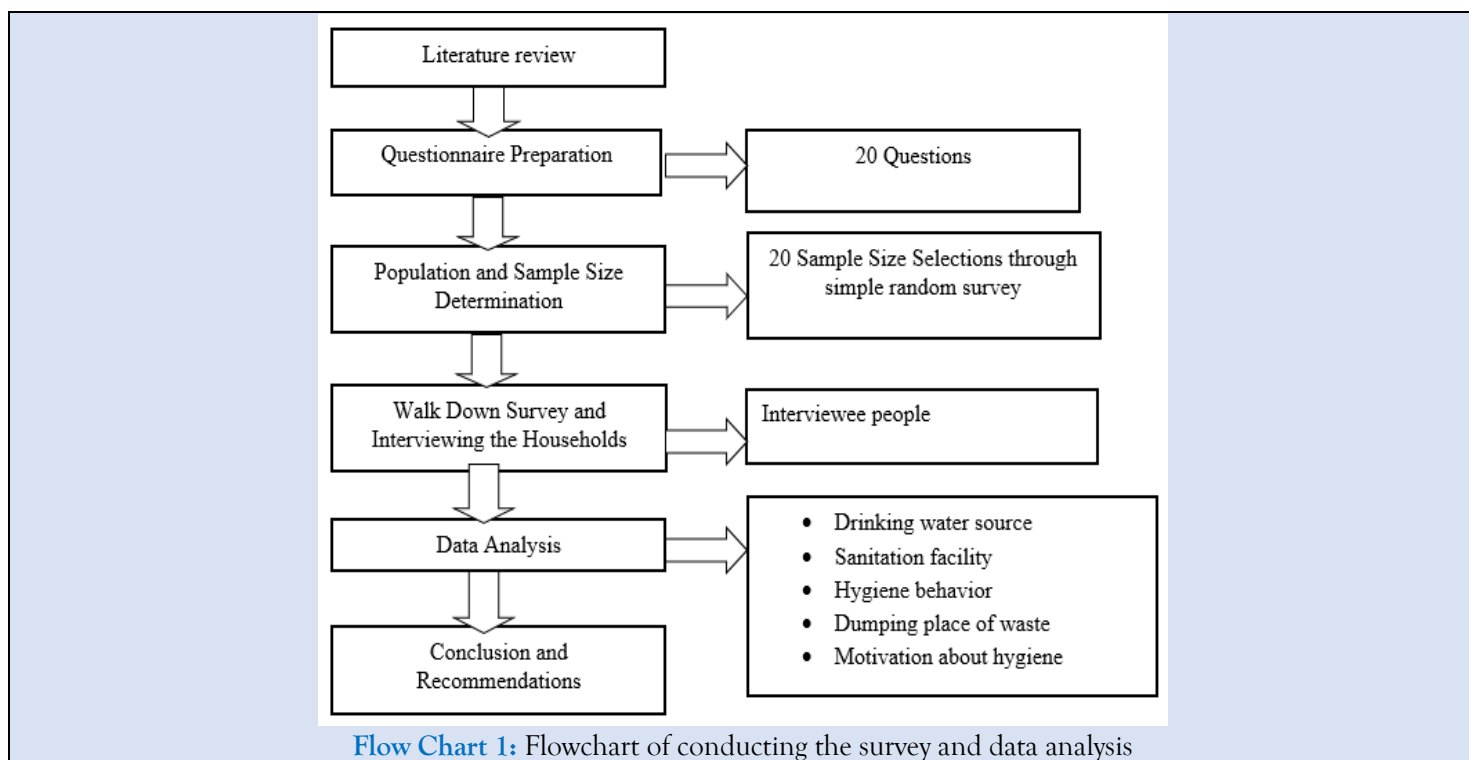
Although being insightful, the study does have a number of drawbacks to take into account. For instance, the study area was restricted to a constrained geographic area, thereby reducing the generalizability of its findings. The study's sample size was also extremely tiny, which could have had an impact on how representative the findings were overall. Another restriction is the short study period, as a longer timeframe could provide a more thorough comprehension of the material. The study was also hampered by the small number of variables it examined, which may not have adequately captured

the full complexity of the water, sanitation, and hygiene environment. Last but not least, a problem identified was some families' reluctance to respond to the questionnaires, which could add bias into the study's findings. These restrictions highlight the necessity of exercising caution in how you interpret and use the study's findings.

## Discussion and Analysis

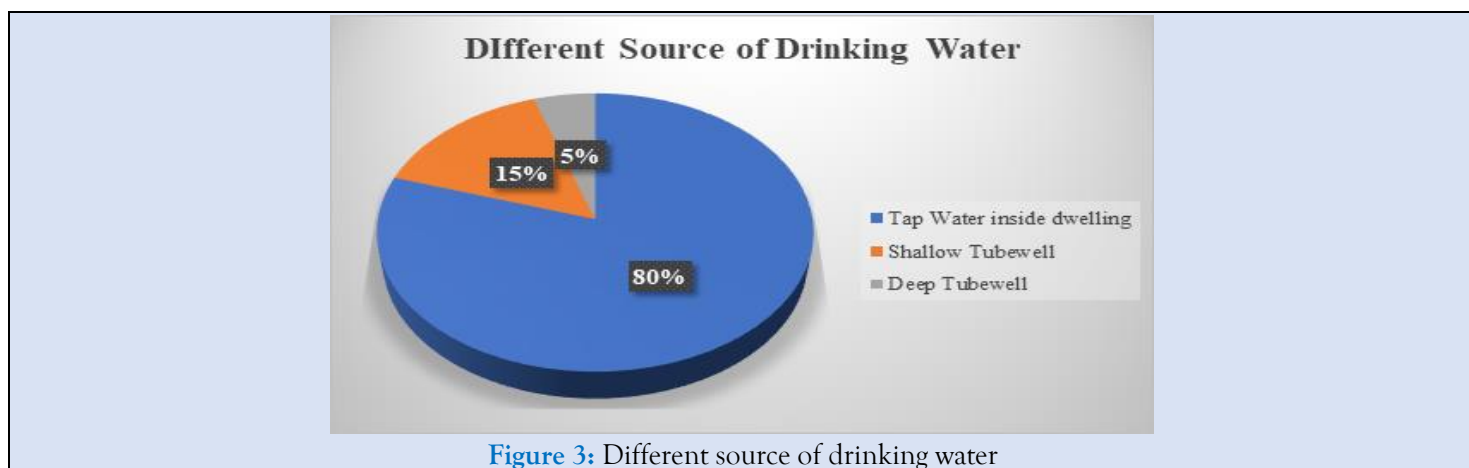
After collecting data frequency distribution table and for graphical representation pie chart were used to

analyze the data. There is a flowchart showing the methodology of the whole case study in Flow Chart 1.



The findings of the study shed light on critical aspects pertaining to water, sanitation, and hygiene within the examined context. Through a comprehensive analysis, this section presents the key observations that emerged from the research, offering insights into the prevailing conditions and practices related to

these fundamental elements. These findings provide valuable information for understanding the current state of water accessibility, sanitation facilities, and hygiene practices, contributing to a deeper comprehension of the broader implications for public health and sustainable development.



According to Figure 3, it is evident that all surveyed residents utilize an improved drinking water source. The majority rely on a motor-based tap water system, with the remaining individuals using shallow or deep tube wells. Additionally, the residents exclusively

possess their drinking water sources, whether motor, shallow, or deep tube wells, with no instances of shared drinking water sources observed during the survey.

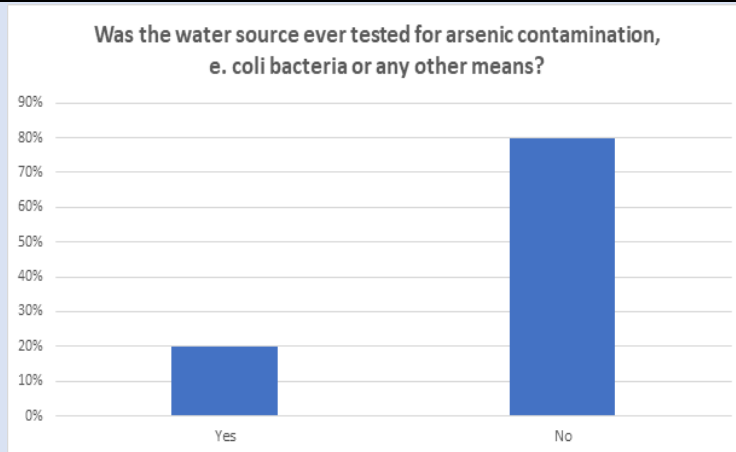


Figure 4: Water source for Arsenic Contamination

A significant observation emerges from the study: a substantial majority of the available drinking water source options had not undergone prior testing through any means. This lack of testing extends to critical parameters such as the presence of arsenic, e. coli, or any other potential pathogens. This concerning gap in water quality assessment underscores the potential risks associated with

consuming water from these sources, as the absence of testing leaves the presence of contaminants and pathogens undetected. This finding (Figure 4) highlights the urgent need for comprehensive and regular water quality testing protocols to safeguard the health and well-being of the community relying on these water sources.

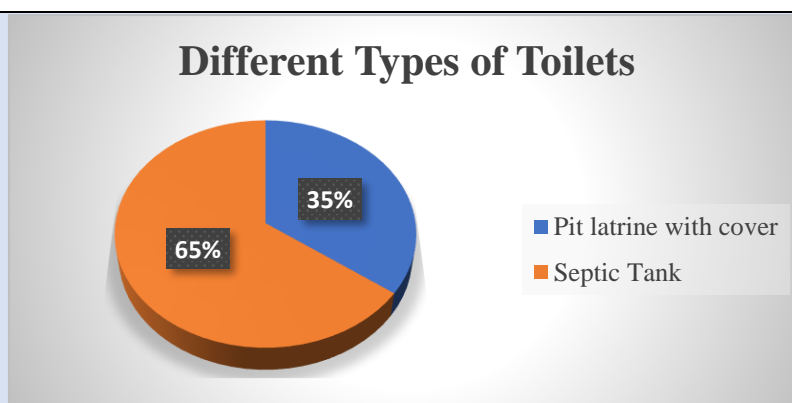
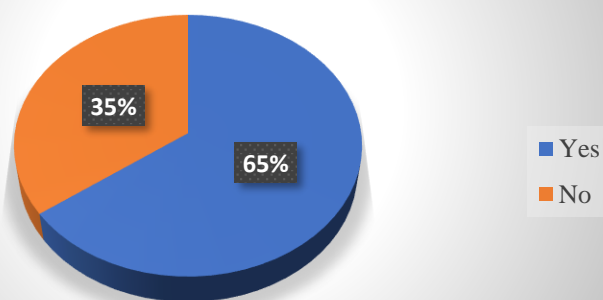


Figure 5: Different types of toilets

The insights gleaned from Figure 5 are significant: every resident included in the survey utilizes an improved type of latrine. Remarkably, none of the surveyed individual's resort to unimproved or hanging toilet facilities. Furthermore, the data reveals that each of these residents not only employs an improved latrine type but also possesses ownership of this facility. This observation underscores a positive

trend towards improved sanitation practices within the surveyed community, showcasing a complete absence of reliance on subpar or inadequate sanitation options. The widespread adoption and ownership of improved latrine facilities reflect a positive stride towards enhanced sanitation infrastructure and hygiene practices, contributing to the overall well-being and health of the community.

### Drinking Water Source within 10 metres/30 feet of the Toilet

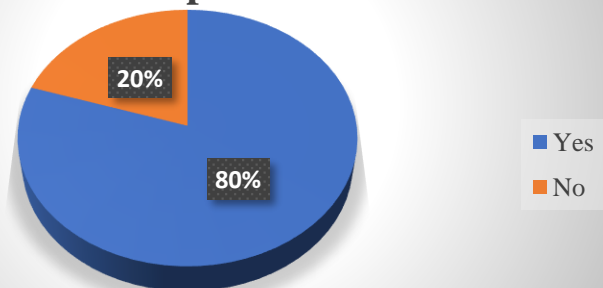


**Figure 6:** Drinking water option within 10 meters/30 feet distance from the toilet

The insights garnered from Figure 6 provide a concerning revelation: approximately 65% of the individuals surveyed have their drinking water source located within a mere 30 feet distance from their respective latrine. This proximity poses a substantial risk of potential water source contamination due to the proximity of latrine pollutants. The relatively short distance between these essential components of daily life creates a worrisome scenario wherein

contaminants from the latrine could feasibly infiltrate the drinking water source. This observation highlights a critical issue that warrants attention, as the potential contamination of the water source could lead to the transmission of waterborne diseases and have significant public health implications. Addressing this risk is paramount in ensuring the safety and purity of the community's drinking water supply.

### Did the pit or septic tank ever be emptied?



**Figure 7:** Pit/Septic tank emptying status

The insights derived from Figure 7 provide a notable finding: among the surveyed households, a substantial 80% of household members have encountered the necessity to empty their pit or septic tank in order to accommodate further waste. Conversely, the remaining households have not yet faced this requirement, as their pit or septic tank has not reached full capacity or overflowed. This observation unveils an essential dimension of waste management,

indicating the varying degrees of maintenance and care required for the proper functioning of these waste disposal systems. The disparity between households that have needed to empty their waste systems and those that have not underscores the dynamic nature of sanitation practices within the surveyed community, shedding light on the challenges and effectiveness of waste management strategies in place.

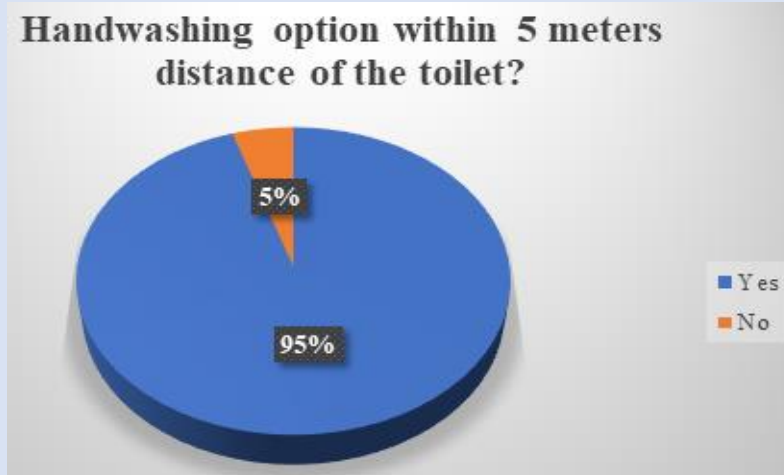


Figure 8: Hand washing option near toilet

The insights derived from Figure 8 unveil a notable pattern: a significant proportion of individuals surveyed have their hand washing facilities conveniently located in close proximity to their toilet. This arrangement proves advantageous, as it simplifies the process of hand washing immediately after using the toilet. The strategic placement of hand washing facilities near the toilet encourages and facilitates proper hygiene practices, as individuals can readily cleanse their hands upon exiting the toilet

area. This observation underscores the importance of thoughtful infrastructure planning, as the accessibility of hand washing facilities plays a pivotal role in promoting and maintaining hygienic practices. The arrangement not only promotes hand hygiene but also minimizes the likelihood of contamination by facilitating a seamless transition from the toilet to hand washing, enhancing overall sanitation and health outcomes within the community.

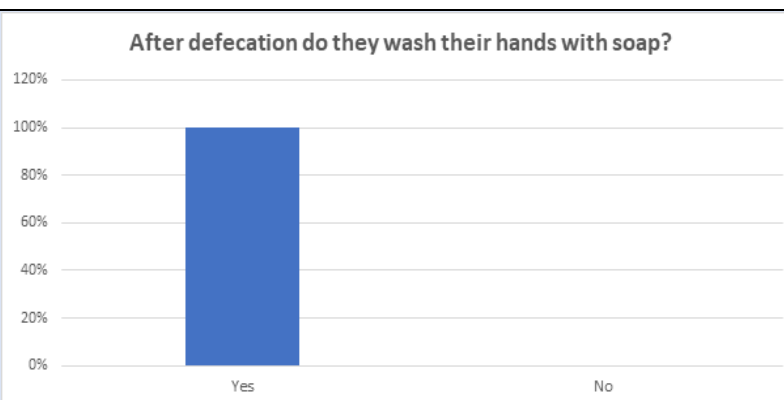


Figure 9: Survey Result of "After defecation do they wash their hands with soap?"

The insights from Figure 9 highlight a noteworthy trend: a considerable portion of household members consistently practice hand washing with soap before eating or engaging in food preparation. Conversely, the remaining members adopt this practice on an intermittent basis. This finding underscores the positive habit of a significant proportion of individuals who prioritize hand hygiene before handling food. The variability in hand washing

frequency sheds light on the diverse behaviors within the surveyed community, emphasizing the need for continued efforts to promote consistent and effective hygiene practices. Encouragingly, the observation of regular hand washing among a notable segment of household members speaks to the potential for further promoting and cultivating hygienic behaviors across the community.

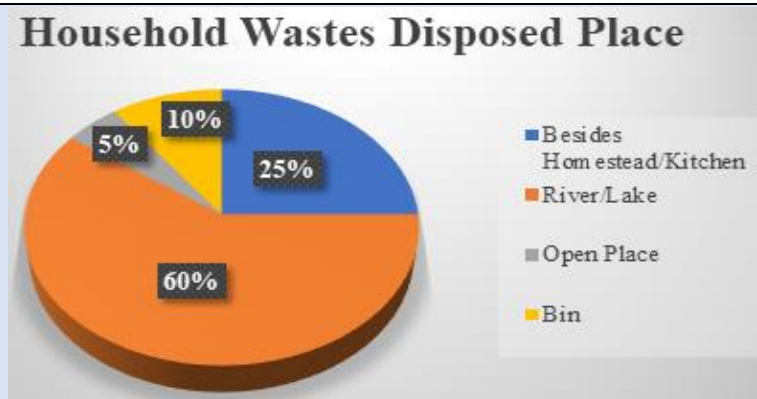


Figure 10: Household wastes dumping place

The insights drawn from Figure 10 reveal a significant trend: approximately 60% of individuals dispose of their waste in close proximity to lakes or rivers, while only a mere 10% opt for proper waste disposal into bins. This prevalent behavior carries substantial environmental and hygiene risks. Dumping waste near water bodies poses a threat to the ecosystem and can lead to pollution, while utilizing designated bins

for waste disposal aligns with proper waste management practices and contributes to a cleaner environment. The observed disparity in waste disposal behaviors underscores the need for heightened awareness and education regarding responsible waste management, as adopting sustainable practices will play a pivotal role in safeguarding both the local environment and public health.

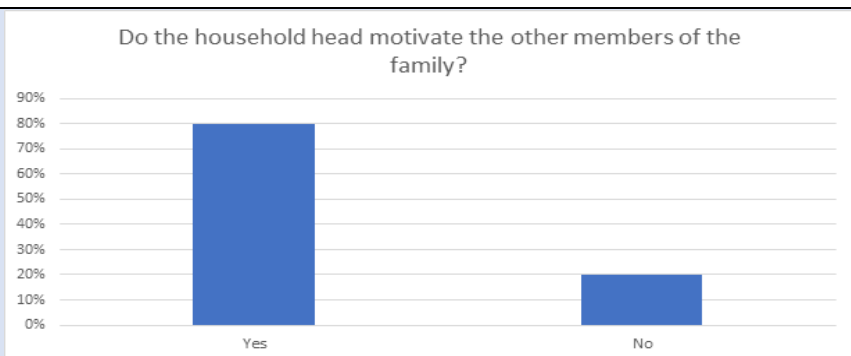


Figure 11: Survey Result of “Do the household head motivate the other members of the family?”

The insights gleaned from Figure 11 suggest a prevalent pattern: a majority of household heads express their engagement in motivating their friends and family members. However, it's important to note that our study's limitations prevent us from substantiating these claims with concrete evidence or proof. This finding underscores the observed

inclination of household heads to encourage positive hygiene practices within their social circles. Nonetheless, the absence of verifiable support for these assertions emphasizes the challenge of definitively assessing the extent of these motivational efforts, highlighting an area for potential further investigation and data collection.

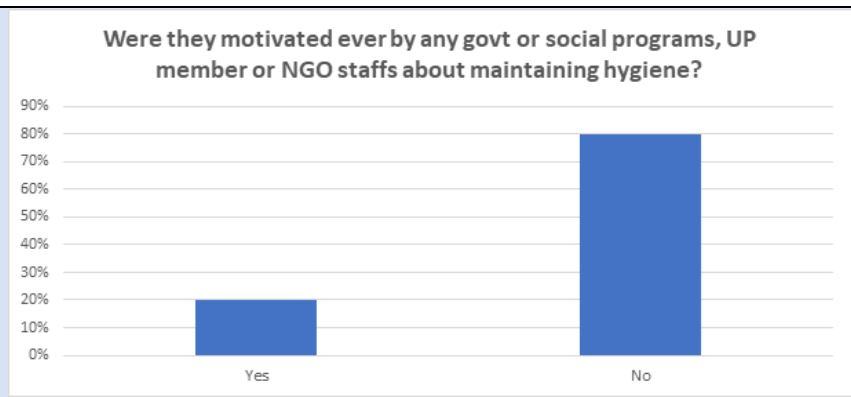


Figure 12: Survey Result of “Were they motivated ever by any government or social programs, UP member or NGO staffs about maintaining hygiene?”



The insights conveyed by Figure 12 reveal a prevailing sentiment: a significant number of residents expressed that they have never been made aware of safe water, sanitation, and hygiene practices through either governmental initiatives or engagement with NGO personnel. This observation underscores a notable gap in the dissemination of essential information related to these critical areas. The lack of awareness campaigns from both official and non-governmental sources highlights a missed opportunity to educate and empower the community regarding crucial hygiene and sanitation matters. Addressing this gap in awareness-building efforts is crucial for improving overall hygiene practices and ensuring the adoption of safe water and sanitation practices within the surveyed population.

## Conclusion

This study summarizes key findings related to water, sanitation, and hygiene (WASH) infrastructure, offering a comprehensive view of the current situation. Firstly, the results show that a significant proportion of the population (98%) has access to improved drinking water sources, highlighting widespread access to safer water. Additionally, 43% of respondents report having a water supply directly on their property. However, a concerning 80% of these water sources have never been tested for toxins such as arsenic and pathogens, raising health and safety concerns. The study also reveals that all households in the sample use improved latrines, reflecting the broader national trend where 86% of households have adopted better sanitation practices. Notably, every household studied has access to personal restrooms, significantly surpassing the national average of around 60%. In terms of sanitation management, 80% of toilets, whether pit latrines or septic tanks, were properly emptied within two years, suggesting responsible maintenance. Additionally, over 95% of residents have access to handwashing facilities. Hygiene practices are strong, with 100% of respondents washing hands with soap after using the restroom, and 65% washing hands before eating or cooking. This is notably higher than the national average, where only about 60% have basic handwashing facilities, and is attributed to increased awareness due to the COVID-19 pandemic. However, waste management remains an area for improvement. Only 10% of villagers use designated trash bins, with most waste being discarded in nearby water bodies or

around homes. This indicates a need for better waste management systems in rural areas. The study also emphasizes the role of household heads in promoting hygiene practices, as they play a crucial part in encouraging family members to maintain cleanliness. Despite this, there is a lack of widespread hygiene awareness campaigns from both government and non-governmental organizations. In conclusion, the study highlights both notable achievements in WASH infrastructure and areas that require further attention to enhance public health and sustainability. The findings provide valuable insights for policymakers and organizations working to improve water, sanitation, and hygiene systems in rural Bangladesh and similar regions.

## References

1. Herrera, V. (2019). Reconciling global aspirations and local realities: Challenges facing the Sustainable Development Goals for water and sanitation. *World Development*, 118:106-117.
2. Giribabu, D., Bharadwaj, P., Sitiraju, R., Burra, M., Rao, P. P., & Reddy, C. S. (2019). Combating open defecation through community-led sanitation. *Dr Sulaiman Al Habib Med J*, 1(3-4):45-51.
3. Giné-Garriga, R., Flores-Baquero, Ó., de Palencia, A. J. F., & Pérez-Foguet, A. (2017). Monitoring sanitation and hygiene in the 2030 Agenda for Sustainable Development: A review through the lens of human rights. *Science of the Total Environment*, 580:1108-1119.
4. Biswas, S., Dandapat, B., Alam, A., & Satpati, L. (2022). India's achievement towards sustainable Development Goal 6 (Ensure availability and sustainable management of water and sanitation for all) in the 2030 Agenda. *BMC Public Health*, 22(1):1-16.
5. Ahmed, M.S. et al. (2021) Mapping and situation analysis of basic wash facilities at households in Bangladesh: Evidence from a Nationally Representative Survey, *PLOS ONE*, 16(11).
6. Arias Granada, Y., Haque, S. S., Joseph, G., & Yanez Pagans, M. (2018). Water and sanitation in Dhaka slums: access, quality, and informality in service provision. *World Bank Policy Research Working Paper*, (8552).
7. Akter, T. and Ali, A.R.M.M. (2014). Factors influencing knowledge and practice of hygiene in water, sanitation and hygiene (WASH)

- programme areas of Bangladesh Rural Advancement Committee. *Rural and Remote Health*.
8. Islam, T., Alam, O. and Misbahuzzaman, K. (2015). Rural Water Supply, sanitation and hygiene in Bangladesh: An investigation of Lohagara Upazila. *SSRN Electronic Journal*.
  9. JMP. (2022, October 31). Household data [Data set]. Water, Sanitation and Hygiene (WASH).
  10. National Hygiene survey 2018 (2020). Dhaka: Demography and Health Wing, Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning.
  11. Progotir Pathy Bangladesh, Multiple Indicator Cluster Survey 2019, Survey Findings Report (2019). Dhaka: Bangladesh Bureau of Statistics (BBS) and UNICEF Bangladesh
  12. Hore, S. (2024). Assessment of Soil Chemical Characteristics in the Context of Bangladesh: A Comprehensive Review. *Community and Ecology*, 2(1).
  13. Arefin, M. S., Talukder, M. A. R., Hore, S., & Hore, R. (2023). A Novel Study on Present Situation of Infrastructure of Water, Sanitation and Hygiene of Rural People in Bangladesh. *Western European Journal of Historical Events and Social Science*, 1(1):44-58.
  14. Hore, R., Hossain, M.Z., Hore, S. et al. (2024). A Comparative Seismic Study of Wrap-Faced Retaining Wall Embankment Using Sands of Bangladesh. *Iran J Sci Technol Trans Civ Eng*.
  15. Hasan, M.M., Hore, S., Al Alim, M. et al. (2025). Numerical modeling of seismic soil-pile-structure interaction (SSPSI) effects on tall buildings with pile mat foundation. *Arab J Geosci*, 18:10.

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