CLEAN WATER SOURCES AND LIVELIHOOD ASSETS IN THE INDUSTRIAL AREA OF BERGAS DISTRICT, SEMARANG REGENCY, CENTRAL JAVA PROVINCE, INDONESIA

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ABSTRACT Water is a vital need for everyone, while its availability is very limited and access gaps still exist. The purpose of this study is to analyze household clean water sources in industrial areas and to assess household livelihood assets. This study used a survey method with 42 respondents selected purposively, namely households living and working in the industrial area of Karangjati Village, Bergas District. The research variables are household clean water sources and household livelihood assets. Data were collected through questionnaires, observations, and supported by in-depth interviews with several key figures. Data analysis was conducted quantitatively using descriptive statistics and with the asset pentagon. The results show that most households use clean water from the Regional Water Company (PDAM) and drilled wells. Household livelihood assets are classified as fairly sustainable. The results of the study support the sustainable development goals, in goal 6 indicator 6.1.

Keywords: Clean Water Sources, Households, Livelihood Assets, Industrial Areas, Sustainable Development Goals.

INTRODUCTION

Water is a basic necessity that is vital to human life. Every individual requires clean water for various basic needs such as consumption, sanitation, hygiene, and daily domestic activities. Not only is clean water essential for survival, but the availability of clean water is also a crucial indicator in measuring the quality of life and sustainable development of a region. However, amidst population growth, urbanization, and industrial expansion, the challenges of ensuring clean water availability are increasingly complex. The availability of safe and adequate water is not always equally accessible to all levels of society, especially in areas experiencing high environmental pressure. In various regions, including those adjacent to industrial centers, significant disparities in access to clean water persist. This activity assumes that the more complex human and industrial activities are, the greater the level of pollution that occurs, thus impacting aquatic ecosystems, sanitation quality, and the availability of safe drinking water for humans (Kustanto, 2020).

Industrial areas in particular face greater challenges in providing clean water. Intensive industrial activity not only drastically increases water consumption but also has the potential to pollute surface and groundwater resources due to production waste and chemical use. This has resulted in a decline in water quality in the surrounding area and poses health risks to communities relying on local water sources. This situation forces households near industrial areas to seek alternative sources such as dug wells, drilled wells, rainwater harvesting, or even bottled water. However, these options do not necessarily guarantee water quality that meets health standards. A study by Suryani and Prasetyo (2021) in the Gresik industrial area revealed that despite the availability of a PDAM network, most households still choose to use water from wells due to affordability and limited service distribution.

The issue of clean water access in industrial areas cannot be separated from the context of community livelihoods as a whole. One relevant approach to analyzing this is the Sustainable Livelihood Framework (SLF) developed by Chambers and Conway (1992) and Scoones (1998). Within this framework, household livelihoods are understood as the result of the interaction of five types of assets: human, natural, physical, financial, and social. Access to clean water is a direct reflection of the condition of a household's physical and natural assets. It is also influenced by the strength of financial assets to pay for services, social assets to secure community support, and human capacity to manage water resources independently. Therefore, clean water issues need to be viewed not only from a purely technical perspective but also from the perspective of integrated community livelihood sustainability.

Based on this background, this study aims to analyze the types of clean water sources used by households in industrial areas and examine the condition of household livelihood assets related to access to clean water.

LITERATURE REVIEW

Clean Water Sources

Household clean water sources are a crucial factor in supporting public health and quality of life. According to the World Health Organization (WHO, 2017), clean water is water used for daily household needs such as drinking, cooking, and maintaining hygiene. It must be free from contaminants that could endanger health. This aligns with the opinion of the Ministry of Health of the Republic of Indonesia in Regulation No. Law No. 492 of 2010 states that clean water must meet physical, chemical, microbiological, and radioactive requirements to be safe for consumption (Kementerian Kesehatan Republik Indonesia, 2010). Some of the main sources of clean water for households include dug wells, drilled wells, tap water or PDAM (Regional Water Company), bottled water, rainwater, and springs.

Statistics Indonesia (BPS) research (2023–2024) shows that in Indonesia, the main source of drinking water for households varies between urban and rural areas (BPS, 2024). In urban areas, households rely more on tap water and bottled water, while in rural areas, many still use wells or springs. Meanwhile, according to (Harianja, Sipayung, Purba, & Abdilla, 2022), the quality of drinking water from refill depots is greatly influenced by poorly maintained equipment and inadequate sanitation conditions, which have a high risk of contamination by Escherichia coli, thus emphasizing the importance of maintenance and hygiene to ensure water quality.

Livelihood Assets

Livelihood assets are a key concept in the study of sustainable development and community welfare. According to Chambers and Conway (1992), livelihoods can be understood as the capabilities, assets, and activities a person needs to live. Within the Sustainable Livelihood Framework (SLF) developed by the Department for International Development (1999), livelihood assets consist of five main assets: human capital, social capital, natural capital, physical capital, and financial capital. These five assets are interconnected and serve as the foundation for households and communities to meet their living needs and improve their well-being. Scoones (1998) emphasized that the success of a community's livelihood strategy depends heavily on the combination of assets held and how these assets are managed to address vulnerabilities and capitalize on opportunities. Meanwhile Ellis (2000) argued that asset diversity enables households to develop better adaptive strategies in the face of social, economic, and environmental change. Thus, livelihood assets are not merely the ownership of resources, but also represent a community's ability to effectively utilize and manage these resources so they can strengthen their resilience, adapt, to changing conditions, and achieve sustainable livelihoods.

Clean water sources are closely linked to community livelihood assets because water is a basic need that supports household survival and productivity. According to Chambers and Conway (1992), livelihoods depend not only on financial or physical assets but also on the ability to manage natural resources, including water, which is a key asset in the Sustainable Livelihood Framework (Department for International Development, 1999). Clean water, as part of natural capital, plays a direct role in supporting health (human capital), strengthening labour productivity, and enabling communities to access economic opportunities. Scoones (1998) emphasized that the sustainability of livelihood strategies is strongly influenced by the availability and quality of natural resources. Therefore, limited access to clean water will reduce a community's capacity to manage other assets, such as social, physical, and financial assets. Ellis (2000) also emphasized that diversification of livelihood assets, including the use of water resources, provides opportunities for better adaptation to economic and environmental risks. Thus, the availability of clean water sources not only serves to fulfil basic needs, but also serves as an important support for the sustainability of livelihood assets, both through improving health, economic productivity, and social resilience of the community.

METHODOLOGY

This research was conducted in Karangjati Village, Bergas District, Semarang Regency, Indonesia. This research was conducted in Karangjati Village because it is one of the areas in Bergas District with a high concentration of industry, particularly along the Semarang-Solo route. The presence of factories and industrial areas near residential areas puts pressure on clean water resources. The population in this study was all households living in Karangjati Village, Bergas District, Semarang Regency. The sample consisted of 42 household respondents, selected purposively from the population in Karangjati Village, Bergas District. The purposive sampling technique was used, considering certain criteria: households living in areas adjacent to industrial areas and using clean water sources for daily needs.

The main variables in this study consisted of two aspects: the type of clean water source used by the household and household livelihood assets, which encompass the five types of assets within the Sustainable Livelihood Framework (human, natural, physical, financial, and

social assets). Data collection was conducted using several techniques: distributing closed-ended questionnaires to obtain quantitative data, field observations to assess the physical and environmental conditions of respondents' homes, and in-depth interviews with key figures such as neighbourhood heads, community leaders, and representatives from clean water management agencies to enrich the data and gain contextual perspectives.

Prior to analysis, the questionnaire data underwent a data refinement process, including validity and reliability tests to ensure the accuracy and consistency of the measurement instruments. Construct validity was tested using Pearson's product–moment correlation to assess whether each item measured the intended concept, while reliability was tested using Cronbach's Alpha, with coefficients above 0.70 considered acceptable for internal consistency. The questionnaire employed a Likert scale, explicitly ranging from 1 (strongly disagree) to 5 (strongly agree), to measure respondents' perceptions of their asset ownership levels. This scale allowed for the quantification of subjective judgments related to the five livelihood asset dimensions.

Quantitative data were analyzed using descriptive statistics to present frequencies, proportions, and mean scores for the types of clean water sources used and the levels of ownership across each livelihood asset category. In addition, the analysis utilized the asset pentagon approach, which visually and numerically illustrates the relative strength of the five livelihood asset types, enabling the identification of the most and least dominant dimensions among households.

Meanwhile, the responses obtained from in-depth interviews were analyzed using a qualitative descriptive analytical approach. This included coding, categorization, and thematic analysis to identify recurring patterns, contextual explanations, and community-level dynamics related to clean water challenges and livelihood conditions. The qualitative findings were then compared with quantitative results to achieve a more comprehensive interpretation of household livelihood conditions in industrial-area communities and their relationship to access to clean water sources.

RESULTS AND DISCUSSION

Household Clean Water Sources

Water sources in the Bergas District industrial area come from various sources, such as PDAM (Regional Water Company), drilled wells, and dug wells, which are utilized to meet both industrial operational needs and the domestic needs of the surrounding population. This utilization pattern reflects the geographic conditions and available infrastructure in the area. The results obtained from the average use of clean water sources in Karangjati Village are presented in Table 1.

Table 1. Clean water sources in Karangjati Village, Bergas District

Clean Water Source	Total	
	n	%
PDAM Water	25	59,52
Drilled Well With Filtration System	17	40,48
Total	42	100

Source: Processed data, 2025

In Karangjati Village, the primary source of clean water for households is divided into two: 59.52% use the Regional Water Company (PDAM) and 40.48% rely on drilled wells with filtration systems. The absence of rainwater or dug wells indicates that the community has chosen water sources that are relatively safer and of guaranteed quality. This composition indicates that local residents rely more heavily on the piped water network managed by the PDAM, as it is considered more practical, offers guaranteed quality, and offers relatively stable distribution compared to non-piped water sources. No use of rainwater or dug wells was found in this area. This can be interpreted as a shift in community preference toward more modern and safer sources of clean water. Dug wells, which are generally susceptible to bacterial contamination and domestic waste, are no longer preferred, while rainwater utilization is also not an alternative, likely due to limited storage facilities and a lack of continuity of supply throughout the year. The results of this study align with Chambers and Conway's (1992) findings, which state that access to adequate natural resources, including water, is a crucial livelihood asset for communities. The use of PDAM by the majority of households reflects the availability of clean water infrastructure. This aligns with the findings of the Statistics Indonesia (BPS, 2024), which show that access to safe drinking water in urban areas in Indonesia continues to increase, with PDAM being one of the primary providers.

The relatively high proportion of drilled wells indicates limited PDAM coverage or a preference among communities for drilled wells as a more stable and economical alternative. These findings suggest that drilled wells can be a viable water source if equipped with an adequate filtration system. The results of this study align with those of Putra & Mairizki (2020), who assessed groundwater quality based on physical and chemical parameters and then compared them to drinking water quality standards, including Minister of Health Regulation 492/2010. The results indicate that drilled wells or groundwater are suitable for consumption if they meet the tested parameters.

The sustainability of drilled wells requires attention. Scoones (1998) emphasized that sustainable livelihoods are significantly influenced by the quality of natural resources, including groundwater. In areas experiencing industrial growth and population density, drilled wells are prone to waste contamination and deterioration over time. This is in line with research by Nadiyah Khairunnisa (2025) who found that the distance between septic tanks and wells/groundwater sources affects the total coliform and E. coli content in shallow groundwater in Jakarta. This situation can be categorized as having a fairly good level of clean water access, as all households use improved water sources. However, special attention still needs to be paid to the long-term quality of drilled well water. Local governments need to expand the reach of the Regional Water Company (PDAM) and encourage well users to ensure they use filtration systems that meet health standards and conduct regular water quality tests.

Methods of Obtaining Clean Water for Households

Water sources for communities in the industrial area of Bergas District come from various methods, including using PDAM water, drawing from their own wells, drawing from public wells, and collecting rainwater. The results obtained from the average method of obtaining clean water sources in Karangjati Village are presented in Table 2.

Table 2. Methods of obtaining clean water sources in Karangjati Village, Bergas District

How To Get Clean Water	Total	
	n	%
Water Pipes	25	59,52%
Water Pumps	17	40,48%
Total	42	100,00%

Source: Processed data, 2025

The primary source of clean water for households in Karangjati Village is divided into two broad categories. The majority of households, 59.52%, obtain clean water through the PDAM (Regional Water Company) pipeline, while the remaining 40.48% still rely on water pumps (drilled wells with pumping systems). No households used public wells, rainwater, or other alternative water sources such as springs or surface water. This reflects that the community generally has access to adequate water sources. Access through the PDAM provides advantages in terms of supply continuity, ease of distribution, and quality assurance because the water is managed according to certain standards. Meanwhile, households using water pumps also continue to have adequate access to clean water, especially because they are generally equipped with filtration systems to maintain water quality. According to Chambers and Conway (1992), the availability of clean water is a vital asset within the framework of sustainable livelihoods, as water not only serves basic household needs but also impacts community health, productivity, and quality of life.

The use of PDAM by the majority of households reflects the Karangjati community's connection to urban infrastructure, which is more stable in terms of quality and distribution. This aligns with the BPS Report (2023), which states that access to safe drinking water in Indonesia is increasing year by year, with PDAM as the primary provider in urban areas. However, the proportion of households still relying on private wells indicates variations in patterns of meeting clean water needs, influenced by factors such as residential location, economic conditions, and the accessibility of the PDAM network. The results of this study are in line with research (Kurniawati & Ulfa, 2024) which found that many drilled well samples did not meet several standard parameters (including pH, turbidity, color, odor, and chemical content such as Fe) indicating that the quality of water from drilled wells can vary and requires routine testing and processing. The difference in access between PDAM users and private well users in Karangjati shows that not all households receive clean water services of the same standard. According to Scoones (1998), the sustainability of community livelihoods is highly dependent on the quality and availability of natural resources, including clean water. Therefore, local governments need to ensure the expansion of PDAM services to be more equitable, while also encouraging well users to use filtration systems that meet health standards. This step can ensure sustainable access to clean water, thereby supporting public health, environmental quality, and household livelihood resilience.

Distance to Household Clean Water Sources

The distance between a household and a clean water source is a critical factor influencing the level of community access to this basic need. In Karangjati Village, the distance to household clean water sources reflects the varying levels of affordability and availability of clean water facilities used by residents. The results of the average distance to clean water sources in Karangjati Village are presented in Table 3.

Table 3: Distance to Clean Water Sources in Karangjati Village, Bergas District

Distance To Get Clean Water	Total	
	n	%
Inside The House/Yard	42	100,00%
Total	42	100,00%

Source: Processed data, 2025

Households access clean water sources within their homes or yards. Forty-two households (100%) utilized water sources that were very close by, so none had to travel a distance, whether less than 100 meters, 100–500 meters, or more than 500 meters. This indicates that the community has very good access to clean water, as proximity facilitates meeting daily needs such as cooking, washing, bathing, and drinking. The WHO (2017) emphasizes that one of the main indicators of clean water access is the distance to the water source, with the availability of water within the home or yard categorized as an ideal basic service. The availability of clean water sources near the home also has important social implications. According to Cairncross and Feachem (1993), close access to clean water can reduce the time and labour burden on households, especially for women and children, who in many areas still play the primary role in fetching water. This finding is in line with research by (Sebayang, Sapha, & Hidayat, 2025) which shows that access to water and sanitation is correlated with health status and household socioeconomic indicators — indicating that households with better access tend to be healthier and in more stable economic/family conditions.

This condition reflects equitable access to clean water infrastructure through the PDAM network and private wells. The results of this study are in line with (Setyoadi, 2012) who found that the provision of adequate clean water and sanitation infrastructure significantly supports the reduction of water-related diseases (such as diarrhea) in the community. Scoones (1998) also emphasized that access to basic services, including clean water, is a key pillar within the sustainable livelihoods framework, as it is directly related to the health, well-being, and sustainability of household livelihoods. Access to clean water not only reflects the fulfilment of basic service standards but also strengthens the sustainability of community livelihoods. Access to clean water within the home or yard is an ideal service, as it not only meets the quantity and quality requirements but also minimizes physical burden and improves the overall quality of life for the community.

Household Livelihood Assets in Karangjati Village

Household livelihood assets are a crucial component of the sustainable livelihood framework, determining a household's capacity to meet living needs, adapt to pressures, and sustainably improve well-being. In this context, households in Karangjati Village, Bergas District, are assessed based on five main asset types: human assets, natural assets, physical assets, financial assets, and social assets. The results of the average household livelihood assets in Karangjati Village are presented in Table 4.

Table 4. Household Livelihood Assets in Karangjati Village, Bergas District

Livelihood	Total

Assets	Total Average	%
Human	3,50	65,04
Natural	3,70	73,1
Physical	3,30	66,79
Financial	2,40	47,26
Social	2,30	46,63
Average	3,04	59,76

Source: Processed data, 2025

Household livelihood assets in the industrial area of Karangjati Village, Bergas District, Semarang Regency can be explained using the asset pentagon as follows.

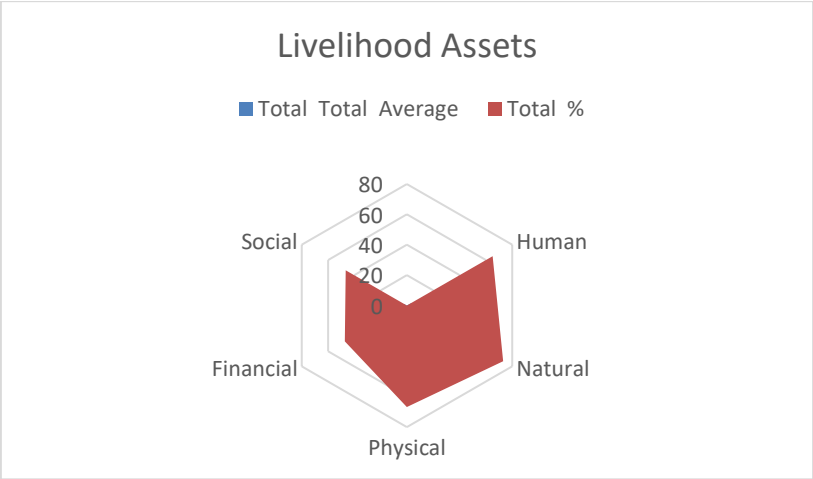

Figure 1. Asset Pentagon
Source: Processed data, 2025

The sustainability of household livelihood assets reached 59.76%, which is classified as moderate. Of the five asset types, natural assets received the highest score of 3.70 or 73.1%, which is classified as high. This achievement indicates that the community has good access to natural resources, particularly the availability of clean water and productive land, which are the main assets in supporting sustainable livelihoods. This aligns with Ellis (2000) perspective, which emphasizes that natural assets are the main foundation of a sustainable livelihoods framework, as environmental resources directly influence a household's ability to meet basic needs and adapt to change.

Human assets and physical assets performed quite well, with scores of 65.04% and 66.79%, respectively, which are classified as moderate. This achievement reflects that the quality of education and public health is at a relatively adequate level, although there is still room for improvement. A good education provides opportunities for household members to acquire skills and capacities that can increase resilience to social and economic change. Meanwhile, good health is a crucial asset in maintaining labour productivity and reducing vulnerability to disease. A high level of physical assets indicates that most households have access to basic infrastructure, such as adequate housing, road networks, and other public

facilities. Adequate infrastructure not only supports people's daily activities but also facilitates economic mobility and access to social services. According to Ellis (2000), human and physical assets are crucial for building sustainable livelihood strategies because they act as a bridge to optimize the use of natural and financial assets. This finding is in line with research (Mukhtar & Pradoto, 2021) which emphasized that access to physical aspects such as sanitation, clean water, health facilities, educational facilities, housing conditions, and infrastructure such as embankments/pump houses are part of the indicators in measuring the "adaptive capacity" of the community.Therefore, although the results are still in the moderate category, human and physical assets can be said to provide a strong foundation for communities to build sustainable livelihoods, provided they are continuously improved through investment in education, health, and infrastructure. Scoones (1998) emphasized that adequate human assets will enhance a household's adaptive capacity, while strong physical assets support accessibility and expand livelihood opportunities. Research by (Sukesi, Satoto, Murhandarwati, & Padmawati, 2021) shows that health education interventions improve healthy housing conditions and community social capital in Sleman, which supports community health levels.

Financial assets (47.26%) and social assets (46.63%) were both in the low category, constituting a weakness in household livelihood sustainability. Low financial assets reflect limited income sources and limited access to formal financial institutions such as banks, cooperatives, or microcredit institutions. This situation hinders households' ability to save, invest in productive activities, and cope with economic shocks such as rising prices of basic necessities or job losses. According to Scoones (1998), financial assets are essential capital that can increase household flexibility in choosing livelihood strategies. Therefore, limitations in this aspect directly impact the community's low adaptive capacity. Meanwhile, weak social assets are reflected in minimal community participation in formal and informal groups, weak social networks, and limited collective support among residents.

Social assets are crucial for strengthening solidarity, expanding access to information, and opening economic opportunities through collaborative networks. According to Putnam (2000), social trust and participation in community organizations can strengthen social capital, which in turn enhances community development capacity. These findings in Karangjati align with research by Sari and Utami (2021), which showed that weak social and financial assets often hinder household livelihood sustainability, despite relatively strong natural and human assets. Therefore, increasing access to inclusive financial institutions and strengthening the role of local community groups are important strategies to promote more equitable and resilient livelihood sustainability in Karangjati. These findings align with a study by Sari and Utami (2021), which explains that while natural and human assets can support sustainable livelihoods, weaknesses in financial and social assets remain major obstacles to household capacity development. Furthermore, Suwondo et al. (2020) emphasize the importance of integration between assets in promoting livelihood sustainability, particularly in areas experiencing development and urbanization pressures. Their study in Bergas District demonstrates that the strength of one or two assets alone is insufficient, as true sustainability can only be achieved through a balance between natural, human, physical, financial, and social assets. Thus, although household livelihood conditions can be categorized as quite sustainable, efforts to strengthen financial assets through increasing inclusive financial access and economic empowerment, as well as strengthening social assets through increasing community participation, mutual cooperation, and institutional support, are essential to ensure that livelihood sustainability can be increased evenly across all levels of society.

CONCLUSION

Households using PDAM (Water Utility Company) have better physical assets due to the support of piped infrastructure, but financial attention is needed, given that subscription fees can be a burden on low-income groups. Appropriate recommendations include strengthening customer groups, providing subsidies or progressive tariffs, and providing education on installation maintenance to ensure efficient service. Meanwhile, households using drilled wells rely on natural assets and are therefore vulnerable to declining groundwater quality and availability. This requires sustainable extraction practices, pump and filter maintenance, diversification through rainwater harvesting, and collective regulation if wells are shared. In general, both groups require financial and social support through access to microcredit, village-level water forums, and water conservation programs to ensure sustainable livelihoods.

Community livelihood assets are categorized as moderate. Natural assets are a key strength, with a sufficient supply of clean water and productive land. Human and physical assets are also adequate through education, health, and basic infrastructure, although they still need improvement. However, financial and social assets are low, reflecting limited income, access to financial institutions, community participation, and collective support. This condition weakens households' adaptive capacity to economic and social pressures. The strength of natural, human, and physical assets needs to be supported by strengthening financial assets through inclusive financial access, productive economic empowerment programs, and business capital support. Furthermore, enhancing social assets can be achieved by strengthening community participation in local groups, cooperatives, and community-based organizations to strengthen solidarity and social networks. Therefore, although livelihood conditions in Karangjati are already quite good, strategies to strengthen financial and social assets are key to improving sustainable livelihoods that are more equitable, resilient, and inclusive across all levels of society.

Recommendations that can be made to several parties, particularly to support the sustainability of household livelihoods, are as follows:

1. The local government needs to expand inclusive financial access through collaboration with banks, cooperatives, and micro-finance institutions, along with productive economic empowerment through training on MSMEs, entrepreneurship, and marketing of local products. They also encourage the formation of revolving funds or community-based savings and loan groups to strengthen household economic resilience.
2. Households using drilled wells need to raise awareness of the importance of sustainable groundwater management, for example by limiting excessive water extraction, constructing infiltration wells, and regularly maintaining pumps and filters to maintain water quality. Village governments can provide support by providing water quality testing programs, technical training, and access to microfinance for water facility improvements.
3. Households using rainwater are advised to equip their reservoirs with simple filtration systems and covers to ensure safe water quality, and to utilize rainwater only as a supplemental, not primary, source. Government support can include assistance with more efficient reservoir technology, sanitation outreach, and incentive programs for households that practice water conservation.

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