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Local Perception and Behavior in Domestic Waste Management and Water Quality of The Brantas River, Dinoyo Ward

Ilham Misbakudin Al Zamzami[1*], Yogita Ayu Dwi Susanti[1], Siti Mariyah Ulfa[2,3], Maharani Pertiwi Koentjoro[2,4], Ridwan Danuarta Galisong[4], Lisa Aulia[4], Andi Kurniawan[1,2], Wresti L. Anggayasti[2,4*]

[1*]Faculty of Fisheries and Marine Science, University of Brawijaya, Malang, Indonesia.
[2]Microbial Resources and Biotechnology Research Group, Graduate School University of Brawijaya, Malang, Indonesia.
[3]Faculty of Mathematics and Natural Sciences, University of Brawijaya, Malang, Indonesia.
[4]Graduate School University of Brawijaya, Malang, Indonesia.

Abstract

Waste management by society not only reflects individual responsibility but also plays a crucial role in environmental sustainability and community welfare. This research aimed to understand society's perception and behavior regarding domestic waste and its surrounding waters. Understanding societal behavior is the key to sustainable environmental management. Direct inquiry was conducted to the sample population of 25 respondents who represented various age, education, and cultural groups in the densely populated residential area surrounding the Brantas River in Dinoyo Ward. Field observations were done to take water quality parameters and monitor the residents' behavior regarding waste management. The results indicated that 76% of respondents know the impact of river pollution, although most did not contribute actively to reducing their domestic waste volume. About 44% of respondents never saw anyone littering the river, which may be due to the regular waste pick-up system. This was supported by water quality parameters that did not demonstrate any sign of pollution, although high turbidity was indicated. Comprehension of the results of this study is hoped to inspire the ideas of solid intervention plans to increase awareness and decrease the negative impact of domestic waste on the Brantas River in Dinoyo Ward.

Keywords: society perception and behavior, domestic waste management, aquatic environment, Brantas River

INTRODUCTION

Brantas is one of the longest rivers on Java Island and crucially supports the socio-economic life of the surrounding people. This river is the primary water source for agricultural irrigation and supplies domestic and industrial needs [1]. Besides that, the Brantas River also occupies an important place in the cultural and historical aspects of the communities who reside along its stream [2]. Unfortunately, in parallel with the population and industrial growth in recent decades, Brantas must face serious problems regarding water pollution and waste accumulation problems. Anthropological activities heavily contributed to increased domestic, industrial, and agricultural waste. They become the main factors contributing to the degradation of river water quality [2]. The increase in waste volume dumped into the river body, especially the visible plastic garbage and even microplastic, has caused a significant negative impact on aquatic ecosystems and public health [3].

Correspondence address:
Wresti L. Anggayasti
Email : wl.anggayasti@ub.ac.id
Address : MT. Haryono 169 Malang, 65145

Previous studies have demonstrated the detrimental effects of domestic and industrial waste, which gradually cause the Brantas' water quality to decline [4], [5]. Brantas water pollution not only disrupts the equilibrium of the aquatic ecosystem but also affects human professions that depend on the river [6]. Furthermore, fish and other river biota experience a significant reduction in population number due to the resulting low dissolved oxygen and high toxicity [6]. In connection, it is also likely that local people who use water from Brantas for their daily activities will be harmed by chemical contaminants that are dangerous to human health [7]. Although the government and other related parties have tried to tackle the pollution problems of the Brantas River, implementing the policies has faced serious obstacles. One of them is related to the perception and behavior of the residents.

In truth, laws on protecting and managing the environment at both national and local government levels, such as Undang-Undang Republik Indonesia Nomor 32 Tahun 2009, should become the basis for thorough preservation efforts in Indonesia [8]. This law covers many aspects, including waste management, the prevention of environmental

pollution, and natural conservation. *Undang-Undang Republik Indonesia Nomor 18 Tahun 2008* regulates waste management through reduction, sorting, collection, picking up, pooling, and stacking up [9]. This regulation also emphasizes the principles of sustainable and responsible waste management.

Sustainable Development Goals (SDGs) also became the point of reference as a global initiative for environmental protection, which was adopted by all members of the United Nations in September 2015 as a part of Agenda 2030 for Sustainable Development [10]. The guidelines about waste management are covered in SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), and SDG 12 (Responsible Consumption and Production) [11]. SDG 6 particularly elaborates on water pollution management and sanitation, which also covers waste management to prevent water pollution [11]. Similarly, SDG 11 and 12 also stress the importance of sustainable waste management in the city area, including reducing waste volume and improving recycling and reusing waste [11].

Further, SDG 13 (Climate Action) stated that good waste management would contribute to a lower greenhouse effect, especially methane (CH4), which is the dominant gas emitted by landfills [10, 11]. SDG 14 (Life Below Water) is closely related to reducing sea pollution, especially plastic waste, which is proven to endanger sea animals. Finally, SDG 15 (Life on Land) elaborates on the effort to slow down land degradation and habitat loss, which can be connected to using areas for landfills if the waste is not managed correctly [10, 11]. Ideally, Indonesian legal laws and the SDGs should be the reference points for all citizens who care about the environment.

This study aims to dig deeper into the aspects related to waste management by the locals, including the awareness level and the corresponding actions they take in daily life. As supporting data, some parameters, which consisted of temperature, pH, conductivity, turbidity, water current, BOD (Biological Oxygen Demand), DO (Dissolved Oxygen), orthophosphate, and TSS (Total Suspended Solid) [7, 12], were taken to ensure the Brantas water quality. This data will strengthen the survey results on locals' behavior within a one-kilometer radius of the sampling spot.

This study occurred in the Dinoyo Ward of the Lowokwaru District of Malang City. Lowokwaru is a highland area of 460 m above sea level, with some regions dominated by hills higher than 500 m above sea level [13]. Interestingly, the clean water for their residential needs is supplied by reservoirs in Dinoyo Ward [13]. The use of wells for groundwater is also still prevalent here. According to demography data of 2023, Dinoyo Ward has a population of 11,410, dominated by students (3,112), non-worker residents (2,059), and housewives (1,789) [14]. They most likely carry out their daily activities around their houses and residential areas, including those which potentially create waste.

Dinoyo Ward itself is situated in the upstream of the Brantas River. It is an economically growing area. The existence of at least two big universities, hospitals, healthcare facilities, traditional markets, and small and medium enterprises here [15, 16] may be harmful to the local environment and water quality [17-20]. Studies about water quality parameters of the Brantas watershed in Dinoyo Ward are quite frequently done, and most of them indicate water pollution due to domestic activities [21, 22]. However, there was still a lack of investigation into the active participation of the locals in reducing and managing domestic waste.

This study is thus expected to represent the efforts to understand the water quality of the Brantas River in a certain part of Dinoyo Ward, especially about residents' or small industries' perceptions and behavior related to their waste management. These analyses may give policymakers, related governments, and NGOs insights into creating mitigation and management programs to tackle domestic waste problems along the Brantas River more efficiently and effectively and to enhance the living quality of the surrounding community.

RESEARCH METHODS

Research Design

This research used a cross-sectional study approach to collect data at a single time point [23]. The data were obtained from local population samples which represent various age, education, and cultural groups.

Population and Sample

The population being studied was located within Dinoyo Ward, the City of Malang, within the radius of one kilometer from the water quality sampling spot, at the coordinates of 7.94181, 112.61286 (Figure 1) of the Brantas River. The local residential area was near the Dinoyo ceramic tourism village (*Kampung Wisata Keramik Dinoyo*). The selected population sample consists

of 25 respondents selected randomly within the residential area. The respondents were chosen based on their daily activity. More than half of these respondents are Housewives who run most domestic activities, including waste management. This choice also reflects the Demographic data of Dinoyo Ward, whereby Housewives represent the third-most dominant profession [14]. The rest consists of residents who work locally and whose activities are perceived to impact the river directly, should they mismanage their waste, such as the owners of small food and beverage industries.

Figure 1. The stream of Brantas River in Dinoyo Ward, the City of Malang. The red mark within the stream was the location for measurement of river water quality, while the direct interview and observation were conducted within a radius of one kilometer from the riverbed.

Research Instruments

The research instruments had two main components: the survey questionnaire and direct field observation. The questionnaire consisted of structured questions to gauge the respondents' perceptions about domestic waste. Meanwhile, the direct field observation was meant to examine waste management habits or behavior in the sampling area.

Perception and Behavioral Data Collection

As explained previously, the data were collected by interviewing the randomly selected respondents. The survey covered the questions to comprehend their understanding of waste management, their behavior, and the factors affecting those objects. Lastly, field observation gathered information about domestic waste management habits in the sampling area.

Water Quality Measurement

The water quality parameters were taken at the marked spot in Figure 1. A water quality checker measured temperature, pH, conductivity, and turbidity (WQC-22A, DKK TOA Corporation, Japan). The current meter observed the water current (Flowatch FL-03, JDC Instrument, Switzerland). The values of DO and BOD were taken with a BOD meter (HI98193, Hanna Instruments, Italy). The nitrate test was carried out using spectrophotometry (SNI:6989-79-2011). The orthophosphate measurement was done using the ascorbic acid spectrophotometry method (SNI:8567-2018). Finally, the TSS measurement used the gravimetry method (SNI:06-6989.3-2004).

Data Analysis

The collected data were analyzed using Microsoft Excel software, mainly with a statistical descriptive approach to describe the perception and behavior of residents in Dinoyo Ward.

RESULTS AND DISCUSSIONS

Community Perception of Domestic Wastes

To study the impact of anthropogenic activities on water quality, a field survey was conducted around the Brantas River watershed of Dinoyo Ward, where the water quality sample was also taken (Figure 1). The field survey involved 25 adult residents who live within a one-kilometer radius of the riverbed. According to the observation, the riverbed area was relatively free from residential houses. However, several coffee shops and small restaurants were on the river cut bank. The locals do not manage these small businesses.

The questions directed to the respondents are about knowledge and awareness about preserving water quality and daily activities in managing domestic wastes, including organic, non-organic, and mainly plastic wastes. The results in Figure 2 show the percentage of domestic wastes based on their type. The dominance of plastic waste (72%) represents the lifestyle of people in suburban areas, especially in culinary and food stock trading, whereby single-use plastic products such as cutleries, bottles, and plastic bags are very common.

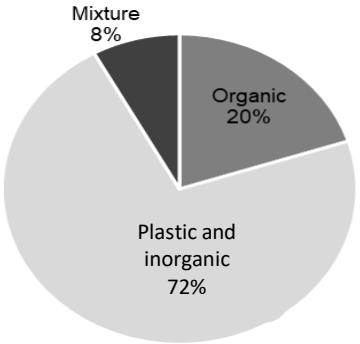

Figure 2. The type of domestic waste in the households around the Brantas River watershed. The three categories are organic waste, plastic, other inorganic waste, and mixture.

The surveyed 25 respondents were of the productive age of 18-66 years old and had various professions. However, approximately half of them are housewives or owners of small food stalls. They are the ones who actively manage household or business wastes daily.

In consideration of the activities of the respondents near the Brantas River stream, they were asked about their knowledge regarding river pollution. Figure 3 shows that most of the population (76%) stated they know about the impact of river pollution, and 12% understand the negative impact very well. In addition, the respondents conveyed that an official always takes domestic waste in that area every day. Therefore, the possibility of local people throwing their domestic waste into the river has become very small. It can be said that this system may become the basis of the respondents' claim that they know about the danger of river water pollution.

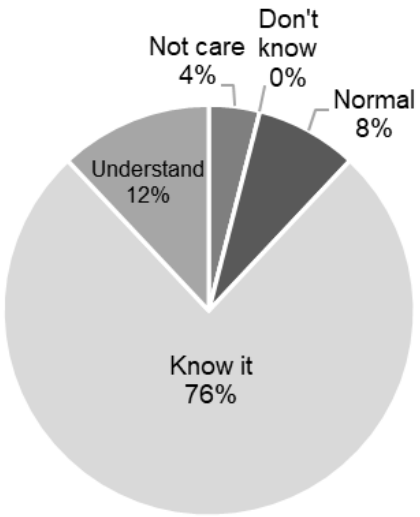

Figure 3. Respondents level of knowledge on the impact of river pollution

The data in Figure 3 was further clarified by in-depth inquiries about the respondents' behavior in managing domestic waste—the three diagrams in Figure 4 report the results. Surprisingly, although the response related to the locals' knowledge of water pollution showed a positive trend (Figure 3), the answers in Figure 4 still implied the lack of awareness about the tight relationship between domestic waste management and environmental health and sanitation.

In detail, more than three-quarters of the respondents preferred single-use plastics (Figure 4A), and a similar number stated that their household produces large quantities of waste in a day (Figure 4B). Meanwhile, Figure 4C demonstrated that only 36% of the respondents actively tried to reduce their household waste. In comparison, a more significant 44% of respondents doubted if they had successfully reduced their household waste or not. Figure 4 shows the lack of active participation in domestic waste management. However, since the respondents also mentioned an existing and regular waste pick-up service in that area, the probability of water pollution due to local littering can be minimized.

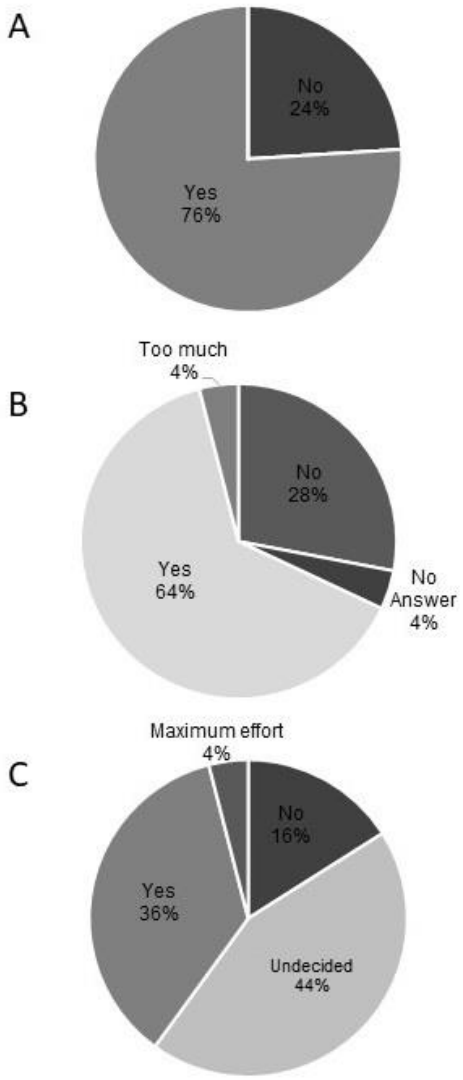

Figure 4. The local behavior regarding domestic wastes: (A) Preferring single-use plastics; (B) Producing high levels of domestic waste daily; (C) Trying to reduce the level of domestic waste.

The answers given by the respondents regarding their views about other people's behavior, especially littering, seem to be divided, as shown in Figure 5A. As many as 12% of respondents stated that they had seen someone littering the river, and 24% said they saw such occurrences frequently. However, 20% did not care whether someone littered the river. Figure 5B shows that, in total, almost half of the respondents made sure that they would warn anyone who throws their rubbish into the river. However, a similar percentage of the respondents claimed that monitoring other's behavior like that is unimportant.

The data in Figure 5 does not reflect a thorough understanding of the community's active participation in maintaining Brantas River quality. Considering Figure 4, it can be said that although the locals claimed to understand the impact of river pollution (Figure 3), they do not know that they must also contribute to preserving the river's cleanliness.

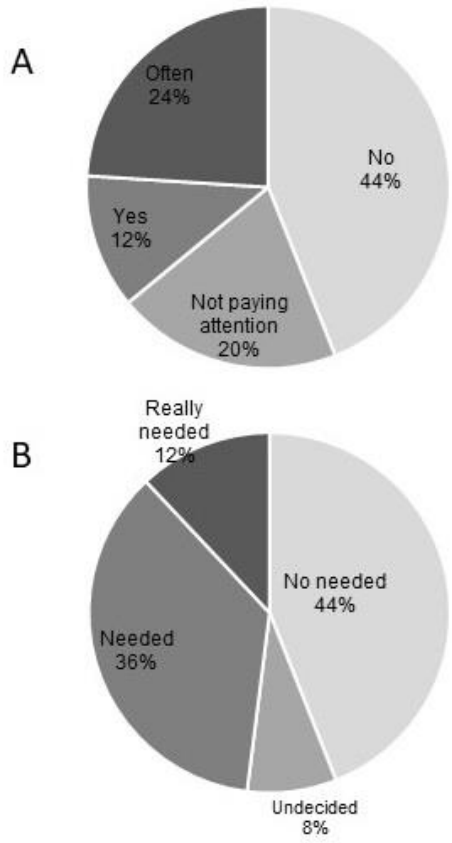

Figure 5. Respondents' perception regarding others' sanitary behavior: (A) Witnessing others littering to the Brantas River; (B) Feeling the necessity to warn the littering person.

The Water Quality of Brantas River in Dinoyo Ward

The water quality data obtained in the Brantas River watershed of Dinoyo Ward of Malang City consisted of 10 parameters, namely temperature, pH, conductivity, turbidity, Dissolved Oxygen (DO), Total Suspended Solid (TSS), water current, nitrate, orthophosphate, and Biological Oxygen Demand (BOD). The values are demonstrated in Table 1 and contrasted to river water parameters officially issued by the Government of Indonesia in 2021 as *Peraturan Pemerintah Republik Indonesia Nomor 22 Tahun 2021* [24]. Class 2 water is categorized as a water source for recreational purposes, fish breeding, animal husbandry, and farming. On the other hand, Class 3 is designated for the latter three uses.

Parameters	Average (± Stdev)	River Class 2	River Class 3
Temperature (°C)	21.80 (±0.08)	Dev 3	Dev 3
Conductivity (mS)	0.32 (±0.34)	-	-
Turbidity (NTU)	141.67 (±1.25)	-	-
TSS (mg/L)	0.03 (±0.00)	50	100
Current (m/s)	0.61 (±0.01)	-	-
pH	7.70 (±0.08)	6-9	6-9
DO (mg/L)	7.01 (±0.01)	Minimum 4	Minimum 3
Nitrate (mg/L)	0.29 (±0.01)	10	20
Orthophosphate (mg/L)	0.17 (±0.01)	0.2	0.1
BOD (mg/L)	5.20 (±0.08)	3	6

Table 1. The result of water quality in Brantas River in comparison to Class 2 and Class 3 water quality parameters limit in accordance with Government rules [24].

The average water temperature during sampling was shown to be 21.80 °C. This relatively low value was likely to be influenced by the sampling time at 07.00 AM, Western Indonesia Time. The local temperature at that time was reported to be 19-20°C, which explained the water temperature of the Brantas River. Meanwhile, conductivity measurement displayed an average number of 0.32 mS. This low conductivity was caused by the small number of charged mineral ions in Brantas River itself [25].

The turbidity meter gave a measurement average value of 141.57 NTU. This high turbidity could be observed by the eye at the time of sampling. More specifically, this is caused by organic and inorganic particles dissolved in the sampling spot [26]. Meanwhile, the TSS was predicted to be 0.03 mg/L on average. This value is inversely proportional to the average turbidity number. It is then suspected that the condition is

caused by a low number of insoluble materials, including bulk metal concentrations [27, 28]. The observed current showed an average result of 0.61 m/s. This signifies that at 07.00 AM that day, with constant wind and sunny weather, the flow of the Brantas River in Dinoyo Ward was not very strong. Subsequently, the average pH of the water was 7.70. This pH value is still within the pH range determined by the Indonesian government. This may indicate that the Brantas water is preserved from acidification, a sign of pathogen contamination [29]. This is likely due to the sampling time, when the frequency of anthropological activities of the people from the surrounding households, which can affect the river biologically and chemically, was still sparse [30].

On average, a high DO value of 7.01 mg/L was obtained at the sampling spot. The stony riverbed at the sampling location caused the elevated oxygen diffusion rate due to the frequent splash of river water, a principle akin to aeration in aquaculture [12]. Then, a BOD average of 5.20 mg/L was obtained. This BOD value commonly reflects microorganism activities [31, 32]. Finally, the river water possessed a nitrate concentration of 0.29 mg/L and an orthophosphate content of 0.17 mg/L.

In short, from Table 1, two parameters that are close to and exceed the limits are the BOD and orthophosphate values. Our reported BOD value is close to the limit for Class 3 water and exceeds the permitted limit for Class 2 water [24]. This indicates that local river water is unsuitable for recreational purposes, and residents may have to be cautious when using the water for fish breeding.

Previous studies in different sites of the Brantas River stream, both up and downstream, indicated domestic wastewater pollution by measurement of BOD [21, 33], particularly due to organic leftovers from kitchen, lavatory, and the uses of detergents or soaps [33]. However, the BOD of this study is considerably less than the 12-13 mg/L range reported in neighboring areas in Dinoyo Ward [21]. Similarly, the reported orthophosphate value here was not as high as the discovered 3.275 mg/L in Benoa Bay of Bali [34]. These facts may be due to our study's relatively controlled waste management and location, which is some distance away from agricultural and industrial areas as the main contributing factor for phosphate and nitrate pollution [34].

CONCLUSION

Most respondents who lived near Brantas River in Dinoyo Ward knew about the impact of water pollution, although more than three-quarters preferred single-use plastics. A similar number of respondents admitted that they produced much domestic waste daily. Fortunately, the local daily waste pick-up system seems to prevent littering to rivers, which is likely to happen when the domestic waste volume is large or unmanageable. This regular pick-up service and its contribution to waste management may also explain why almost half of the respondents did not see anyone littering. Thus, it represents one of the best domestic waste management strategies. In addition to the apparent awareness and controlled waste management, the residents' anthropological activity may determine the river pollution level. No wonder there was only a small sign of water pollution in that area, as shown by the quality parameters. Nevertheless, further measurements should be taken at different times to ensure the consistency of the Brantas River water quality in that area.

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