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Regional Case Study

The Dynamics Impact of Urban Area on the River Health in Surakarta City

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Abstract

Surakarta City is traversed by the Bengawan Solo River Sub-Basin which includes Kali Pepe River, Gajah Putih River, Kali Anyar River, Jenes River, and Premulung River. This condition results in the main burden of river water pollution coming from anthropogenic activities, both domestic and industrial. This study aims to examine the influence of urban area dynamics on river health with a case study of Surakarta City. This study used qualitative descriptive method. Data collection was carried out through observation techniques, and depth interviews. The results showed that there are three factors that affect river health, namely population increase, industrial and domestic activities, and public perception and participation. Surakarta City is one of the areas that contributes to river pollution from moderate to severe levels. However, there have been many efforts to evaluate river health by the local government, namely by normalizing riverbanks, controlling waste pollution, and other river management programs.

Keywords: Urbanization; river health; evaluation

1. Introduction

Urbanization is an inevitable process in socioeconomic development (Wu et al., 2021). The attractiveness of urban areas is getting bigger because of the easy access to better education, health services, public transportation, and other aspects of life. However, urbanization also causes several economic and environmental problems, such as traffic congestion, noise pollution, and biodiversity decline (Zuriyani, 2017). Urbanization increases the mobility and intensity of human activity. This affects the structure and function of ecosystems on an unprecedented time span and scale.

Many ecosystems are negatively impacted by urbanization from construction land activities, extensive industrialization, deforestation for agriculture, settlements and other human activities (Putra et al., 2024). These major pressures can lead to ecosystem degradation and a decline in ecosystem health. A disturbed ecosystem will affect its ability to provide various resources for living things. In other words, the health of ecosystem health will decrease (Ritiau, 2021). Therefore, more attention should be paid to the health of ecosystems to support the sustainability of cities.

Rapport (1995) explains the concept of ecosystem health in detail and defines ecosystem health as its ability to maintain organizational structure and ability to recover after interference with self-

regulatory processes. Healthy ecosystems have complex structures, resistance to external disturbances, and provide sustainable resources for humans. The structural and functional unity of an ecosystem is a basic prerequisite for achieving sustainable development (Latuconsina, 2019).

The health of river ecosystems in urban areas is strongly influenced by anthropogenic activities (Kospa & Rahmadi, 2019). Surakarta City is one of the cities that has undergone many changes both from its physical and social conditions. This causes the river ecosystem to be vulnerable to pollution. Surakarta City is traversed by the Bengawan Solo River Sub-Basin which includes Kali Pepe River, Gajah Putih River, Kali Anyar River, Jenes River, and Premulung River. This condition results in the main burden of river water pollution coming from anthropogenic activities, both domestic and industrial. The decline in environmental quality, in this case, water quality is the impact of waste from activities that are discharged into river bodies without prior treatment in an uncontrolled time span and concentration. Supratiwi (2014) states that around 60-70% of river pollution sources come from domestic waste, where only 6.1% of waste can be treated. The entry of polluting burdens is an obstacle to the conservation of river water resources (Karami & Titah, 2024). Conservation of water resources, one of which is rivers, is important, especially in urban areas as stated in Law No. 17 of 2019. Therefore, it is necessary to study the health of river ecosystems in urban areas. The dynamics of urban areas cannot be avoided but must be accompanied by sustainable environmental management, especially in river watersheds. This study aims to examine the influence of urban area dynamics on river health with a case study of Surakarta City.

2. Method

2.1. Time and Place of Study

Surakarta City is an autonomous region with city status in Central Java Province. Astronomically, Surakarta City is located between 110º45'15" - 110º45'35" E and 7º36'00" - 7º56'00" LS with an area of 46.72 km². Administratively, the northern and western areas of Surakarta City are bordered by Karanganyar Regency and Boyolali Regency, the southern part is bordered by Sukoharjo Regency, and the eastern part is bordered by Karanganyar Regency. Surakarta City has 5 sub-districts, 51 kelurahan, 626 hamlets with a total of 2,789 neighbourhoods in 2021. The research was conducted in the Bengawan Solo watershed that passes through Surakarta City, namely Kali Pepe River, Gajah Putih River, Kali Anyar River, Jenes River, and Premulung River in March-April 2024. The focus of this research is to find out how the dynamics of land and social conditions at the research site.

2.2. Data Collection

The data used in this study is in the form of primary data and secondary data. Primary data collection was carried out by observation, depth interview, and documentation methods, while secondary data was sourced from literature review. Field observations are carried out to observe the perception and behavior of local people and determine the condition of flows and riverbanks. Interviews were conducted with 10 local key figures, in this case sub district (*kelurahan*) officials and village heads, who were selected using purposive sampling. Purposive sampling methods are used to effectively select respondents who have appropriate and useful information on limited research resources (Campbell et al., 2020). Data collection was semi-structured interviews covering variables related to the research, including knowledge (river conditions, community conditions, wastewater management, residents' sanitation systems), attitudes (reflecting habits in maintaining river health such as water conservation programs, ownership of trash bins, healthy latrine management). In addition, literature studies with relevant topics are also carried out to support and complement the research results.

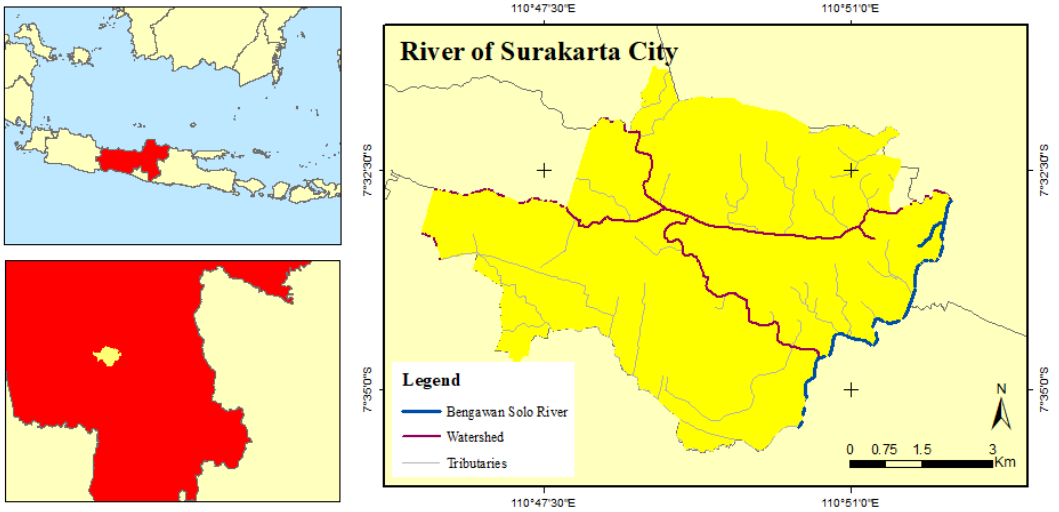
3. Result and Discussion

3.1. General Characteristics of Rivers in Surakarta City

The rivers that divide Surakarta City, namely Kali Pepe River, Gajah Putih River, Kali Anyar River, Jenes River, and Premulung River can illustrate how the dynamics of urban areas affect river health (Table

1). The five tributaries have a major influence on the water quality of the Bengawan Solo River because it empties into the river. The condition of the river in Surakarta City is influenced by two seasons, namely the dry season (May to October) and the rainy season (November to April), with an average humidity of 80%, an average monthly temperature of 26.7°C. The minimum temperature of 26.1°C occurs in July, while the maximum temperature of 27.2°C occurs in October, the average monthly sunshine duration is 6.3 hours. The monthly average humidity in the Bengawan Solo watershed is around 80%, where the minimum monthly average humidity occurs in September at 77.4% and the maximum monthly average humidity occurs in January and February at 82.3%. The Bengawan Solo watershed is a potential water source for efforts to manage and develop water resources (SDA), to meet various needs and requirements, including for domestic needs, raw water for drinking water and industry, irrigation and others.

The Pepe River is divided into upstream and downstream. The upstream part has a length of ±2.7 km while the Lower Pepe River has a length of ±5.76 km. The dynamics of urban areas that affect the health of this river are sources of pollution dominated by household waste. Kali Anyar River has its headwaters in Tirtonadi to Tempuran which stretches for ±6.3 km. This riverbank, used to be a slum but has normalized the area so that the burden of pollutants coming from settlements is reduced even though there are other sources of pollution, namely organic waste from household industries. The Premulung River has a length of ±2.55 km with a width of 25 - 36 m and a depth of 10 - 15 m. Gajah Putih River only has a width of ±8 meters with a length of ±2.85 km which flows in the northern part of Surakarta City. Jenes River is a river with a length of ±28 km which originates in Boyolali Regency and flows to Pasar Kliwon District. Most of these rivers can no longer be used to support daily activities because their conditions are moderately to severely polluted.



Graphic 1. Map of river in Surakarta City

Table 1. Rivers in Surakarta City

Subdistrict	Name of River	Urban Village
Banjarsari	Anyar	Gilingan
	Pepe	Gilingan, Punggawan, Manahan, Mangkubumen, Ketelan, Kestalan, Stabelan
	Gajah Putih	Sumber
		Sumber
Serengan	Premulung	Tipes

Subdistrict	Name of River	Urban Village
	Jenes	Serengan, Danukusuman
Jebres	Pepe	Kepatihan Wetan, Kepatihan Kulon, Sudiroprajan, Gandekan, Kampung Sewu
Laweyan	Jenes	Bumi, Panularan, Sondakan, Laweyan
	Premulung	Pajang
Pasar Kliwon	Jenes	Sangkrah, Kedung Lumbu, Semanggi, Joyosuran, Pasar Kliwon
	Pepe	Kampong Sewu, Kedung Lumbu

3.2. Factors Affecting River Health

The dynamics of urban areas are considered to affect river health. There are three factors that affect river water quality, namely population distribution, climatic conditions, and industrial business. The Central Java Environment Agency, said that the factor that most disturbs river health is the presence of small, medium and large industries that dispose of their waste in river flows within a period of time and concentration that is difficult to identify. The waste is not managed properly according to the Standard Operating Procedures (SOP) set so that many have not met water quality standards. Surakarta City is one of the areas that contributes moderate to severe pollution in Central Java Province (Handayani & Syafrudin, 2021).

Surakarta City is located at the intersection point between Central Java, East Java, and the Special Region of Yogyakarta. This city has a very strategic location that provides its own benefits and attractions for business actors to develop their businesses (Paningrum, 2021). The existence of the Bengawan Solo River as the longest river on the island of Java whose flow passes through Surakarta City is a challenge in environmental management. Surakarta City is a densely populated and labor-intensive area with various industrial and domestic activities. No wonder the rivers in this city are polluted due to the high waste load received (Table 2.). Surakarta City has 12 rivers that divide the central area of the city to the suburbs, five of which will be studied in this study. Each river certainly has different characteristics and pollution behavior.

Table 2. River class status in Surakarta City

River	Status
Jenes	Class IV
Premulung	Class IV
Gajah Putih	Class IV
Kali Anyar	Class III & IV
Kali Pepe	Class III & IV

Source: (DLH Surakarta, 2018 in Tamami, 2020)

Based on Government Regulation No. 22 of 2021 concerning Environmental Protection and Management, divides water classes as follows:

Class I : Water whose designation can be used for drinking water raw water, and/or other designations that require the same water quality as these uses;

Class II : Water whose designation can be used for water recreation infrastructure / facilities, freshwater fish farming, animal husbandry, water for irrigating crops, and / or other designations that require the same water quality as these uses;

Class III : Water whose designation can be used for freshwater fish farming, animal husbandry, water for irrigating crops, and/or other designations that require the same water quality

as these uses;

Class IV : Water whose designation can be used to irrigate crops and/or other designations that require the same water quality as these uses.

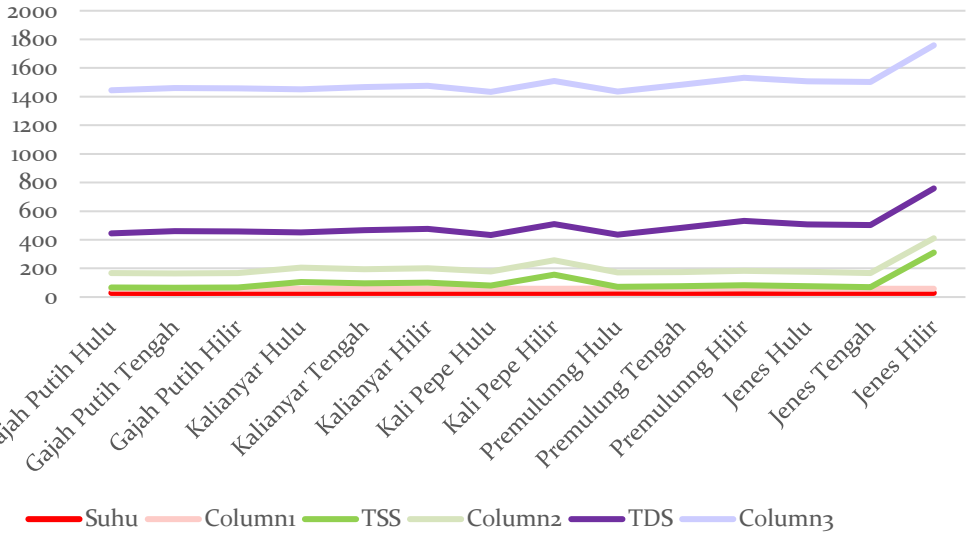


Figure 2. Physical parameters of water quality in 2023

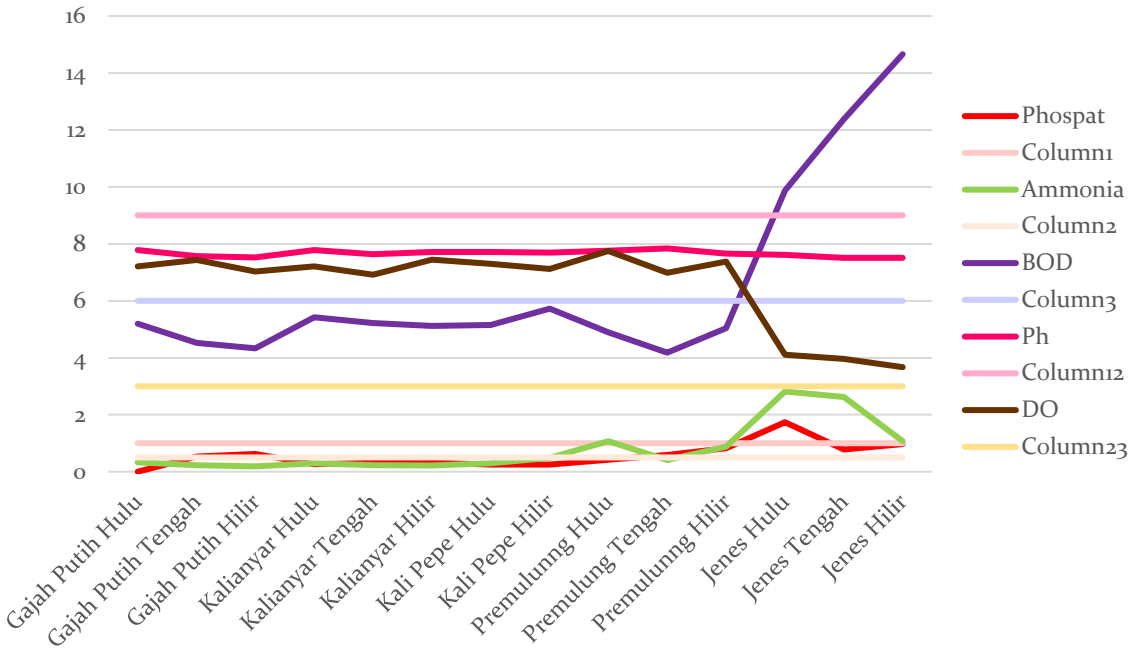


Figure 3. Chemical Parameters of Water Quality in 2023

Table 3. Recapitulation of river water quality in 2023

River	Parameter							
	Temp.	**pH**	**DO**	**BOD**	**TSS**	**TDS**	**Phosphate**	**Ammonia**
	°C		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Gajah Putih Hulu	28.6	7.78	7.21	5.2	9	278	0.4808	0.3253
Gajah Putih Tengah	28.1	7.57	7.43	4.52	7	296	0.5328	0.2336
Gajah Putih Hilir	28.8	7.52	7.03	4.33	8.5	290	0.6261	0.1873
Kalianyar Hulu	29	7.78	7.21	5.42	46	246	0.2621	0.2922
Kalianyar Tengah	28.3	7.64	6.92	5.22	37	272	0.3146	0.2263

Kalianyar Hilir	28.7	7.72	7.44	5.12	42	276	0.3200	0.213
Kali Pepe Hulu	28.3	7.71	7.3	5.15	21	254	0.2525	0.2965
Kali Pepe Hilir	28.4	7.69	7.12	5.72	99	252	0.2523	0.4895
Premulunng Hulu	29.3	7.76	7.75	4.89	12	264	0.4233	1.068
Premulung Tengah	29	7.84	6.99	4.18	16	308	0.5926	0.4135
Premulunng Hilir	29.1	7.66	7.38	5.04	24	348	0.8285	0.881
Jenes Hulu	28.7	7.61	4.11	9.87	17	332	1.738	2.816
Jenes Tengah	28.5	7.51	3.96	12.38	10	334	0.7786	2.622
Jenes Hilir	28.8	7.51	3.67	14.66	252	348	0.9718	1.068
Quality standards III	Dev 3	6-9	3	6	100	1.000	1	0.5

Source: (DLH Surakarta data, 2023 and PP No. 22 of 2021)

The determination of river class is quite important because it is a reference to the status of water quality which will be monitored periodically every year (Ramadhawati et al., 2021). Most of the rivers in Surakarta are rivers across the administration of city districts so that the class assignment is a provincial class. The condition of river pollution in Surakarta is already very concerning because it is in the class IV category were class IV functions only for agriculture and industry not for consumption. River pollution causes an unpleasant odor that disturbs the comfort of local residents. High concentrations of pollutants in rivers also threaten the life of aquatic biota. Overall, river pollution has a detrimental impact on all living (Uddin & Jeong, 2021).

River water quality in Surakarta City is seen from the physical and chemical parameters of water that will indicate river health problems (Table 3.). The determination of river quality is carried out based on water quality standards in PP No. 22 of 2021 concerning the Implementation of Environmental Protection and Management. The parameters of BOD, Phosphate, and Ammonia in all rivers have concentrations above the established quality standards (Figure 2. and Figure 3.). These three parameters have a high value due to domestic waste or domestic waste discharged into rivers. The concentration of BOD in river flow can be affected by the decomposition process of organic matter, tempeh tofu factory waste, and animal husbandry. The cause of high phosphate and ammonia content in river flows is the input of compounds from various sources, such as the use of fertilizers in rice fields and the disposal of organic materials for household activities around the river (Bashar & Fung, 2020). High phosphate content in waters can trigger eutrophication, thereby reducing the amount of dissolved oxygen (DO) in waters. While in other parameters, namely temperature, pH, DO, TSS, TDS, most of them still qualify for class III and class IV water quality standards. Thus, it can be said that the quality of river water in Surakarta City is polluted a lot due to organic waste originating from domestic and industrial activities.

According to the results of the interview, the dynamics of urban areas that are factors causing the decline in river health in Surakarta City are the existence of settlements on the riverbank area, the number of cottage industries or large industries that dispose of waste into the river flow, and the behavior of people who are less concerned about environmental health. Settlements on the banks of the river are mostly illegal settlements. This happens because of the high number of people who migrate to urban areas (Prayojana et al., 2020). The existence of socioeconomic inequality is directly related to the very high cost of land, while geographical factors are more urgent because the availability of positions used as settlements is very small (Christiawan, 2017). According to data from the Directorate General of Population and Civil Registration (Dukcapil) of the Ministry of Home Affairs, Solo City's population density reached 12,391 people per square kilometer at the end of 2021. As a result, many residents set up houses on riverbanks with conditions that do not meet standards of healthy homes regulated in the Minister of Health Regulation No. 2/2023, such as poor sanitation systems and too close to the river. Slums located on the banks of the Surakarta City River are scattered in several locations, such as slums on the banks of the Premulung River located in Sondakan Village and Pajang Village, river banks in Pucang Sawit Village, Kali Pepe River banks in Gendekan Village

and Jebres Village, and also slums on the banks of the Kalianyar River (Mahayati et al., 2024; Arista, 2023; Ramadhani and Fajriyanto, 2021; Sasongko et al, 2022)

Surakarta City as a dense urban area with industrial activities, it puts its own pressure on environmental health due to the discharge of waste into river flows. Industrial waste, has become one of the most significant sources of river pollution (Gaur et al., 2020). Waste that has not been treated properly contains various types of pollutants that can damage river ecosystems and are even harmful to humans and animals. Organic waste, domestic waste, and agricultural waste contain compounds such as phosphate, nitrogen, and ammonia that can cause eutrophication of waters.t Meanwhile, inorganic waste such as heavy metals, pesticides, dyes, and other chemicals can be harmful to human and animal health if consumed. Therefore, there needs to be more serious efforts in processing industrial waste before it is discharged into the river to reduce the impact of river pollution.

Tributary pollution has a major effect on the water quality of the Bengawan Solo River. Water channel systems originating from industry or households will flow either through WWTP (Wastewater Treatment Plant) or not to the Bengawan Solo River. Surakarta city is one of the famous batik cloth centers in Indonesia (Krisna and Kristiyani, 2023). An important part of batik production is the coloring process which can use dyes from natural and synthetic materials such as Remazol, indigosol, and naphthol (Subagyo, 2021). This causes the generation of liquid waste containing various river pollution parameters such as organic matter, suspended solids, high oil or fat and harmful heavy metal content, namely Zn, Cd, Cu, Cr and Pb (Apriyani, 2018). (Hanum et al. 2022). The batik industry pollutes many rivers due to limited costs or access to communal WWTPs so that most of the waste produced is not treated but directly discharged into water bodies (Hanum et al. 2022). According to a survey by the Surakarta City Environmental Agency, it is stated that 8 out of 10 textile industries in Kliwon Market do not have WWTP (Tamimi, 2020). Meanwhile, some industrial waste in Sondakan Village and Laweyan Village is managed by communal WWTP. However, the condition of communal WWTP needs to be considered to optimize waste management in and out of WWTP.

Sources of river pollutants also include liquid waste from households. Household liquid waste in Surakarta City reaches 98%. (BPS Surakarta, 2019). Waste pollution by households is not only in the form of gray water but also black water. Black water is waste that comes from toilets and contains potentially pathogenic organic materials, including feces and urine. Meanwhile, gray water is waste that comes from non-toilet sources, such as used water for laundry, bathing, and washing dishes (Putri et al., 2018). Sewage pollution can occur due to inadequate sanitation or IPAL systems. Although the community's privately owned latrines are in good condition, not all of the community-owned latrines are healthy latrines because they are not equipped with feces handling (blackwater). According to research by Qomariah et al., (2018), it is stated that the Communal WWTP has not been effective in reaching the majority of the population, because its ability only serves 17% to 26% of black water waste from the service area. This shows that not all residents have access to manage their waste with WWTP.

The behavior of people who are less concerned about the environment has become one of the main causes of the decline in river health. There are still many people who deliberately throw their waste into the river (Wijayanti et al., 2021). This causes the river to be full of garbage so that the flow of water is hampered and even flooded. According to research (Ayuningtias, 2019) river pollution is caused by low public awareness and the absence of applicable law enforcement. The Surakarta city government has made many socialization and education efforts to the community such as waste sorting socialization, waste recycling socialization, and river cleanup activities (Dewi, 2022; Ristanto, 2022; Aulia and Triwahyudi, 2020).

4. River Health Evaluation

4.1. Normalization of Riverbanks

Normalization of river banks in Surakarta City is mostly carried out to deal with slums and

domestic waste pollution in the watershed. There are two patterns of handling that are intervened, namely relocation and restoration. Through relocation, residents living on riverbanks are moved to safer and more livable locations, which are usually equipped with basic infrastructure, such as access to clean water and proper sanitation systems (Oktavia & Warlina, 2017). Meanwhile, the restoration of riverbank areas involves rehabilitating and revitalizing the area by improving environmental conditions, such as replanting vegetation, normalizing rivers, and building green infrastructure. This effort not only aims to improve environmental quality and reduce disaster risk, but also to improve the social and economic welfare of affected communities (Resa et al., 2017). With proper and sustainable relocation and restoration, it is hoped that safer, cleaner, and more sustainable riverbank areas can be created, so as to provide long-term benefits for local residents and the surrounding environment (Setiawati, 2022).

The arrangement of settlements on the river border was carried out on the banks of the Bengawan Solo watershed, precisely in Pucang Sawit Village. In the years (2002, 2004, 2008 and 2011), the number of slums in Pucang Sawit Village initially increased but decreased as the government program progressed. From Ramadhani & Fajriyanto (2021) research, it can be seen that in 2000 and 2004 slums were increasing. This shows an increase in the number of migrants heading to Pucang Sawit village from year to year. However, in 2008 the number decreased due to relocation or eviction by the City Government. But there are still some buildings that survive around the riverbank. Then in 2011 evictions continued until almost 75% of the initial area of slums was reduced.

Slum management is also carried out on the Kalianyar River which crosses the Tirtonadi area. Handling efforts have been carried out since 2016 through relocation and restoration activities (Mahayati et al., 2024). However, until now the handling of slums on the banks of Kali Anyar has not been optimal as shown by the uneven handling of slums between villages. The difference between the area is organized and not yet can be seen from the condition of the buildings on the banks of the river. This is influenced by the readiness factor in handling slums which is a challenge to realize the achievement of the 0% slum-free target. Funding is also one aspect that needs to be prepared in handling slum areas. In addition, the community as an object of development participates in providing support and aspirations to support the alleviation of slums.

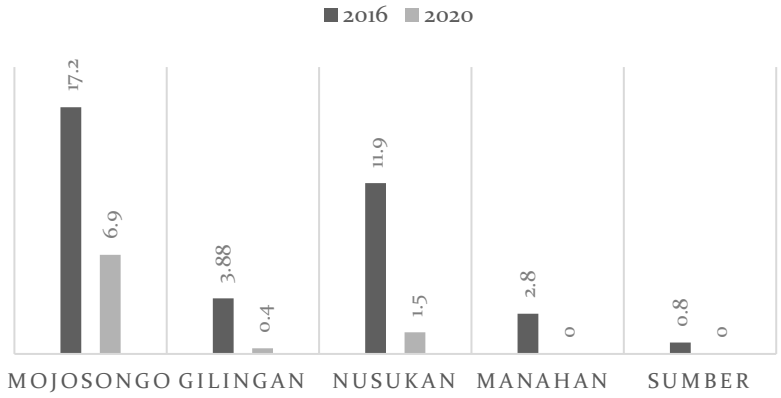


Figure 1. Area of slums on the banks of the Kali Anyar River in 2016 & 2020 (Ha)

In **Figure 1.** Shows a reduction in the area of slums in each village on the banks of the Kalianyar River. Of the five villages that are included in the slum area on the banks of Kali Anyar, three villages are categorized as slums. Meanwhile, Sumber and Manahan villages are no longer categorized as slums according to the update of the location of slums in Surakarta Mayor Decree No. 640/60.9 of 2020.

Reducing slums, especially in riverine areas, can have a significant impact on river pollution. By reducing slums, the risk of direct sewage discharge into rivers can be minimized, resulting in improved river water quality (Nurokhman and Kurniawan, 2019). Slum reduction also allows the government to more easily implement effective sanitation infrastructure and organized waste management systems. This not only reduces the pollution burden on the river but also improves the health and quality of life of the

surrounding communities.

4.2. Waste Pollution Control

Waste in urban areas originating from land is often carried by runoff water to water bodies (Rahmawati & Syamsu, 2021). In addition, waste is often illegally dumped directly into water bodies or left to accumulate on riverbanks. Sometimes, waste also comes from community activities along the riverbanks such as trading, farming, raising livestock, or others. Apart from these sources, the presence of waste in the river causes a decline in river health.

There are several programs in Surakarta City that aim to minimize river pollution by garbage both from the government and community participation.

1. Socialization of public awareness
   Handling waste problems must start from the source, one of which is household waste. Socialization of public awareness about the importance of a clean river can be held by gathering residents at certain events to protect the surrounding environment, especially rivers, such as regular meetings of men, PKK women, youth Karang Taruna, and others. The activity method is carried out by counseling and waste management practices (Sekarningrum et al., 2020). Education that can be conveyed in socialization activities, such as the importance of the role of clean rivers, the benefits of rivers, the impacts received by the community if the river is polluted, and the actions or behaviors that should be owned by the community to maintain river cleanliness (Nurwanti et al., 2024). This activity is important to increase public awareness in managing waste.
2. Procurement of trash cans at certain locations
   One of the causes of river pollution by garbage is the lack of availability of trash bins in residential areas, especially on the roadside or riverbanks. In the research of Wijayanti et al (2021), it was mentioned that tourists visiting Kampung Batik Laweyan often throw their garbage into the Jenes River due to the lack of trash bins. Therefore, the provision of trash bins in the tourist village area, especially those located close to the river, is very important to reduce and manage waste so as to minimize environmental pollution (Istanto et al, 2021). Waste that pollutes the river includes organic waste (wood, leaves, twigs, fruit peels) and inorganic waste (plastic, bottles). Therefore, ideally it is necessary to classify organic and non-organic waste bins. In line with Munandar et al (2024), improving facilities by providing trash bins according to their type, both organic and inorganic, is done to increase public awareness about the dangers of waste for the environment.
3. Installation of garbage nets on rivers
   According to the National Waste Management Information System of the Ministry of Environment and Forestry in 2023, the amount of national waste generation reached 38 million tons. Of the total national waste production, 65.71% (13.9 million tons) can be managed, while the remaining 34.29% (7.2 million tons) has not been managed properly. Meanwhile, waste generation specifically in Surakarta City reaches 152,975 tons/year. The high amount of waste generation requires comprehensive waste management, one of which is in the river area. The installation of nets in river bodies is expected to capture waste that is washed away by river currents (Wulandari, 2021). The choice of net type is quite important to optimize its function that can hold waste. This program requires the active participation of the community to work together to lift the netted waste in the river through community service activities at a certain time.

4.3. River Management

Good river management is needed for the realization of regional development plans and environmental sustainability. River management is complex and multisectoral. It requires the

cooperation of various parties, in this case the government, private sector, and community or can be interpreted as collaborative governance. Community involvement is important in improving the quality of clean water sources in Surakarta City. In the research of Mumpuni et al (2020), there are several river management programs to maintain river health that have been implemented in Pepe River, Anyar River, and Premulung River, namely 1) the first Clean River Program (PROKASIH); 2) Clean production, waste management, and pollution control; 3) Construction of Tirtonadi Rubber Dam.

Program Kali Bersih (PROKASIH) aims to control river pollution. This program is supported by the establishment of Pokja Sungai (Working Group) which serves as a medium for education and communication to the community to encourage community participation in river protection and conservation. In reality, local community participation is still minimal. Many initiatives to clean the river come from outsiders such as students and environmental activists. So, it is necessary to make efforts to attract the interest of the community to be involved in the implementation of this program.

Clean production, waste management, and pollution control program. This program is intended for small and medium enterprises (SMEs), especially batik entrepreneurs in Surakarta City. This was done considering the high rate of river pollution due to batik waste in the Premulung River. This program was implemented in 2017 and needs real follow-up in order to have a significant and sustainable impact on river health. The construction of the Tirtonadi rubber weir was carried out by the Bengawan Solo River Basin Center (BBWS) starting in 2014. The construction of this weir aims to support the implementation of the water tourism development plan in the Lower Pepe River by maintaining the volume of water in the Lower Pepe River to minimize the potential for flooding in urban areas. In addition, the rubber weir also provides public space facilities for the community without reducing the function of the river itself. Tirtonadi rubber weir provides public education on the importance of water and sustainable management of water sources.

5. Conclusions

Dynamics of urban areas on river health in Surakarta City. There are three factors that affect river health, namely population increase, industrial and domestic activities, and public perception and participation. This contributes greatly to the pollution of rivers. Surakarta City is one of the areas that contributes moderate to severe pollution in Central Java Province. However, there have been many efforts to evaluate river health carried out by the government, private sector, and community, namely by normalizing river banks, controlling waste pollution, and other river management programs. Based on the research results, there are several suggestions that can be given for further research such as increasing the number of respondents as a research sample so that the results are more representative, adding time variables to the research to be able to know past, present and future conditions.

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