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Evaluation of domestic wastewater and river management in Belian Village, Batam City Sub-district, Indonesia

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Abstract. Domestic wastewater management is one indicator of sustainable development achievement. Belian Village in Batam City, Indonesia, needs to be evaluated because it has the potential to disrupt environmental conditions. The purpose of this research is to determine the current conditions and make recommendations for domestic wastewater management solutions in Belian Village, Batam City. This study was carried out through direct observation, documentation of activities, and literature searches. From 2014 to 2020, increased access to drinking water and sanitation in Batam City was measured. Despite the increase, it is still observed in Belian Village that wastewater is discharged directly into river bodies. The river's quality will deteriorate as a result of this. To mitigate the negative effects of these activities, communal processing solutions can be implemented. By considering operation and maintenance, an up-flow filter tank can be used for wastewater treatment.

Keywords: Batam City; Domestic Wastewater; River; Up-Flow Filter

1. Introduction

Direct wastewater disposal without prior treatment will affect the community's quality of natural water sources [1,2]. Duriangkang Dam, the largest raw water source in Batam City, is

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polluted by coliform bacteria [3]. Duriangkang Dam is included in the threshold that does not meet water quality standards as a source of drinking water which requires E. coli values below 100 MPN/100 ml [3]. Coliform bacteria (E. coli) are microorganisms used as indicators to test for water contamination by feces [4]. Escherichia coli will become pathogenic if it moves from its usual habitat to other host parts. For example, if E. coli in the intestine enters the genital bladder can cause cystitis, which is an inflammation of the mucous membrane of the organ. The unique nature of E. coli is a parasite in the digestive tract of humans and warm-blooded animals. In humans, it sometimes causes enteritis, peritonitis, cystitis, and so on [5].

The existing condition of domestic wastewater management in the study area does not follow Batam City's domestic wastewater management [6,7]. The domestic wastewater management policy in Batam City uses a local treatment system (on-site sanitation system), which uses a septic tank in each house and is equipped with an infiltration field. The high price of land and the type of land in Batam City, which is difficult to absorb water, makes developers provide very limited house lots. This is one of the reasons why septic tanks in Batam City are not equipped with infiltration [3]. The absence of a catchment area causes domestic wastewater from the septic tank to be directly discharged into the drainage channel [8]. It pollutes the receiving water body, such as the condition of water bodies in the study area. As a result, the state of the receiving water body looks cloudy and black. This has become a significant problem in the study area and other big cities with high population density. Therefore, to prevent pollution, it is necessary to manage domestic wastewater. This study aims to evaluate the existing condition of domestic wastewater management in Belian Village, Batam City sub-district.

2. Methods

The location is intended to dig up information about problems in the community. In addition, a literature review is intended to obtain an overview of science and technology that is appropriate to be given to the community regarding solutions to existing problems. Belian is the name of a village located in the Batam City sub-district, Batam City, Riau Islands, Indonesia (see Figure 1). The area of this village is 14.60 km², with a population in 2020 of 71,484 people and a density of 4,896 people/km² [9].

The type of research in this thesis is field research with a qualitative descriptive method, namely analysis intended to describe a problem. The data collection method is a very urgent part of the research itself. This study's data collection procedures were questionnaires, observations, interviews, and documentation. The data collected must have specific characteristics/conditions to not deviate from the existing problem.

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Figure 1. Study location [10].

3. Result and discussion

Floods often occur in several densely populated residential areas, one of which is in the Batam City sub-district, Batam city. This can happen because of the high intensity of rain; the area is also a densely populated area and the existing drainage system on Jalan Raja Isa is still inadequate [11]. This flood usually always occurs every year, but this problem still cannot be solved. One of the efforts to overcome this flood disaster is the existence of a good drainage system, supported by the related planning aspects in it. The drainage system is a series of water structures that are used to reduce or remove excess water from a land so that the area can be used optimally [11]. Batam City development priorities and targets in 2018 in the context of implementing mandatory and optional affairs which are the authority of the Batam City Government number one are improving road infrastructure facilities and infrastructure, drainage, urban utilities, city cleanliness and flood control [12].

The rapid development of housing and shopping areas in Batam District has reduced the rainwater catchment area and caused puddles. In addition, the existing drainage channels have reduced effectiveness due to the disposal of garbage in the drainage channels, drainage channels also lack maintenance [13]. For example, the growth of weeds and the amount of garbage in the drainage canals hinders the flow of water when it rains. As a result, every rainy season, water from the drainage channel overflows, flooding the roads around the drainage canal.

Due to human activities, water pollution changes conditions in a water reservoir such as lakes, rivers, oceans, and groundwater [14]. Lakes, rivers, oceans, and groundwater are an essential part of the human life cycle and are part of the hydrological cycle. In addition to also drain the water drain sediment and pollutants. Its various functions are beneficial for human life. The most significant use of lakes, rivers, oceans, and groundwater is for agricultural irrigation, raw material for drinking water, as a drainage channel for rainwater and wastewater, and has the potential as a tourist attraction [15].

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Based on statistical data from Belian Village, Batam City (Table 1), access to drinking water and sanitation has increased from 2014 to 2020. Access to safe drinking water and sanitation is essential in determining life expectancy in countries [16]. The results of development in drinking water and sanitation will influence the welfare of the population, especially from the health aspect [17]. The development of the water and sanitation sector affects health status because water and sanitation infrastructure are part of the factor in building life expectancy. Increasing access to proper water and sanitation at the individual, household, and community levels will reduce community-based diseases and contribute to increasing life expectancy. On the other hand, pollution of drinking water by wastewater and human waste (feces), which contains organisms that can cause disease, viruses, pathogenic bacteria, and so on, can spread quickly throughout the drinking water service network system and cause epidemics or epidemics outbreaks [18].

Table 1. Existing condition of access to drinking water and access to sanitation in Batam City Sub-district, Batam City [19,20].

Indicator (%)	2014[1]	2015[1]	2019[2]	2020[2]
Floor area < 20 m^2	13.01	7.1	7.9	9.2
Floor area per capita < 7.2 m^2	14.3	6.04	6.1	7.4
Access to proper drinking water (%)	92.93	94.13	94.42	97.62
Access to proper sanitation (%)	83.4	85.76	98.13	95.99

The source of water pollution is primarily determined by the type of activity and the use of water resources by humans around the water. Water quality has decreased due to the entry of various wastes, both liquid, and solid waste, into the water flow. The level of river pollution can affect the capacity of the river. The higher the level of river pollution, it can reduce the river's capacity and even exceed the ability of the river. The natural ability of river water against pollution must be maintained to minimize the decline in river water quality [21]. Figure 2 shows the condition of wastewater disposal at one of the study sites in Belian Village, Batam City.

Figure 2. Existing condition of river management in the study area.

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There are many activities around the river, one of which is domestic activities that can cause pollution and affect and reduce water quality. The increase in the discharge of domestic wastewater produced can cause an increase in the burden of domestic wastewater pollution so that it can reduce the quality of water in the river. Pollution of domestic wastewater can cause an increase in the composition of organic matter in rivers and increase the value of COD and BOD, which causes reduced oxygen in river water and reduces river water quality [22–24]. The high level of river pollution can reduce the river's capacity and even exceed the river's capacity. In addition, human activities around the riverbanks produce household wastewater directly discharged into drainage channels or rivers, which causes the quality of the river to be polluted. Countermeasures against domestic wastewater pollution can be done by building a Wastewater Treatment Plant (WWTP) so that wastewater from households can be treated first before flowing directly into water bodies [6,25]. The solutions offered to manage domestic wastewater can be seen in Figure 3.

PROBLEMS	SOLUTION
The existing condition of domestic wastewater management in the study area does not follow Batam City's domestic wastewater management. The domestic wastewater management in Batam City uses a local treatment system (on-site sanitation system), which uses a septic tank in each house and is equipped with an infiltration field. However, the septic tank building in the study area is not equipped with a catchment area. This is because the high price of land in Batam City makes developers provide minimal house lots. This is one of the reasons why the septic tanks in Batam City are not equipped with infiltration so that it pollutes the drainage channels and then flow into the dam and causes pollution. In addition to other reasons, the type of soil in Batam City is difficult to absorb water, so it is considered useless if an absorption field is created.	It fosters the community to make a pilot unit of a septic tank with an up-flow filter. Septic tank technology with an up-flow filter tank is a solution to replace the absence of infiltration fields in the residents' septic tanks due to the type of soil that is difficult to absorb water. The up-flow filter is operated by a biological process that utilizes microbes in the wastewater to be treated. These microbes will degrade pollutants before being discharged into water bodies. The up-flow filter can be built underground so that the land above it can still be operated, such as a parking lot. This is also a solution to the problem of high land prices in Batam City.
Respondents do not really understand what efforts should be made in managing domestic wastewater. The deficient level of public awareness of the importance of managing domestic wastewater is also a significant problem in this study. The public is not aware of the negative impacts that can occur due to poor domestic wastewater management.	The community needs to be given guidance regarding materials related to domestic wastewater management. The materials for the development of domestic wastewater management that will be given to residents include: 1. General domestic wastewater management, which includes: - The process of water pollution and its consequences, - Sources/activities that can pollute water, - Efforts to prevent and manage water pollution 2. Management of septic tanks with up-flow filters, which include: - Septic tank treatment process with up-flow filter - Septic tank design with up-flow filter - Septic tank infrastructure with up-flow filter - Operation and maintenance of septic tanks with up-flow filters Residents will also be given the training to practice making a pilot unit of a septic tank with an up-flow filter and operating and maintaining a septic tank with an up-flow filter. The material will be explained in more detail in the implementation method.

Figure 3. Problem and solution of wastewater treatment in study area.

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The design and principles of waste management that can be used are management with an up-flow biofilter, which in general, the working principle of septic with an "up-flow" filter, is the same as an ordinary septic tank, which consists of a settling tank plus a filter filled with gravel. or crushed stone. Anaerobic bacteria carry out the decomposition of organic substances in wastewater or faces. The settling tank consists of two rooms, and the first is sludge digestion and a sludge collector. At the same time, the second chamber functions as second sediment and a reservoir for sludge that is not deposited in the first tank, and the overflow water from the settling basin is channelled into the filter media with the flow direction from top to bottom [26].

Planning a septic tank with an up-flow filter is preceded by drawing the physical environmental conditions in the yard and its surroundings, including the location of the up-flow filter and the final drain. So that what is observed and measured is the location of the land that will be used for a septic tank with up-flow filters. Measurements and observations include measuring land area, distance to the location of the lavatory at home, or the location where a new latrine will be built, soil conditions (hard, rocky, loose, clay, and so on). Distance to the nearest drinking water sources (dug wells, pipes, water reservoirs), including neighbours'. Condition and presence of drainage channels, ditches, or rivers around the house to drain water from the septic tank with an up-flow filter (distance, height difference with the selected septic tank area). The groundwater depth around the land is measured simply by measuring the water depth of the nearest well. The depth of groundwater will affect the construction method to be carried out. The difference in the height of the land with the house building, precisely with the location where the septic tank with up-flow filter is located or can be built.

The recommended height difference is between the beginning of the flow - the end of the flow descending a minimum of 2. Then describe the house's condition where a septic tank is built with an up-flow filter, namely the position of the lavatory (front, back, left/right side). This path allows pipes to pass from the direction of the septic tank location because it will be related to the demolition of walls and floors. Pipelines are chosen with the minimum risk of floor/wall demolition. The best alternative paths are plotted in the location sketch drawing and selected with the minimum risk for the homeowner, both in terms of cost and convenience.

Septic tank treatment process with up-flow filter ware we propose for sewerage treatment in Batam City. High removal rates of pollutant reflected the effectiveness of septic tanks with up-flow filter [27–30].

1. Treated water from the septic tank flows through the inlet pipe to the bottom of the up-flow filter. The function of the inlet pipe to the bottom of the up-flow filter is as follows:
    a. Flowing wastewater directly to the bottom of the filter media to flow upwards through the filter media.
    b. Provides a push to the water under the filter media to flow upwards.

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   c. Reduce or prevent clogging of the filter media. The remaining mud particles carried by wastewater will settle to the bottom or bottom of the up-flow filter.
2. There is a filter media in the up-flow filter from pieces of PVC pipe.
3. The treated water will undergo a process of decomposition and further processing by bacteria attached to the filter media/material so that the quality of the wastewater can meet quality standards.
4. The treated water from the up-flow filter will then be channeledchannelled to the environment or water body (drainage, river, lake, sea).

Operation and maintenance of septic tanks with up-flow filters with the cultivation of decomposing bacteria [31–33], namely by:

1. Perform a start-up process to cultivate bacteria in the septic tank and up-flow filter. Fill the septic tank with an up-flow filter with water and enter the bacteria according to the recommended dose on the packaging label.
2. Bacterial cultures for start-ups can be purchased at stores that sell sanitary equipment, with various brands and packaging, such as EM4, start bio, bio2000, and so on.
3. The septic tank can be used after the bacterial cultivation process is complete.
4. The process of forming decomposing bacteria will be developed more quickly.

4. Conclusions

Domestic wastewater management in Batam City uses a local treatment system (on-site sanitation system), which uses a septic tank in each house and is equipped with an infiltration field. For example, in the Belian Village there is still a direct discharge of wastewater into river bodies. This will cause a decrease in the quality of the river body. Communal processing solutions can be implemented to avoid the negative impacts of these activities. Planning a septic tank integrated with up-flow filter is preceded by drawing the physical environmental conditions in the yard and its surroundings, including the location of the up-flow filter and the final drain. The recommendation system has removal rates of pollutant reflected the effectiveness of septic tanks with up-flow filter. This of course is also accompanied by the operation and maintenance of cultivation of decomposing bacteria.

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