Investigating Water Qualities of Karang Mumus River: Is It Secure to be Used by Populations?

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Abstract. In the case of people who live nearby, access to water from the Karang Mumus River is necessary for daily activities. It is speculated that there is contaminated material in this river due to its muddy appearance and the unpleasant odor that can be felt in some places of the river may be a potential health hazards. Main goal of this study is to investigate environmental carrying capacity characteristics (BOD, COD, and TSS) and contaminants caused by coliform bacteria or heavy metals (Cr(VI) and Fe) from Karang Mumus River. This research was a descriptive observational study. Water sampling was carried out in July and October 2023 from 3 spots under the bridges, which reflects conditions in the dry and rainy seasons. Water samples will be examined at the Mulawarman University, that the BOD, COD, TSS, Fe, and Cr(VI) will be examined at Water Laboratory; while the examination of coliform bacteria was carried out in the Microbiology Laboratory. All data that have been collected will be presented in distribution table. There is no increasing of BOD, COD, TSS, and Cr(VI) that exceeds the standard threshold value of water quality, but Fe and coliform are higher than their normal value. All of these findings hold true for both the rainy and dry seasons, with the concentration increasing during the latter one. We still must aware of underlying problem inside this river whenever want to use it, so keeping Karang Mumus in good conditions must be suggested, in order to maintenance our health in the best form.

1   Introduction

Most residents of the heavily populated residential Karang Mumus River still use this water supply for hygiene and sanitation needs. There are puddles of waste on the water's surface, the water appears as being black, and there is a terrible smell of decaying trash. The Karang Mumus River is said to have quality issues. The purported problem is frequently associated with the removal of household garbage from local residents' activities, as well as from a variety of small enterprises, hotels, marketplaces, farms, and agricultural areas—some of which are still undeveloped land [1].

Through the use of the QUAL2kw model and the ArcGIS model [2], the current state of the polluted Karang Mumus River water has been proven by the BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), and TSS (Total Suspended Solid) examinations. These analyses demonstrate that the capacity is overloaded above the standard value, making it only appropriate for inclusion in the water quality standard class II. There is more information that indicates this river's liquid coal mine waste keeps the water quality status category in class II [3].

The introduction of foreign materials, such as iron and other heavy metals, in amounts greater than the water's carrying capacity, is another cause of pollution in this river's water. In aquatic biota, the presence of heavy metals can lead to death as well as harm to the gills and liver. Considering the current state of affairs, it is plausible that issues arising from the utilization of water in certain settings that bear particular implications for human well-being may arise in the future [4-6].

pH, temperature, and brightness are some of the common water quality characteristics that have been directly evaluated up until now. Additional tests, including dissolved oxygen tests, are used to determine whether or not there is water contamination [3, 7, 8]. Numerous different tests have also been conducted, including the determination of the concentrations of heavy metals including lead, mercury, and cadmium in water. The ecosystem, including biota, sediment, water, and others, is contaminated, accumulated, and even contaminated by the high concentration of heavy metals in waters [7, 9]. As a result of their investigation, other heavy metals such as nickel, cobalt, and chromium VI [10, 11], Fe [12-14] have been reported. Some research points to the presence of oxidizing heavy metals like iron (Fe) as the cause of river water turning brown or black [12, 15, 16].

The East Kalimantan Provincial Government published a report on the results of water quality monitoring in 2018 that included an analysis of the physical, inorganic chemical, and microbiological (coliform bacteria) characteristics of the river water in Samarinda [3]. The analysis of water quality parameters is fairly comprehensive; however, in order to bolster the publication's novelty, the author intends to add the analysis of Cr (VI) and Fe heavy metal parameters in the water of the Karang Mumus River, which is still not included in the report's examination, as well as update data that hasn't been updated in last a few years.

The fact that water is a universal solvent that can get contaminated is the reason why this research is so urgently needed. Water is highly contaminated because it can dissolve more compounds than any other liquid on the planet. Human activity is typically the cause of water pollution in the sea, lakes, rivers, groundwater, and other bodies of water. Living creatures will suffer if the physical, chemical, or biological qualities of water are altered. A freshwater crisis brought on by water pollution endangers sources of drinking water as well as other essential requirements for humans and other living creatures [17-19].

For the obvious reason that water is a basic human necessity, the Karang Mumus River's pollution could pose a threat to the local population [18]. Due to the fact that even in children and newborns, the amount in the body can reach 80% of body weight [20, 21]. Blood is one type of fluid found in the human body that is used as a conduit to provide nutrients and oxygen to the body's tissues. The possibility exists that issues in the supply function could lead to issues within the human body [22], particularly if contaminants are already present in the water [10, 23-25]. Stunting or stunted height growth [26], low baby weight [27], and concentration abnormalities [21] are among the issues linked to water use that have been documented. According to assertions from multiple sources, academics surmise that the Karang Mumus River's alleged pollution poses a risk to public health, particularly for susceptible populations like newborns and toddlers.

According to H.L. Blum's theory, there are four interrelated components that constitute the basis of environmental involvement that impacts health degree parameters: the environment (40%), health behavior (30%), health services (20%), and genetics (10%). Prior to the development of Blum's theory, health issues were thought to be primarily caused by genetic factors. However, Blum's theory raises the possibility that other factors also play a role, with behavior and environment playing a major influence [28-32].

The author's goal in writing this article is to gather information about the findings of tests conducted on coliform bacteria, heavy metal particle nano-analysis (Cr (VI) and Fe), and environmental carrying capacity (BOD, COD, and TSS) in the Karang Mumus River.

2   Materials and Methods

The researcher took samples of Karang Mumus River water from 3 bridge locations that cross this river. This water sampling was carried out in July and October 2023, which reflects conditions in the dry and rainy seasons. Sampling was carried out on the 1st at 9.00 Central Indonesia Time in those months. Those sampling points of the Karang Mumus River at several locations around the Lambung Mangkurat Bridge in Samarinda, which have coordinates 117° 09' 10.1457" E 0° 29' 27.6665" S, 117° 09' 21.6432" E 0° 29' 31.4340" S, and 117° 09' 31.1835" E 0° 30' 10.6989" LS [33] in the application Google Earth that can be seen at Fig. 1.

Fig. 1. An image of Samarinda, Indonesia's Karang Mumus River was obtained using the Google Earth program. This river cuts through Samarinda City, a popular place for residents to live, work, and engage in other activities. This river has three coordinates that need to be used and examined. The area between the two locations on this map is represented by number 2, since number 1 represents the area that is more upstream and number 3 represents the area that is more downstream. This image was a screen shooting's picture been taken from Samsung A04e.

Water samples will be examined at the Water Laboratory and Microbiology Laboratory, both located at the Faculty of Fisheries and Marine Sciences of Mulawarman University. The parameters examined at the Water Laboratory are BOD (APHA 5210-B, 22nd year.2012), COD (SNI 6989.2:2019), TSS (SNI 6989.3:2019), Fe (SNI 6989.4-2009), and Cr(VI) (SNI 6989.53-2005); while the examination of coliform bacteria was carried out in the Microbiology Laboratory. All data that have been collected will be presented in distribution table.

Research permits and ethics were submitted to the Ethics Committee of the Faculty of Medicine, Mulawarman University on September 20, 2023 within Surat Persetujuan Kelayakan Etik 187/KEPK-FK/IX/2023.

3   Results

The Karang Mumus River water quality parameter group will be shown in two camps. The BOD, COD, and TSS parameters shown by the first group served as the primary point of reference for figuring out the environment's carrying capacity in the Karang Mumus River's water. The invisible nanoparticles or microscopic characteristics that are present in the river's water between coliform bacteria and others like: Cr(VI), Fe, and other elements make up another category.

Table 1. Results of BOD, COD, and TSS Examinations at 117°09'10.1457" E 0°29'27.6665" S

No.	Parameters	Quality Standards	Jul-23	Oct-23	Unit
1	TSS	50	31	38	mg/l
2	BOD	3	2.16	2.18	mg/l
3	COD	25	6.673	11.717	mg/l
4	Cr(VI)	0.05	0.008	0.008	mg/l
5	Fe	0	0.092	0.322	mg/l
6	Coliform	0	460	1100	mg/l

Table 2. Results of BOD, COD, and TSS Examinations at 117°09'21.6432" E 0°29'31.4340" S

No.	Parameters	Quality Standards	Jul-23	Oct-23	Unit
1	TSS	50	34	47	mg/l
2	BOD	3	1.48	2.4	mg/l
3	COD	25	4.62	7.83	mg/l
4	Cr(VI)	0.05	0.008	0.008	mg/l
5	Fe	0	0.141	0.218	mg/l
6	Coliform	0	43	240	mg/l

Table 3. Results of BOD, COD, and TSS Examinations at 117°09'31.1835" E 0°30'10.6989" S

No.	Parameters	Quality Standards	Jul-23	Oct-23	Unit
1	TSS	50	11	20	mg/l
2	BOD	3	1.22	1.68	mg/l
3	COD	25	3.511	5.762	mg/l
4	Cr(VI)	0.05	0.008	0.008	mg/l
5	Fe	0	0.048	0.137	mg/l
6	Coliform	0	460	240	mg/l

The results of BOD, COD, and TSS examinations are in Table 1., 2., or 3. shows that there is no increase in quantity that exceeds the standard threshold value of water quality, so if this data is included in the spatial map, the color that appears should be green or yellow instead of red. Green indicates no improvement, while yellow indicates the presence of a number around the quality standard threshold value [2]. Based on this data, this condition indicates that the Karang Mumus River can regenerate the existence of pollutants that were reported a few years ago. The location of the area in Table 1 reflects the area that is more upstream, while Table 3 is the one that is more downstream, so the 2nd location is the area between upstream and downstream.

4   Discussion

The success of the Karang Mumus River in preventing the exceedment of the standard water quality threshold value cannot be separated from the role of environmental carrying capacity. The greatness of this environmental carrying capacity is determined by the conditions of rainfall [33] that affects concentration, or wind activity that affects the waves of the river [34, 35]. The researcher would like to underline that the examination of parameters in July 2023 which represents the dry season, and October 2023 which reflects the rainy season, especially Fe and coliform bacteria, actually showed a difference in results, where in 3 different locations there was always an increase that was still not until the previous decrease in the standard water quality threshold value, so it is necessary to raise the idea that seasonal changes may play a role in the fluctuations that occur aforementioned. To support this new hypothesis, researchers have not been able to provide a reason explaining this phenomenon because there is no publication of data on citizen activities or government performance at that time.

The results of this 2023 data search are different from what happened in 2017 [36] or 2020 [2] who reported that at this sampling location, it turned out that there was a red color on the spatial map [2], which showed that it was considered a critical point. Reports of pollution in this river can be physically seen with a cloudy brownish color, so the Samarinda Municipality Government participates in socialization to maintain the balance of the river ecosystem [37]. Researchers assess the great steps taken by the Samarinda Municipality Government to restore the provision of green open space on the border of the Karang Mumus River which has a positive impact on reducing population density [38] at the same time creating conditions for the Karang Mumus River to be used as a source of drinking water if it succeeds in entering the class I water quality standard category, so that this achievement is worth maintaining.

The increase that occurred in October 2023, where it has entered the rainy season, is not enough to make changes to the values of environmental carrying capacity parameters (BOD, COD, and TSS), let alone to the point of having to experience a decrease in the quality standard class, even when there is a record increase in COD 4,301 mg/l at the first bridge site. One of the reasons for the success of the Samarinda Municipality Government in reaping this glorious result is through the garbage collection movement which has been carried out regularly since 2019, so that contrasting conditions like those that occur in other rivers, for example the Citarum river which is filled with a lot of garbage piles on the river surface can be prevented [39].

The results of the examination of heavy metal levels at all monitoring points of the Karang Mumus River on all tables, showed that the Cr(VI) level was normal, but the dissolved Fe level in the sample water was above the normal value, even during a span of 3 months the Fe concentration increased at the beginning of the rainy season. Referring to the standard of inspection, the scores of both are in the class II category which is still allowed to be used as a source of water for bathing and washing, but not for drinking.

Referring to Table 1, there is a difference in the data on the results of the examination of dissolved Fe levels in July and October, namely 0.092 and 0.322, indicating a difference in concentration of 0.230 mg/L. The 3-month span with this difference in concentration raises suspicions about whether there is indeed a slow but constant increase in concentration, or another possibility is that there is a sudden increase directly in October 2023. The opportunity for a sudden increase in concentration should be negligible considering that there are no major industrial or mining activities around this river, so it is suspected that there is a source of increased concentration apart from the activities of residents on the banks of the Karang Mumus River, although the Samarinda Municipal Government has launched a restoration movement since almost 1 decade [39]. Researchers think about the possibility of increased iron from rainfall [40], which tends to be different in July and October, where there was an increase from 170.8 to 184.9 [41] giving rise to a new hypothesis that there has been oxidation in metals that are submerged or in river water.

The results of the examination of heavy metal levels at the two monitoring points of the Karang Mumus River in Table 2 showed that the dissolved Cr(VI) and Fe levels in the sample water also increased above normal values. Referring to the standard of inspection, the scores of both are in the class II category which is still allowed to be used

as a source of water for bathing and washing, but not for drinking. The value of Fe at this monitoring point is the highest among the other two monitoring points, it is suspected that there is a source of Fe added to this river. The search for the presence of this additional Fe level should be discussed in other studies, especially those that focus on the pure environment, not limited to the topic of health risks carried out by the research team.

The data from the Fe content test at the 2nd location in July which reached 0.141 turned out to be not the peak of concentration, where the examination in October showed a value of 0.218, meaning that in a span of 3 months there was only an increase of 0.077 mg/L. Researchers assume that the increase in October may be even greater because in Indonesia, The beginning of the rainy month only occurs in September [41], so that where is the chance of the outbreak of cases Water-borne disease Need to be aware of [42].

The results of the Fe content test in July 2023 with a value of 0.048 are the best conditions ever in the researcher's data record, but this result also increased in October 2023, namely 0137 as happened at locations 1 and 2, which means that the difference between the two is 0.089 mg/L. Researchers see this phenomenon as a related condition considering that the three locations of the Karang Mumus River water sampling point are in 1 track. Similar conditions are also experienced by other researchers who use different parameters to assess the water quality standards of the Karang Mumus River [2, 36].

The concentration of Cr(VI) in the Karang Mumus River is always below the pollution threshold value. This result seems to look good because looking at the low concentration numbers seems to look normal, but if you think that there may be another hypothesis that suspects that some concentrations of Cr(VI) can undergo transformation into other heavy metals, it is assumed that the increasing concentration of iron in the river is not primary to the presence of iron itself. To support this thinking, the authors try to collect publication data that explain that Arsen [43], Aluminum [44], even radioactive materials such as Plutonium can increase the concentration of this iron [45], so that the normal form of iron ions as $Fe2+$ can change to $Fe3+$ which is known as an oxidant agent [46]. Looking at the existence of metal concentrations in water, some formulate the order of concentration as follows: $Cd < Cu < Pb < Ni < Zn < Mn < Fe$ [47], convincing the authors that iron as the heavy metal material that has the highest concentration may be a secondary content of other metals. The presence of dissolved iron ions in high concentrations, regardless of primary or secondary sources, is said to cause a change in the color of river water [48], so that the idea that the change in the color of the river water to brownish may be an allegation of the existence of oxidation of this metal there, as can be seen from the documentation of the Karang Mumus River in Fig. 2.
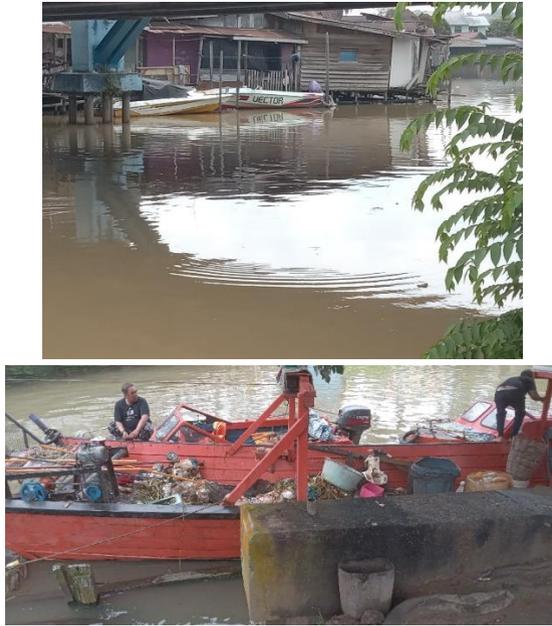
Fig. 2. The current condition of the water in the Karang Mumus River, which is known to be filthy, appears to be brown. 2a. At the water surface, sometimes we can find garbage, not always comes from residents house. 2b. Everyday, worker from Dinas Lingkungan Hidup Samarinda cleaned up bunch of garbage by traditional boat. The documentation was taken on August 1st, 2023 using the HP Oppo J21's camera.

Based on the results of the examination of coliform content in water samples from 3 locations of the Karang Mumus River located under 3 bridges, it turns out that there is a contrasting difference between the new bridge and 2 other bridges. The increase in concentration occurred in the first 2 locations, while on the third bridge closest to the port/estuary, there was a decrease. Researchers assume that there are residential activities around the location of the water quality inspection monitoring point that triggers an increase in the level of this bacteria. The first location used to be a former bird/pet market but is now empty because there has been a relocation. The inhabitants of this area are now switching locations and trading around location 2. Initially, the researcher assumed that the first location of the river was an area that received the discharge of the flow from Segiri Market, a settlement as well as a trading area that was more crowded than the three river water sampling locations chosen by the researcher, should indeed receive the impact of waste discharge/flow from the market so as to allow for an increase in concentration. The condition that this researcher thinks is not/has not been proven because of the spatial map display of other researchers before [36], even though the logic of the researcher's thinking assumes that the population density on the riverbank will be in accordance with waste disposal activities such as bathing, washing, or sanitation [1]. Another possibility that can affect the difference in examination results is rainfall which indicates a relationship between those seasons [33], or wind

activity that affects the waves of river flows [34, 35] is considered to have provided positive support to reduce the presence of pollutants in the Karang Mumus River.

Ideally, these coliform bacteria do live in river water, but this increase in number raises the suspicion that there are many nutrients that can be utilized by coliform bacteria [49], one of which is sourced from household waste that flows directly into river water [50]. Based on the observations of researchers in the field, there are still quite a number of residents' houses located on the banks of the Karang Mumus River, where one of the sources that is suspected to be connected to the increase in coliform bacteria levels comes from latrines, bathrooms, laundry places or cooking/eating utensils [1]. The Karang Mumus River provides free water source support to residents, but in conditions contaminated with this pathogenic bacteria, it poses a risk of increasing the incidence of illness for the population around this river [51].

Comparing the data on the inspection of the carrying capacity of the environment which is included in the class I water quality standard category, but in fact the Samarinda City Government or the Provincial Government only mentions that the water source of the Karang Mumus River is still in the class II category, making researchers assume that there are parameters that are being taken into account by this Regional Government to be aware of its existence that can increase, Especially during the transition of the seasons.

5   Conclusions

Water is a vital need for human life, but it is necessary to be aware of the possibility of health problems due to the components in the source of water consumed, such as river water, that can be obtained directly for free. There are several heavy metals and microorganisms that exist inside Karang Mumus River and make a pollution. Even though our river has environment carrying capacity (BOD, COD, and TSS) to regenerate river water conditions, but we should beware that those invicible materials can still harm our health.

All environmental carrying capacity metrics, according to the research findings, fit within class I water quality norms. Fe and coliform bacteria are elevated, but the Cr (VI) test findings are normal. All of these findings hold true for both the rainy and dry seasons, with the concentration increasing during the latter one.

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