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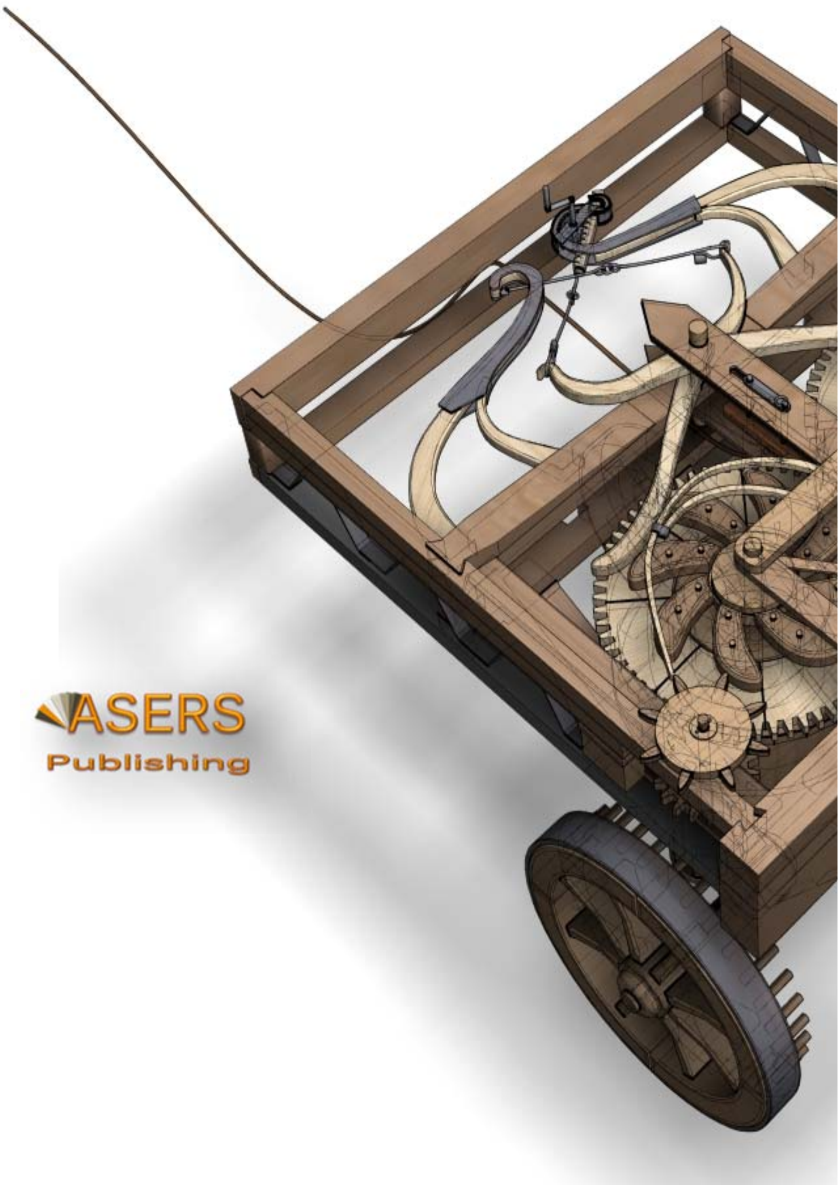

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Journal of Environmental Management and Tourism

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Analysis of Water Quality in Batujai Reservoir Due to Community and Business Activities in Central Lombok Regency

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Abstract

The development of an area must be accompanied by an ever-increasing population growth which will also increase the waste produced. Waste production will put pressure on the environment if it is not managed properly which will eventually end up in water bodies. The increased pollution load is also caused by the habit of people disposing of domestic waste, both liquid waste and solid waste directly into the water. Batujai Reservoir is one of the vital objects for the survival of the people of Central Lombok in particular, and the people of Lombok Island in general. Because of its vital role, the Batujai Reservoir needs to be saved so that the reservoir ecosystem can carry out its functions and benefits in improving the welfare of the people of Central Lombok. There are several community activities that are a source of direct reservoir water pollution (point source) such as fishing activities using floating net cages and disposal of domestic waste by the community which is directly channeled to water bodies. Pollutants collected in the Batujai Reservoir will reduce the water quality of the Batujai Reservoir. This research aims to analyze the water quality of the Batujai Reservoir which is caused by business activities and the community based on Government Regulation Number 82 of 2001 and to determine the water pollution index of the Batujai Reservoir. This study uses a quantitative approach by collecting primary data from direct observations in the field and secondary data based on previous research reports and government reports. The results showed that the average physical parameters were above the water quality standard threshold for class II water quality, the average chemical parameters were above the water quality standard for class III and class IV water quality, while the biological parameters were above the threshold. Water quality limits for class II and class III. The decline in water quality in the Batujai Reservoir is caused by various wastes entering the Batujai Reservoir water bodies. The analysis result with storet system shows that the water quality of Batujai Reservoir is in bad condition or heavily polluted.

Keyword: pollution; waste; quality; water; environment.

JelClassifiation: Q52; Q53; Q25.

Introduction

Efforts to conserve the environment through water quality management due to pollution are important steps to maintain the interests of current and future generations and ecological balance. The increasing pollution load due to the impact of human activities creates pressure on the environment ($Sudipa_a$ *et al.* 2020). The habit of people disposing of domestic waste, both liquid waste and solid waste directly into the water body continuously causes accumulated pollution that can disturb the environment and public health (Armadi *et al.* 2020). The quality of reservoir water is greatly influenced by the tofographic form and the pattern of designation and spatial use of a land such as settlement, agriculture, industry and others. Uncontrolled disposal of domestic and agricultural wastewater will affect the water quality of Tang *et al.* (2012). Batujai Reservoir is one of the vital objects for the survival of the people of Central Lombok in particular, and the people of Lombok Island in general. Because of its vital role, the Batujai Reservoir needs to be saved so that the reservoir ecosystem can carry out its functions and benefits in improving the welfare of the people of Central Lombok. The reservoir basically functions as a water reservoir in the rainy season and a water source in the dry season (Sulawesty *et al.* 2013). Reservoir water pollution is complex and dynamic because the elements in it experience symptoms of transformation and transformation, and the input that enters the river varies with time, both in quality and quantity (Maharani *et al.* 2008). The variables in a dynamic system include the variable level, variable rate, and auxiliary variable (Zhang *et al.* 2009). One of the causes of pollution is behavior that does not care about the environment and poverty (Sudipa 2014). The classical approach model proved unable to predict the availability and use of water resources which are very important for planning and sustainable management due to spatial dynamics (Nandalal and Sumasinghe 2006).

Population growth and increased population activity have resulted in a decrease in the carrying capacity of the environment, one of the water carrying capacities. The carrying capacity of water does not only concern the quantity but also the quality of water ($Sudipa_b$ *et al.* 2020). Waste generated from socio-economic processes must be carefully monitored by the government because these cultivation activities can reduce water quality (Ozdemir *et al.* 2014). Areas that have limited water resources tend to cause socio-cultural problems such as conflicts between communities ($Sudipa_c$ et al, 2020). Basically, dam construction aims to regulate the flow and continuity of river water supply, including as a power plant, but it causes many socio-economic and ecological problems around the world (Lessard *et al.* 2013). Batujai Reservoir as a source of irrigation for agricultural fields, and as a source of raw water for drinking water. Batujai Reservoir water pollution comes from several activities, among others: population, agriculture and livestock. Potential pollutants that can contaminate reservoirs are solids and or liquids (Brahmana *et al.* 2010). This research aims to analyze the status of water quality due to water pollution and damage to the reservoir environment. The research method used a quantitative approach with reservoir water sampling to determine the physical, chemical, and biological parameters of water carried out by purposive sampling which was differentiated based on the distance from the inundation area of the Batujai Reservoir with residential areas, agriculture, markets, industry, lodging, hospitals and other activities. When the research was conducted in November 2018 - September 2019.

1. Methodology

The water quality of Batujai Reservoir has a close relationship with the condition of human settlements and other supporting facilities such as shops, markets, restaurants and hospitals, as well as agricultural activities, especially those related to the disposal of domestic, agricultural and industrial wastewater. The research design used by researchers is to identify business activities and community behavior that can cause environmental pollution and damage impacts, to analyze the level of pollution and environmental damage to the Batujai Reservoir waters based on quality standards stipulated in the Government Regulation of the Republic of Indonesia Number 82 of 2001 as presented in Figure 1.

Determination of pollution status is determined by using a pollution index as stipulated in the Decree of the Minister of Environment Number 115 of 2003 as follows:

$$\text{PIj} = \sqrt{\frac{(\frac{Ci}{Lij})^2_M + (\frac{Ci}{Lij})^2_R}{2}}$$

Information:

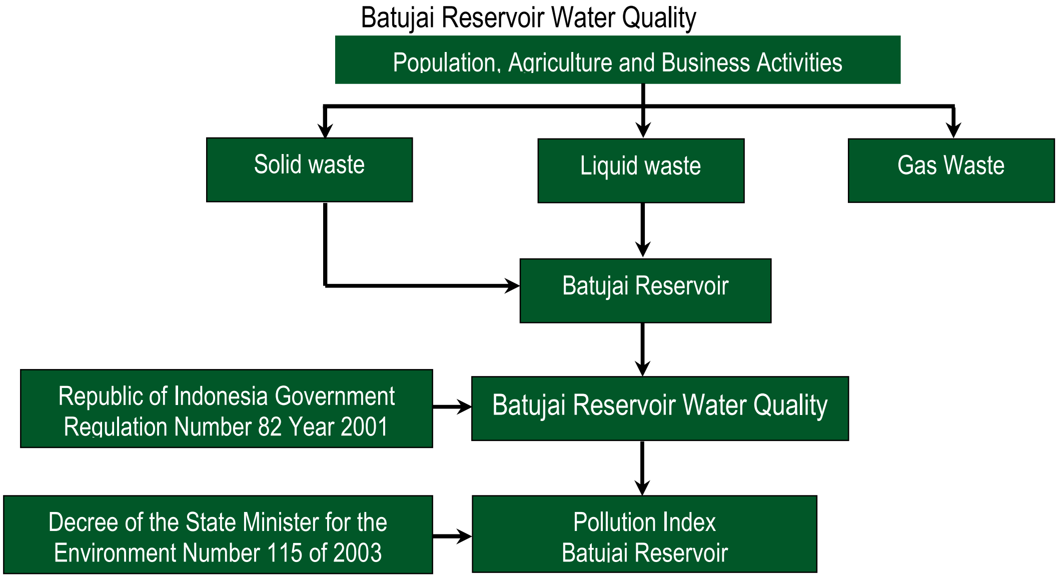
Li : Water quality concentration for water quality standards (j)

Ci : Water quality concentration survey results

Pij : Pollution index for designation (j)

(Ci/ Lij)M : Ci/Lij Maximum
(Ci/ Lij)R : Ci/Lij Average

Figure 1. Framework



The status of water quality standards is stated as follows:

1. $0 \le Plj \le 1,0$: According to quality standards (good condition)
2. $1,0 < Plj < 5,0$: Lightly polluted water
3. $5,0 < Plj \le 10$: Moderately polluted water
4. $Plj > 10$: It is heavily polluted

2. Result and Discussion

Existing Condition of Water Quality in Batujai Reservoir

To determine the existing condition of the water quality of the Batujai Reservoir, it was carried out by comparing the results of the analysis of physical, chemical and microbiological parameters of water quality from samples taken at several sample points of river and reservoir water with applicable water quality criteria, namely referring to Government Regulation Number 82 2001 concerning Management of Water Quality and Control of Water Pollution. Sampling and laboratory analysis of water quality were carried out 3 (three) times, namely sample I (first) on August 12, 2019 to August 29, 2019, sample II (second) on August 28, 2019 to September 16, 2019, and sample III (third) from 11 September 2019 to 20 September 2019. Batujai Reservoir water as raw material for drinking water, technical irrigation and other household needs, so based on these regulations in this study as a comparison used Class Water Quality Criteria I, II, III, or IV.

Water Temperature

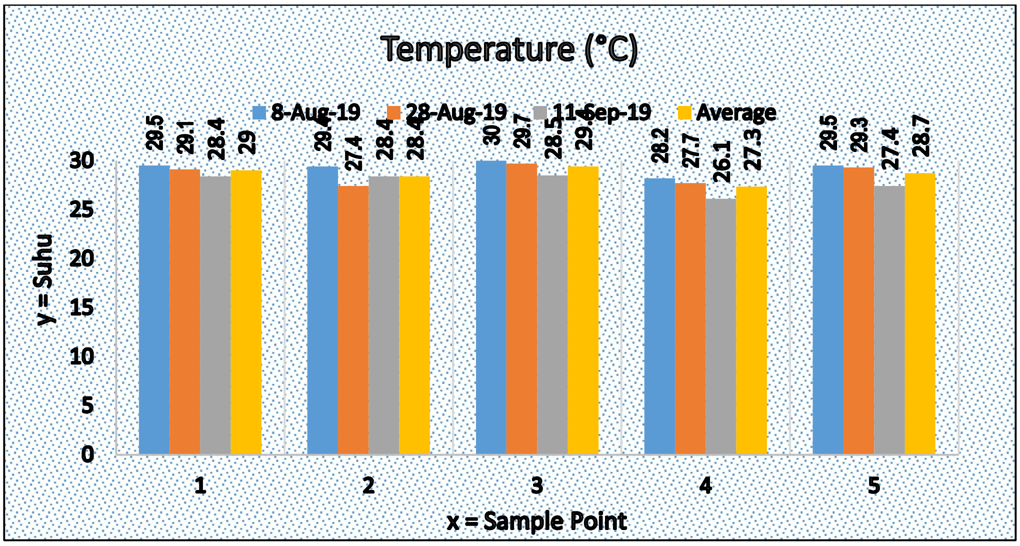
Water temperature greatly affects the ecological aspects of reservoir waters and has a close relationship with reservoir water quality. The higher the water temperature the quality decreases, because the dissolved oxygen content will decrease so that many aquatic microorganisms die. The high and low water temperature is influenced by air temperature, water depth, vegetation cover at the reservoir border and water turbidity. Water temperature can also be influenced by the speed of chemical reactions that take place in the water. In general, the higher the temperature, the faster the chemical reaction takes place. High water temperatures will increase the solubility of chemical compounds and affect the impact of pollutants on aquatic life.

The results of water temperature measurements for each sampling point were carried out 3 (three) times. The value of reservoir and river water temperature fluctuates from sample point 1 (reservoir/intake of drinking water raw materials), sample point 2 (middle part of the reservoir), sampling point 3 (Intake reservoir/Leneng River), sampling point 4 (Sade River/Manhalul Bridge) ulum Karang Lebah), sampling point 5 (Surabaya River weir intake) in general, temperatures range from 27°C-29°C. The highest average temperature value is at sample point 3 (three) intake of the Leneng River reservoir (29.4°C) and the lowest is at sample point 4 (four) the Sade

River (27.3°C). When compared with the standard quality standards for fish culture Government Regulation Number 82 of 2001 can still be tolerated. Anto (2014) states that the temperature range, temperature of the reservoir waters that tilapia can still tolerate is 15-37°C, while the ideal temperature for spawning to produce eggs and larvae is 22-37°C. The temperature difference at each point of observation is influenced by air temperature, differences in sunlight intensity at the time of measurement, climatic conditions, and weather at the time of measurement.

In terms of temperature fluctuations, each sample point is not only influenced by the hot sun but also influenced by the land cover around the sampling point, such as at point 3 (the leneng river) is far from the shade or vegetation (open) so that it affects the high water temperature, while for point 4 the border area is overgrown with vegetation. Besides the lack of land cover, it is also affected by the dry river water conditions. In general, the water temperature of Batujai Reservoir meets the Class 1 Water Quality Criteria and can be used as a raw source of drinking water because the temperature deviation is not more than 3°C. This is in accordance with Government Regulation Number 82 of 2011 concerning Management of Water Quality and Control of Water Pollution with a standard deviation of temperature 3. The results of the water temperature analysis can be seen in Figure 2.

Figure 2. Results of Water Temperature Analysis

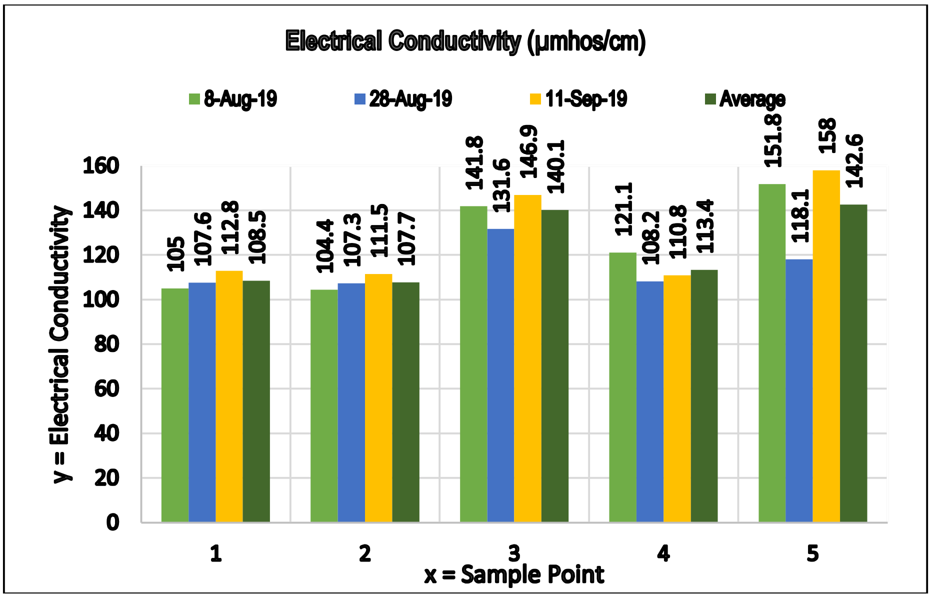


Electrical Conductivity (EC)

Conductivity (Electrical Conductivity) is one of the parameters used to determine the electrolyte content dissolved in water. The conductivity value is influenced by ion concentration, water temperature, and the amount of dissolved solids. In a water, the more dissolved salts that can be ionized, the higher the electrical conductivity value. Each water has a different Electrical Conductivity, Distilled water has an Electrical Conductivity of about 1μS/cm. Natural waters have an Electrical Conductivity value of around 20-1500 μS/cm, while marine waters have a very high Electrical Conductivity value because they contain a lot of dissolved salts. Industrial waste has an electrical conductivity value of up to 10000 μS/cm.

The results showed that there was a difference in the value of Electrical Conduct at each observation point. The average value of Electrical Conduct at five observation points for 3 (three) replications ranged from 107.7 μS/cm - 142.6 μS/cm. The highest value of electrical conductivity was found at sample point 5 (Surabaya River) with an average of 142.6 μS/cm and the lowest at sample point 2 (the center of the reservoir) 107.7 μS/cm. The value of the electrical conductivity of the research location is the basis for knowing how much anion or cation is in the water. In general, there is an increasing trend in the average value of electrical conductivity in locations affected by residential activities from 113.3 μS/cm (point 4), 140.1 μS/cm (point 3), and 142.6 μS/cm (point 5). Apart from being influenced by settlements, the increase in Electrical Conductivity at the research location is also influenced by other business activities such as agriculture, trade / markets, restaurants, lodging, and others. This condition is in accordance with the opinion of Saeni (1989), which states that the increase in the value of Electrical Conductivity is the result of an increase in dissolved salts (such as sodium, magnesium, chloride, and sulfate salts) and dissolved solids originating from resident waste, industrial waste, run off agricultural areas, and other business activities. While the average value of electrical conductivity in reservoir water, namely at sample points 2 and 1, is relatively smaller (107.7 μS/cm and 108.4 μS/cm) because there has been deposition at the bottom of the reservoir. point 5 is due to the low level of public awareness in managing household waste. Observations show that some of the settlements near the river still dispose of rubbish/waste such as organic and plastic waste on the riverbanks, so that when it rains the wastes are washed away into the river. The value of the electrical conductivity of river water increases from upstream to downstream, especially during the dry season. This is thought to be related to the increase in waste disposal in the middle and downstream zones of the river basin which is in line with the increasing population density and other businesses in the area. The results of the analysis of electrical conductivity can be seen in Figure 3.

Figure 3.The results of the analysis of electrical conductivity



Total Suspended Solid (TSS)

The suspended residue consists of suspended particles in the form of mud and fine sand as well as microorganisms especially those caused by runoff or erosion that are carried into water bodies. The suspended residue contains organic and inorganic materials. The results showed that the average value of total suspended solids/residues in the waters of the Batujai Reservoir for each sample point were: point 1 (32 mg/L) point 2 (36 mg/L), point 3 (35.3 mg/L), point 4 (29.3 mg/L), and point 5 (39.6 mg/L). The highest mean TSS value was found at point 5 (39.6 mg/l) and the lowest at point 1 (32 mg/L).

The high level of TSS at point 5 (Surabaya River) is caused by the large number of suspended particles consisting of silt and fine sand as well as microorganisms, especially those caused by soil erosion / run off or erosion that is carried in water bodies or due to deposition and decay organic material from residential and other business wastes. Another effort that affects the high content of suspended residues at point 5 is due to the mining activity of excavation C in the upstream part, so that when the rain of waste, the process of washing sand in the upstream part is carried away by the river flow to the downstream part which will eventually lead to the Batujai Reservoir. The results showed that the higher the value of DHL, it would affect the value of the suspended residue at each sample point, the highest average TSS value at sample point 5 (39.7 mg/l) with an average value of Electrical Conductivity (142.6 μS/cm). This is in accordance with the opinion of Akan et al. (2007) which states that the increase in the value of suspended residues is caused by the presence of increased silt (silt) and clay particles in river water. The average results of measurement of suspended residues at each sample point ranged from 32 mg/l - 39 mg/l.

According to Adedokun *et al.* (2008), high suspended solids will affect aquatic biota in two ways. First, blocking and reducing the concentration of light into water bodies, thus inhibiting the photosynthesis process by phytoplankton and other aquatic plants. This condition will reduce the supply of dissolved oxygen in water bodies. Second, directly high TSS can disturb aquatic biota such as fish because it is filtered by gills.

Degree of Acidity (pH)

The degree of acidity (pH) is one of the important parameters in monitoring water quality and determining the value of water use for domestic, irrigation, aquatic organisms and other purposes. The pH value shows the level of acidity or strength of acids and bases in water. The amount of water pH affects the solubility and form of chemical compounds in water bodies. Changes in pH in waters will affect changes and biological activity. According to Adeyemo *et al.* (2008), the growth of aquatic organisms can take place well in the pH range 6.5-8.2. The pH category is declared bad if the laboratory test results are close to a value of ≤ 6 (acidic in nature) or close to a value of ≥ 9 (alkaline). The recommended level of acidity according to the class 1 drinking water quality standard is in the range 6-9. The results showed that the pH value of the Batujai Reservoir water fluctuates, but is still in the normal water pH range according to the quality standard, namely pH 6-9. The average pH value of the Batujai Reservoir waters at all observation points is 7.09. The highest pH value was found at sample point 1 (7.48), the lowest pH value was at sample point 5 (6.70). Fluctuation in pH value in river water according to Siradz *et al.* (2008) is influenced by several things, including organic matter or organic waste. The increase in acidity is influenced by organic matter which releases O_2 if it undergoes a decomposition process, anorganic materials or microorganic waste. Inorganic industrial wastewater generally contains high amounts of acid so that it is also high in acidity, acid rain due to gas emissions.

In general, the pH of the waters of the study area is still in a safe range as a source of drinking water based on the class 1 quality standard which requires a pH value of 6-9. The high and low pH value at each observation point is thought to also be caused by differences in the time of taking the test sample and the effect of the input of domestic waste pollution which is also fluctuating, although the average pH at the 5 sample points of observation is 7.09. This shows that the disposal of domestic waste such as water used by community washing and other activities on the side of rivers and reservoirs does not disturb the degree of acidity of the waters. The pH value shows the level of acidity or strength of acids and bases in water. The amount of water pH affects the solubility and form of chemical compounds in water bodies. Changes in pH in waters will affect changes and biological activity. According to Adeyemo *et al*. (2008), the growth of aquatic organisms can take place well in the pH range 6.5 - 8.2. The pH category is said to be bad if the laboratory test results are close to a value of ≤ 6 (acidic in nature) or close to a value of ≥ 9 (alkaline). The recommended degree of acidity according to the class 1 drinking water quality standard is in the range 6 - 9. There are differences in pH levels at sample points 1 (7.50), 3 (7.16), and 5 (7.14) but they are still in natural levels. Normal tolerance, namely the pH level is not acidic or not alkaline, which is still in the normal interval with a pH range of 6.5 - 8.2. Even so, the difference in pH levels at point 1, 3, and point 5 is influenced by the discharge of organic waste from both domestic waste and agricultural waste at observation point 1 (one).

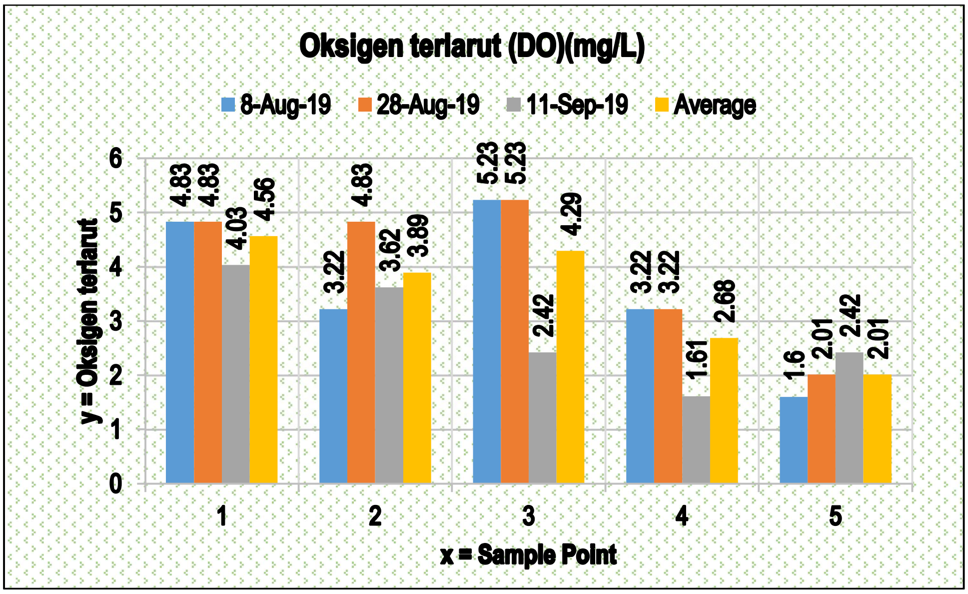
Dissolved Oxygen (DO)

Dissolved oxygen (DO) is a key parameter of water quality that describes the condition of water freshness. According to Raja *et al.* (2008), DO levels indicate the amount of dissolved oxygen in water or indicate oxygen status in water bodies. DO levels in natural waters are usually less than 10 mg/ l. DO content is important for the survival of aquatic organisms, so that the determination of dissolved oxygen in water can be used as a rule for determining water quality. Dissolved oxygen is a vital requirement for the survival of aquatic organisms and can be a limiting factor in determining the presence of living things in water. Waters contaminated with organic matter will experience a decrease in dissolved oxygen content because the oxygen available in water will be used by microorganisms to decompose organic pollutants. Excessive organic pollution will increase the activity of decomposing microorganisms, which will cause water conditions without oxygen (anoxic). In anoxic water conditions, the decomposition of organic matter continues but occurs anaerobically which will produce foul-smelling gases, including methane (CH_4), ammonia (NH_3) or hydrogen sulfide (H_2S) (Environmental Service 2018).

The results showed that the dissolved oxygen (DO) levels in the study area at 5 sample points at sample point 3 (Leneng River) were higher (5.23 mg/l) compared to other sample points, while the lowest DO value was at sample point 5 (1.6 mg/l). This is because in the sampling area (point 5) there are still many domestic activities such as bathing and washing in rivers, disposal of livestock waste, workshop activities, markets and other activities, while at sample point 3 there is already penetration of sunlight entering the river so that the value DO is higher. DO values at points 1 and 2, namely at the intake section for drinking water raw materials and the center of the reservoir (point 2) show that DO levels are lower than DO levels at point 3, this is because in the reservoir there is floating net cage cultivation. According to Water Quality Standards Number 82 of 2001, the DO standard specified for the sustainability of aquatic organisms for class II water is 4 mg/ l, below this value has a negative impact on the life of aquatic organisms. DO concentrations in the waters below 2 mg/l cause mortality in most fish.

In general, dissolved oxygen levels in the research location do not meet the Class 1 Water Quality Standards which require DO levels> 6 mg/l. The DO levels illustrate that in general the Batujai River and Reservoir have been polluted by organic matter that is easily biodegradable. This is in line with the opinion of Rahayu and Tontowi (2005) which states that the amount of dissolved oxygen in water indicates the freshness of the water in that location, so that if the dissolved oxygen level is low, there is an indication that organic matter has been contaminated. The results of the dissolved oxygen analysis can be seen in Figure 4.

Figure 4. The results of the dissolved oxygen analysis

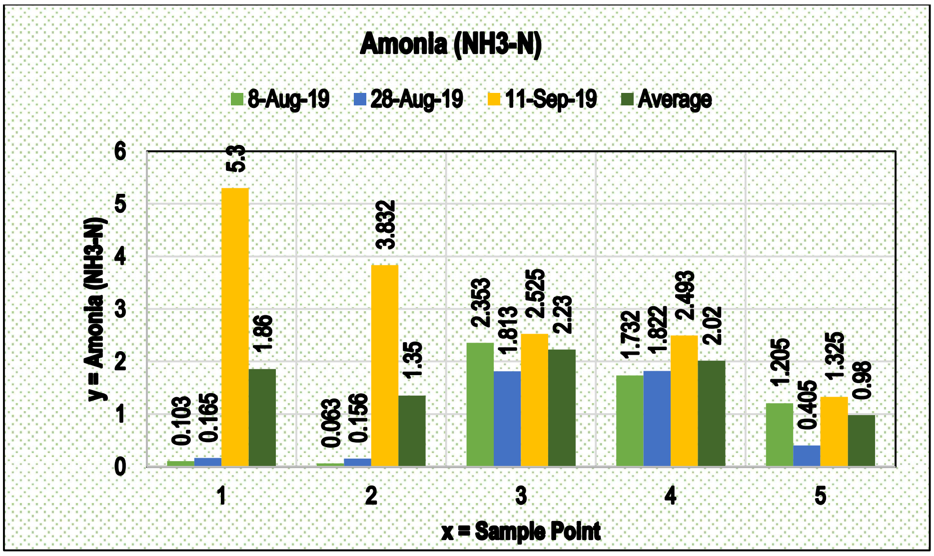


Ammonia (NH_3-N)

The results of the analysis of NH_3-N levels in the waters of the Dodokan River at sampling I (first) (sampling points 3, 4, and 5) showed that the NH_3-N parameters were above the environmental quality standard, respectively, namely 2.35 mg/l, 1.72 mg/l, and 1.20 mg/l, while the sampling points of the Batujai Reservoir (point 1 and point 2) still meet the environmental quality standards of 0.10 mg/l and 0.06 mg/l, respectively. The high value of the NH_3-N parameter at the river sample point indicates the occurrence of water pollution and disturbs fish and other aquatic organisms. This is influenced by business activities around the sampling location, both by agricultural activities and animal husbandry activities. At sampling point 3 with surrounding environmental conditions there are agricultural areas and settlements, sampling points 4 and 5 are surrounded by residential areas and other businesses such as shops and markets. From the results of the analysis, the average NH_3 content at all points shows that the NH_3 content has exceeded the environmental quality standard that has been set for class I water quality (0.5 mg/l). The location of the sampling with the highest pollution level from 3 replications of sampling if averaged at point 3 with an NH_3 value of 2.23 mg/l. This is influenced by agricultural and livestock business activities in the vicinity of the sampling locations, as well as the result of seepage of the population's septic tank flowing into the river. In general, based on the quality standard of water, it requires a maximum NH_3-N level of 0.5 mg/l. In terms of NH_3 parameters, the Batujai Reservoir water is above the environmental quality standard, so that special treatment is needed as a source of drinking water raw water.

Free ammonia (NH_3) that is not ionized is toxic to aquatic organisms. The percentage of free ammonia increases with increasing pH and water temperature. According to Effendi (2003), ammonia toxicity to aquatic organisms is influenced by pH, dissolved oxygen levels, and temperature. At low pH ammonia will be toxic if the amount is large, while at high pH conditions ammonia will be toxic even though the levels are low. When the NH_3-N level reaches 0.06 mg/l, the fish will experience gill damage and at 0.2 mg/l, sensitive fish such as some types of freshwater fish and salmon begin to die, even if the NH_3-N level approaches 2.0 mg/l some fish began to die. The results of ammonia analysis can be seen in Figure 5.

Figure 5. Results of ammonia analysis



Total Pospat

The content of phosphate in the aquatic environment is a limiting factor for the eutrophication (silting) of the aquatic environment and has a negative effect on aquatic life, because it is an unwanted anion in water which can cause a decrease in dissolved oxygen content in water. According to Adeyemo *et al.* (2003), high phosphate and nitrate content in waters can cause eutrophocation, namely increasing algae growth and reducing dissolved oxygen content in water. Phosphate compounds in waters can come from natural sources (such as soil erosion, waste from animals, and weathering of plants) and from industrial waste, agricultural waste, and domestic waste.

The results showed that the total phosphate (P) level at each sample point was point 1 0.293 mg/l, point 2 0.190 mg/l, point 3 1.299 mg/l, point 4 1.578 mg/l, point 5 0.640 mg/l. The highest value was found at observation point 4 (Karang Lebah River) 1.578 mg/l and the lowest at observation point 2 (middle Batujai reservoir) 0.190 mg/l. The results of the analysis of phosphate levels at the study site at 5 (five) observation points are presented in Figure 17 below. Based on the water quality standards for classes 1 and 2 which require a maximum phosphate level of 0.2 mg/l, it can be concluded that from the five observation points only point 2 (the middle part of the reservoir) meets the environmental quality standard class I or class II, namely 0.19. mg/l, while sample points 1, 3, 4, and 5 do not meet the quality standards for class I or class II. Based on the content of phosphate, the classification of the fulfillment of the water quality standard in each sample point of the research location is point 1 in class III, sample point 2 for class I or II, sample point 3 and 4 for class IV, and sample point 5 for class III. The existence of phosphates in the research area is thought to have originated from agricultural activities, domestic waste, especially human waste and detergents. This is in accordance with the opinion of Alaerts and Santika (1984), which states that the source of phosphate compounds can come from the waste of the population, industry and agriculture.

In agricultural areas (sample point 3) phosphate compounds come from agricultural fertilizers, which enter rivers through irrigation channels and rainwater flows. Phosphates can enter rivers through the wastewater of residents and industries using detergents that contain phosphates. This opinion is reinforced by Adedokun et al. (2008), which states that the presence of phosphate ions in river water is caused by the release of agricultural waste into rivers and or the use of phosphate additives in detergent formulations ($Na_5P_3O_{10}$) which enter water bodies through the production of industrial, domestic/urban wastewater.

The high phosphate content is related to the pH and electrical conductivity content. In accordance with the research results, it shows that the lower the pH of the waters, the tendency shows the higher the Phosphate content in these waters, for example in the results of the research sample 1 and sample 5.The highest pH is at sample point 1 (7.48), with a phosphate content of 0.29 mg/L and the lowest pH at sample point 5 (6.7), with a phosphate content of 0.64 mg/L. This is in accordance with the research results of Ferianita-Fachrul et. al., 2005 which states that pH is an indicator of water fertility, phosphate and nitrate are nutrients that are important for the growth and metabolism of phytoplankton which are indicators for evaluating the quality and level of fertility in waters, but if these two substances are very concentrated in waters and exceed the value threshold then there is eutrophication (nutrient enrichment) which is marked by the occurrence of phytoplankton bloom causing the death of various types of aquatic biota.

Biological Oxygen Demand (BOD)

Biological Oxygen Demand (BOD) is the need for oxygen to degrade organic matter into unstable organic then into more stable compounds. The amount of BOD is used as a way to indicate organic pollution in the waters. The more organic matter contained in the waters, the greater the amount of oxygen needed, so that the BOD value is greater, which indicates a high level of pollution.

The results showed that the BOD value of each observation point varied widely. The BOD value at each point ranges from 4 mg/l - 12 mg/l, with the highest value 12 mg/l at point 2 (the center of the reservoir) and point 5 (Surabaya River), while the lowest value is at point 3 (Sungai Leneng) 4 mg/l. The overall BOD value of the study location was above the quality standard threshold class 1 threshold which required a maximum BOD value of 2 mg/l. This shows that at each point the research location shows the high activity of microorganisms from the organic waste disposal. The BOD value at point 3 (three) 4 mg/l which is the lowest value at all observation points but is still classified as class III quality standard as well as for observation point 4 (four) and point 1 (one). This is in accordance with the results of research by Siradz *et al.* (2008), a high BOD value directly reflects the high activity of microorganisms in the water and indirectly provides clues about the content of suspended organic materials. The results of the BOD analysis show that the average BOD value is in the range of class III and class IV water quality standards.

Chemical Oxygen Demand (COD) is the total amount of oxygen needed to chemically oxidize materials, both those that can be degraded biologically (biodegradable) or those that are difficult to be biodegradable (non-biodegradable). The COD value can be used as a measure of high and low water pollution by organic materials which can naturally be oxidized through microbiological processes and result in reduced levels of O_2 in water.

The results showed that the COD levels in the waters of Batujai Reservoir at 5 (five) observation points respectively were: point 1 (one) 40 mg/l, point 2 (two) 60.16 mg/l, point 3 (three) 40 mg/l, point 4 (four) 45.12 mg/l, and point 5 (five) 67.68 mg/l. The highest COD values were found at point 5 (67.68 mg/l) and the lowest value at point 1 and point 3 (40 mg/l). According to Alaerts and Santika (1984), this shows that in addition to organic pollutants that can be biodegradable by microorganisms, there are also materials that cannot be biodegradable. This is confirmed by the opinion of Raja *et al.* (2008), which states that a COD value that is higher than the BOD value indicates the presence of materials that can be chemically oxidized, especially non-biodegradable materials. The results of COD analysis show that the average COD value is within the limits of class III and class IV water quality standards. The results of BOD and COD analysis can be seen in Figure 6 and Figure 7.

Figure 6. Results of BOD analysis

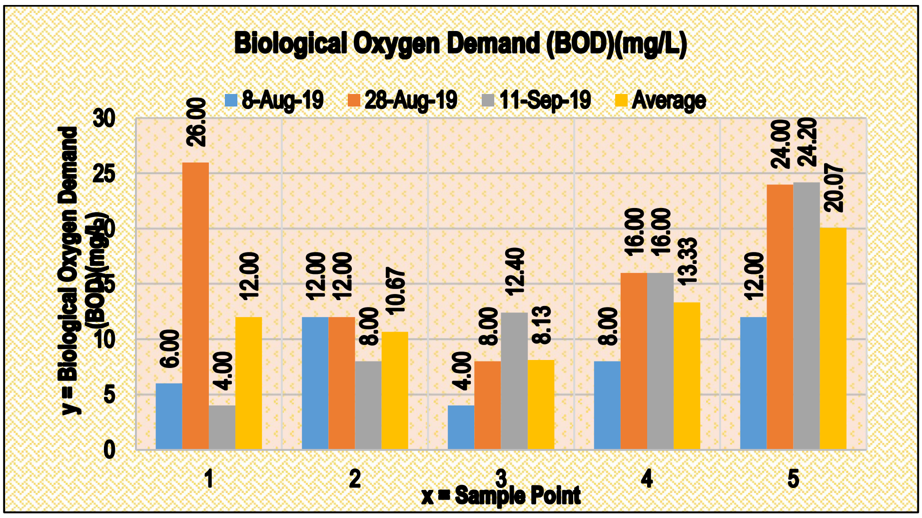
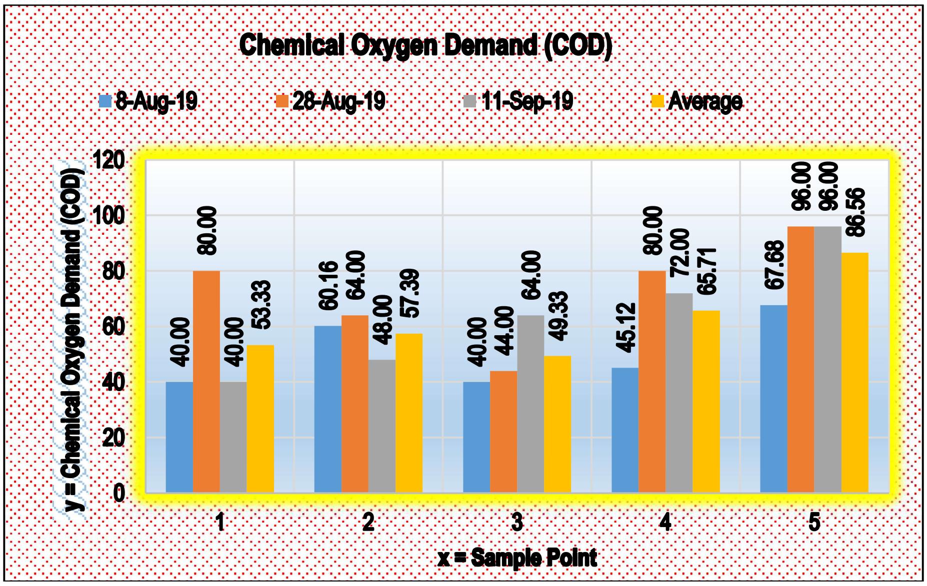


Figure 7. Results of COD analysis



Heavy Metals (Iron (Fe), Lead (Pb), and Mercury (Hg))

Iron (Fe), lead (Pb), and mercury (Hg) are heavy metal groups that cannot be degraded by the body, are toxic even in low concentrations. Its existence in the aquatic environment has become a general environmental problem. Heavy metals become dangerous due to the bioaccumulation system, which is an increase in the concentration of these metal elements in the body of a living being following the accumulation level in the food chain. The accumulation of heavy metal concentrations in nature causes heavy metal concentrations in the human body to be high, because the amount of heavy metals that accumulates is faster than the amount that is degraded.

For the type of heavy metal Lead (Pb) it was found from the results of the study that the research location was free of lead with an average accumulated value of lead content (Pb) at all sample points <0.020 mg/L or still below the specified environmental quality standard, namely 0.03 mg/L for class 1 water. For Mercury (Hg) it was found from the results of the study that the research location was free of mercury with the average accumulated value of Lead (Pb) content at all sample points still below the environmental quality standard set, namely 0.001 mg/L for class 1 water.It's just that at sample point 3 the mercury content in the sampling on August 12,.2019 reached 0.002 mg/L, which exceeds the class 1 water quality standard but meets the class 2 water quality standard, namely 0.002 mg/L. It is feared that heavy metal concentrations in the waters of the Batujai Reservoir will accumulate in aquatic biota, including fish, because the amount of heavy metal that accumulates is faster than the amount that is degraded.

Determination of Water Quality Status. Environmental Quality Index for Batujai Reservoir Waters

Determination of the water quality status of Batujai Reservoir using the Storet method as a reference in monitoring the quality of reservoir water with the aim of knowing the quality (quality) of reservoir water. The determination of the water quality status is based on analysis of physical, chemical and biological parameters. Good water quality will comply with regulations issued by the government with the maximum and minimum permissible levels (concentration). Meanwhile, to find out how far the water is called good or not, it is assessed by the STORET system. The results of the chemical analysis of each water sample are then compared with the quality standard according to the water utilization. Water quality is assessed based on the provisions of the STORET system issued by the EPA (Environmental Protection Agency, Canter, 1977) which classifies water quality into four classes, namely:

(1) Class A: very good, score = 0 meets the quality standard
(2) Class B: good, score = -1 to -10 lightly polluted
(3) Class C: moderate, the score = -11 to -30 is moderate
(4) Class D: poor, score = -31 heavily polluted

The method of assessment is:

- A negative value (-) is given if the analysis results exceed or do not meet the quality standard requirements;
- A zero value (0) is given if the analysis results meet the quality standard requirements;
- Bacteriological parameter value = 3x the value of physical parameters;
- Chemical parameter values = 2x the value of physical parameters;
- If the average number of parameters resulting from the analysis exceeds the quality standard, a value is given = 3x the value given to the maximum or minimum parameter that exceeds the quality standard;
- The number of negative (-) values of all parameters is calculated and their quality status is determined (Table 4) by looking at the scores obtained.

The STORET system is used to determine water quality standards based on the environmental parameters used. Reservoir water sampling was carried out for 3 replications in early August, late August, and early September 2019. The location for water sampling was carried out at 5 (five) sample points, namely: sample point 1 Intake of Regional Drinking Water Company (PDAM), sample point 2 central parts of the reservoir, 3 intake points of the Leneng River Dam, 4 points of intake of the Sungai Sade Karang Lebah Dam, and 5 intake points of the Surabaya River Dam. The results of the analysis of the quality status of water quality at sample point 1 are as in Table 1 below.

Tabel. 1. Status Mutu Kualitas Air Waduk Batujai Pada Titik Sampel 1 (Intake PDAM)

Quality Standards						Measurement results			Scor			
Parameter	Class I	Class II	Class III	Class IV	Unit	Maximum	Minumum	Average	Class I	Class II	Class III	Class IV
Physics												
Temperature	Dev 3	Dev 3	Dev 3	Dev 3	°C	29.5	28.41	29	0	0	0	0
EC	n/a	n/a	n/a	n/a	µS/cm	112.8	105	108.5	0	0	0	0
TSS	50	50	400	400	mg/L	63	16	32	-1	0	0	0
Chemistry												
pH	6-9	6-9	6-9	5-9	-	7.54	7.47	7.5	0	0	0	0
DO	Minimal 6	Minimal 4	Minimal 3	0	mg/L	4.83	4.03	4.56	-10	0	0	0
NH_3N	0,5	n/a	n/a	n/a	mg/L	5.3	0.103	1.86	-8	0	0	0
MBAS	0,2	0,2	1	5	mg/L	2.145	0.06	0.77	-10	-8	-2	0
Pospat	0,2	0,2	1	5	mg/L	0.514	0.293	0.38	-10	-10	0	0
BOD	2	3	6	12	mg/L	26	4	12	-10	-10	-2	0
COD	10	25	50	100	mg/L	80	40	53.33	-10	-10	-8	0
Fe	0,3	n/a	n/a	n/a	mg/L	0.782	0.06	0.52	-8	0	0	0
Pb	0.03	0.03	0.03	1	mg/L	0.02	0.02	0.02	0	0	0	0
Hg	0.001	0.002	0.002	0.005	mg/L	0.0005	0	0	0	0	0	0
Biology												
Total Coliform	1000	5000	10000	10000	MPN/100ml	6300	900	3500	-12	-3	0	0
Scor									**-79**	**-41**	**-12**	**0**

The results of the analysis of physical, chemical and biological parameters at sample point 1 (the intake of the Regional Drinking Water Company (PDAM) as in Table 1 above with a total of 14 (fourteen) environmental parameters show that in general the quality quality status is in accordance with PP 82 of 2001. in class 4 (four), while for Class 1, 2, and 3 according to the results of research and data analysis using a storage system as in Table 1 above shows that the quality of reservoir water at sample point 1 (PDAM intake) is included in class 4 with total score ≥ -31.

Conclusion

The results of the analysis of physico-chemical-biological parameters show that the condition of the Batujai Reservoir is quite apprehensive because various wastes enter the watershed body of the Batujai Reservoir. The results of the analysis with the storet system show that the water quality of Batujai Reservoir is in bad condition or heavily polluted with a pollution index above 31. Serious efforts are needed to overcome the impact of pollution in Batujai Reservoir, namely through structured planning and approaches and taking a socio-cultural approach to the community and businessmen around the reservoir.

Acknowledgment

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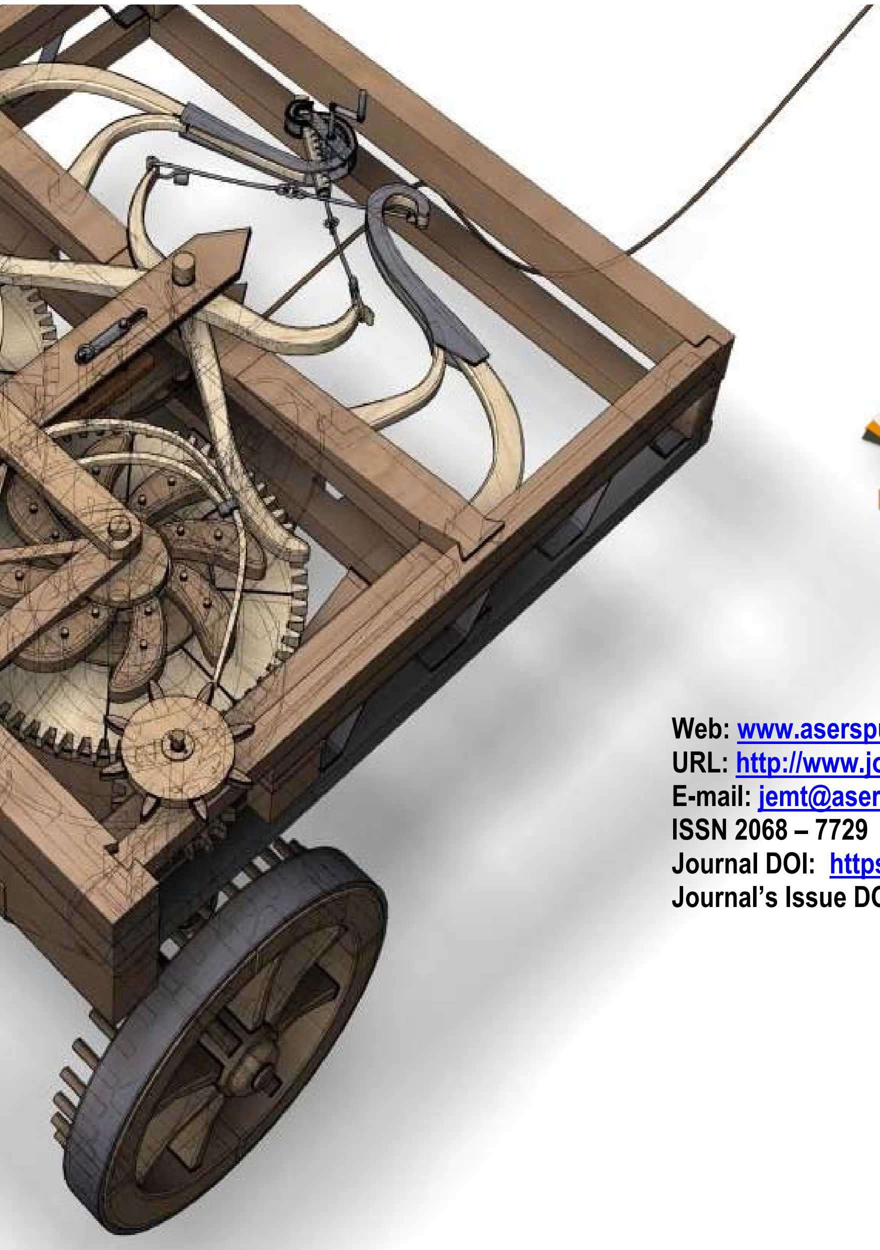

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