Analysis of Water Quality and River Waters Microbology for Manifestation of Food Safety

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Abstract. Banjir Kanal Barat is a river in the Garang watershed, Semarang City, Central Java, Indonesia. Its function is as a source of water for the community. The level of pollution in this river is already high. The purpose of this study is to provide advice to governments, communities and related stakeholders to realize integrated river management, and fisheries-based food security is achieved. This research method is: analyzing the water quality of the Banjir Kanal Barat river, and analyzing the amount of faecal and total coliform bacteria content in the Banjir Kanal Barat river, and analyzing how to overcome the decline in the quality of waters of the Banjir Kanal Barat river due to faecal and total coliform bacteria pollution. The results showed that the water quality at the research location was still in the quality standard. The content of coliform dan faecal bacteria at the study site exceeds the quality standard, this is due to the influence of domestic waste from households. The thing that needs to be done is counseling the existence of a clean and healthy life, especially for people who are still throwing domestic waste into the river. The existence of water purification equipment is also very necessary to overcome this problem. Water quality management can be done with policy analysis. Regulations related to water quality management can be analyzed and then given solutions and recommendations related to these rules so that policies can be taken that are sustainable, integrated, and coordinated between various parties in managing river water quality and food security.

Keywords: food security, water quality, river, faecal coliform, total coliform

1. Introduction

Semarang is the capital city of the province of Central Java. Industries in the city of Semarang are food, beverages, pharmaceuticals, textiles and so on, industries that do not properly process waste will pollute the river to the estuary region. Besides, the problem that occurs in the Banjir Kanal Barat (BKB)/Kanal Banjir Barat (KBB) river is the high coliform bacteria. The high faecal coliform comes from upstream areas polluted by domestic waste from housing, animal husbandry activities and leachate from manure [1]. River management must be synergistic between physical, chemical and biological aspects. This research is a study that elaborates on these aspects: water temperature, water pH, Dissolved Oxygen (DO), and microbiological aspects of river water environment: Total Coliform and Faecal Coliform and increased food safety in the fisheries. Fisheries production in Indonesia is 5.6 million tons/year in 2018. Industrial waste, especially fisheries, if not managed properly will have a negative impact on river waters causing eutrophication [2]. Management of the fisheries sector is faced with various problems namely ownership (common property resources) and the biological, chemical and physical complexity of the waters. These three aspects, if not managed properly, will lead to water pollution, which will affect the health of fish and decrease the quality of fishery products [3] which will have an impact on food security.

2. Methods

Sampling station area in Banjir Kanal Barat River, Garang watershed, Semarang, Central Java, Indonesia (Figure 1). Banjir Kanal Barat river is an estuary in the Laut Jawa. Water quality parameters studied were temperature, pH and DO. DO, temperature and pH were measured using a DO meter type

Lutron 5510. The microbiological parameters studied were faecal coliform and total coliform. Total coliform was analyzed by APHA test method 22nd, 9921.F: 2012. Faecal coliform was analyzed by the APHA 22nd, 9921.D: 2012 test method.

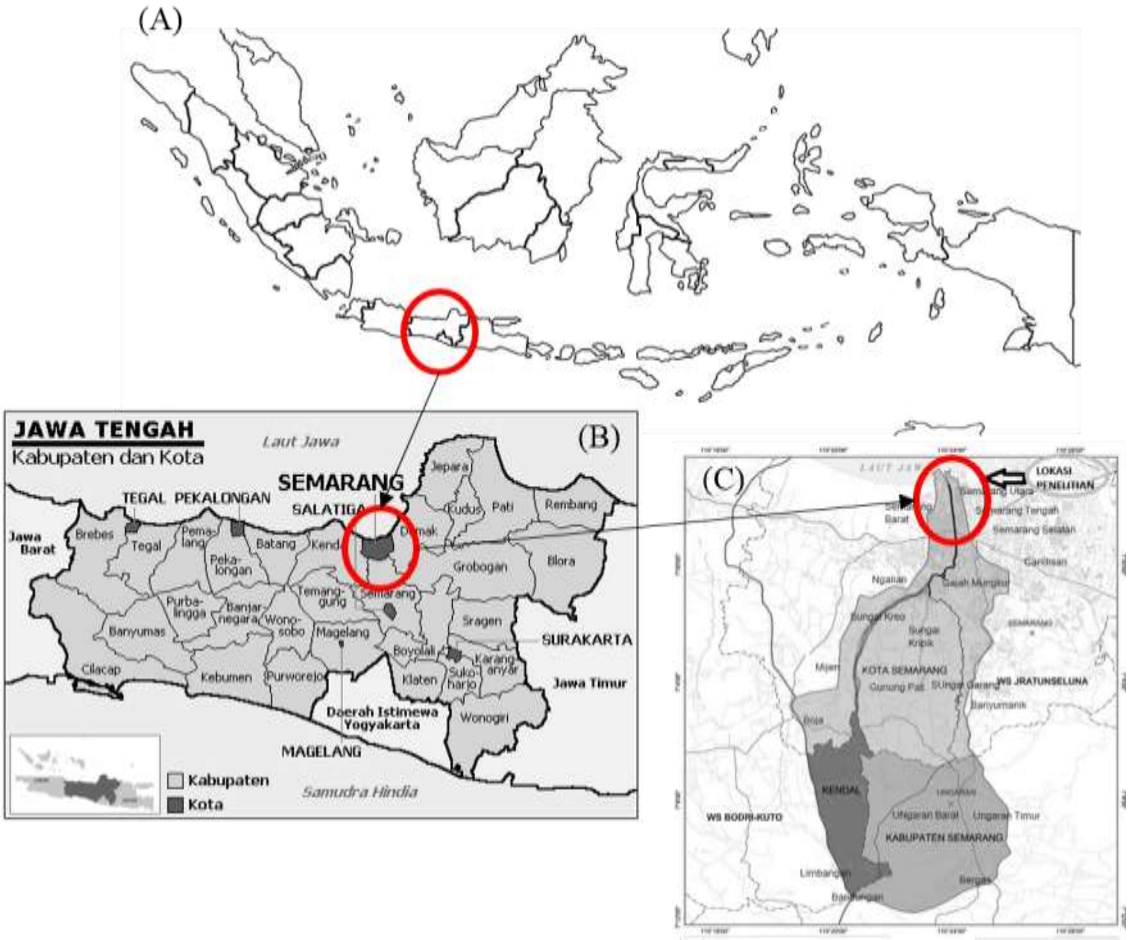

Figure 1. Study area: the map of the Indonesia (A), Central Java Province (B), Location of Banjir Kanal Barat River, Semarang, Central Java Province, Indonesia (C)

3. Results and Discussion

3.1. Water Quality

Dissolved Oxygen (DO) concentration is influenced by the chemical, physical and microbiological aspects of water. The content of coliform bacteria is high, causing low dissolved oxygen concentrations [4]. A decrease in DO is one indicator of decreased water quality [3]. This area is an area of aquaculture that is estimated to have a lot of ammonia waste from fish feed. This can cause a bad influence on the aquatic environment [27]. A good DO concentration for fisheries is 3 mg/L [5]. The range of DO at the study site is 4.6-6.5 mg/L. DO quality standard according to PP No. 82 of 2001 (Indonesia Regulation) class III that is equal to 12.2 mg / L. The DO content at the six sampling points in this study is still in the class III quality standard. At the 1C sampling point the DO conditions were the lowest compared with another sampling point, this is presumably due to the largest input of waste at this sampling point, the DO content in low waters can increase fish respiration through gills, so that the flow of water containing toxic will increase [6]. DO content is influenced by photosynthesis of water, diffusion from the air, water temperature, the process of respiration by aquatic animals that occur at the bottom of the water [7]. Conditions of water discharge are quite heavy and extreme river slope due to the inclined plane at this location three caused water bubbles to cause DO conditions to be high [8]. Changes in DO content can be daily, seasonal, and depend on mixing, water mass movement, respiration, photosynthetic activity and waste entering the water body [9]. DO requirements for fish are divided into two aspects: the consumptive needs of fish that depend on their metabolism and the aquatic environmental requirements of certain species [10]. The DO content graph is presented in Figure 2.

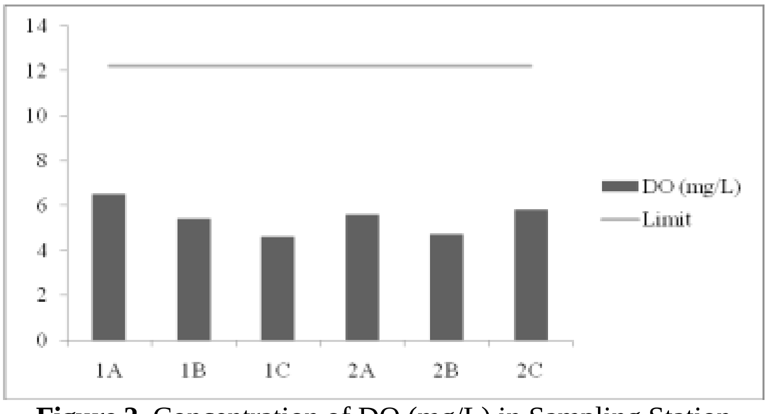

Figure 2. Concentration of DO (mg/L) in Sampling Station

pH is very important in wastewater treatment because it affects the life of the organism. The pH value at the location of this study is between 8.01 - 8.06. The value of natural pH and water that is not polluted is pH 7. The pH quality standards listed in PP 82/2001 classes I, II, and III are 6-9 while class IV is between 5-9. Class I, II, and III standards are suitable for the life of almost all aquatic organisms. Water pH at all sampling points still in PP No 82 of 2001 quality standards. The pH content is influenced by waste disposal which converts the concentration of hydrogen ions in water to acid or base because of its chemical content contained [11]. The reduced pH is influenced by an increase in rainfall intensity due to the entry of organic material into the body of water carried by the rain that enters the river [11]. The decrease in pH and salinity of waters can cause heavy metal toxicity. High hardness can reduce the toxicity of heavy metals. Heavy metals in water with high hardness to form complex compounds that settle in water [12]. An increase in pH in the waters will reduce the solubility of metals in water because an increase in pH changes the stability of the form of carbonate into hydroxide which forms bonds with particles in water bodies so that it will settle to form mud. pH affects the toxicity of a chemical compound [13]. Water pH affects plants and aquatic animals, so it is often used to determine the condition of good or poor water quality as a habitat for aquatic biota [11]. The pH is presented in Figure 3.

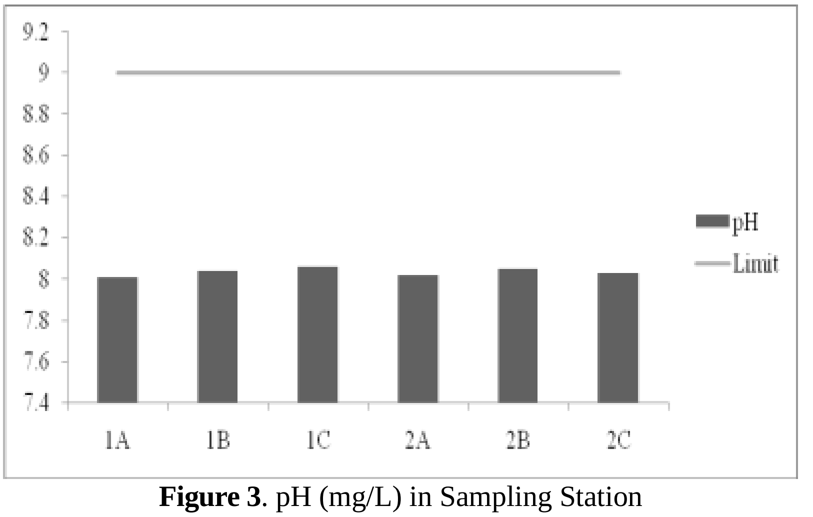

Figure 3. pH (mg/L) in Sampling Station

The temperature at the study site between 29.60C - 30.90C. Low temperatures occur due to measurements in the morning, so that not much intensity of sunlight to the river [14]. Normal water temperature in the river area is 27°C-30°C [3]. Temperature and pH are indicators for certain bacteria, for example, coliform bacteria that are tolerant of the mesophyll temperature range (25-37oC), and neutrophil pH (6.7 - 7.5) [11]. Water temperature is always related to average air temperature, which varies with the seasons [3]. Increased temperature in the river can cause heavy metal toxicity to increase [12]. The temperature in waters can be influenced by solar radiation, solar position, geographical location, season, cloud conditions and the process of interaction between water and air, such as heat transfer, evaporation and wind [15]. The correlation between air temperature and water temperature at daily, weekly, or monthly times is generally used in modeling linear or nonlinear regression types developed to predict changes in flow temperature from air temperature [16]. The temperature is presented in Figure 4.

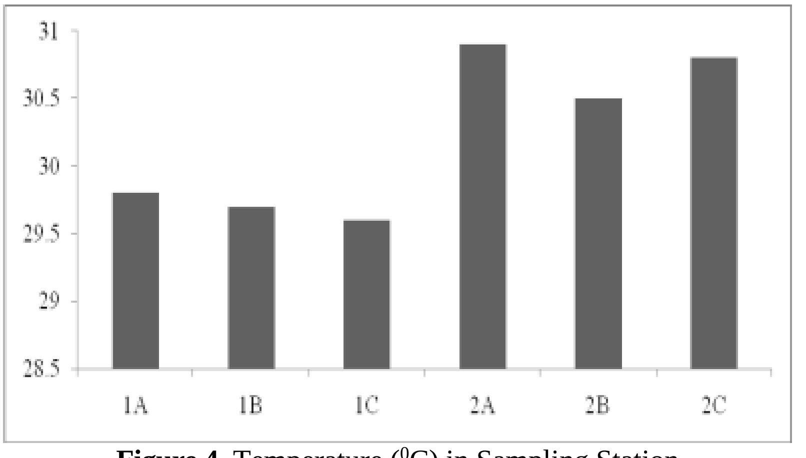

Figure 4. Temperature (^{0}C) in Sampling Station

3.2. Microbiology

River flow, urbanization, industrialization, land use, and rainfall are factors that influence the content of Fecal coliform bacteria. Build public toilets on the river causes the river to be polluted by human waste which is a source of disease. The presence of bacteria in rivers is an indicator of declining water quality. Bacteria in human waste include *Escherichia coli, Shigella sp., Vibrio cholerae, Campylobacter jejuni* and *Salmonella*, these bacteria are members of fecal coliform, which causes diarrheal disease. One way to measure total coliform, faecal coliform, or specific organisms such as *C. perfringens* or *E. coli* is that many animals have faecal indicator bacteria (FIB) in their feces [17]. Communities around watersheds that make rivers as their public toilets make river waters polluted by bacteria [9]. The distance of the septic tank to the water source and recommended is 10 meters [18]. The content of Faecal Coliform in the study location ranged from 11,000 to 79,000 MPN /100 mL. The quality standard for total coliform in PP No. 82 of 2001 amounted to 2000 ml /100 mL. The total coliform content in this study site exceeds the quality standard. Faecal coliform is used as an indicator of water pollution originating from household waste. A faecal coliform concentration>2000 MPN/100 mL is considered harmful to human health [19]. The concentration of coliform in the downstream location depends on the concentration of coliform in the upstream, and land use. Fecal coliforms become the standard needed to monitor and report microbial contamination [20]. Settlements that do not have drainage can affect coliform bacteria. Settlements that do not have a sewage treatment system, human waste is discharged directly and can affect the high fecal coliform [21]. The presence of large coli bacteria influences human life, as evidenced by the quality of drinking water, bacteriologically the level is determined by the presence of these bacteria [22]. Faecal coliform is presented in Figure 5.

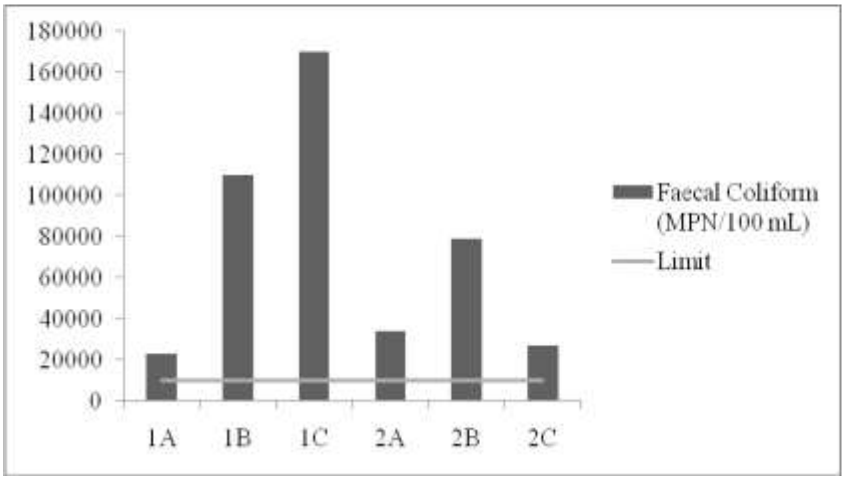

Figure 5. Faecal Coliform (MPN/100mL) in Sampling Station

A total coliform is a group of bacteria that is used as an indicator of pollution [23]. Total Coliform content in the study area ranged from 33,000 to 79,000 MPN/100 ml. Quality standard for total coliform in PP No. 82 of 2001 amounting to 10,000 MPN/100 ml. The total coliform content in this study site exceeds the quality standard. This is due to the presence of excess domestic waste in the study site because there are still many people (especially the homeless), who live around the river and immediately defecate in the river. Each person emits 100-400 billion coliforms per day in addition to other types of bacteria. The presence of *E. Coli* in water indicates fecal contamination and causes the possibility of pathogenic diseases such as bacteria, viruses and parasites and so on. The presence of coliform bacteria is caused by human activity and causes various diseases in digestion [24]. Total coliform density increases rapidly in summer at high temperatures [25]. Physical and chemical properties of waters can affect the survival rate, decay or growth of coliform bacteria. Suspended solids can affect coliform survival or growth by adsorbing coliforms and protecting it from harmful factors, such as UV radiation, metals, and bacteriophage attacks. Suspended solids can also provide coliform bacteria, organic and inorganic nutrients in particles. Coliform mortality rates increase with high water temperatures, whereas temperatures are positively correlated with coliforms. Too high pH is dangerous for the survival of coliforms [26]. The presence of bacteria in the water is influenced by abiotic factors such as temperature, pH, oxygen, humidity, and biotic factors. Water to be used for drinking, domestic, agricultural and industrial purposes is very important to be tested first on the physical, chemical and microbiological parameters of water [11]. Total coliform is presented in Figure 6.

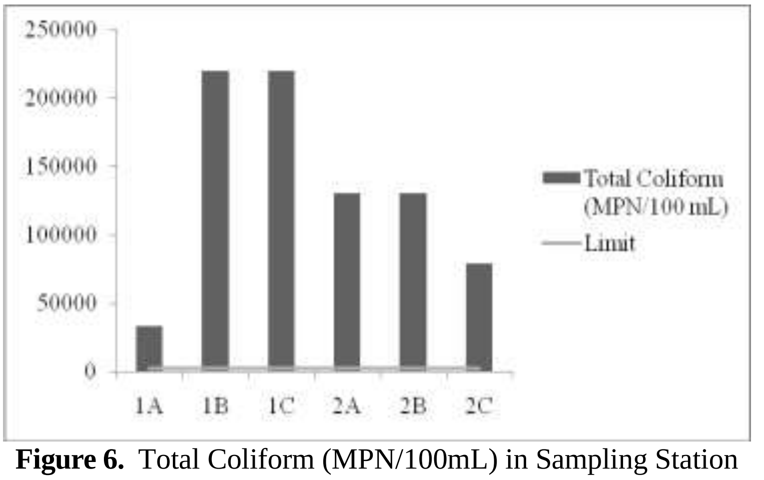

Figure 6. Total Coliform (MPN/100mL) in Sampling Station

4. Conclusion and Recommendation

Water quality at the study site still meets quality standards. The high coliform bacteria at the study site were caused by domestic and industrial waste discharges that did not meet the criteria for good waste disposal. Policy analysis needs to be done by the government to see the effectiveness of some rules regarding water quality. This research needs to be continued continuously, to monitor river water quality sustainably, and to analyze the most appropriate methods to be used in reducing some water quality parameters that exceed the quality standards.

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References

[1] Marlena, B. (2012, September). Kajian Pengelolaan Sub DAS Garang Hulu terhadap Kualitas Air Sungai. In Seminar Nasional Pengelolaan Sumberdaya Alam dan Lingkungan.
[2] Ibrahim, B., & Suptijah, P. (2009). The Utilization of Chitosan on Fishery Industrial Wastewater Treatment. Jurnal Pengolahan Hasil Perikanan Indonesia, 12(2).
[3] Syofyan, I., & Nasution, P. (2012). Studi Kualitas Air Untuk Kesehatan Ikan Dalam Budidaya Perikanan Pada Aliran Sungai Kampar Kiri. Jurnal Perikanan Dan kelautan, 16(01).
[4] Brontowiyono, W., Kasam, K., Ribut, L., & Ike, A. (2013). Strategi Penurunan Pencemaran Limbah Domestik di Sungai Code DIY. Jurnal Sains dan Teknologi Lingkungan, 5(1), 36-47.
[5] Kurniasih, N. (2002). Pengelolaan DAS Citarum berkelanjutan. Jurnal Teknologi Lingkungan, 3(2), 82-91.
[6] Hidayah, A. M., Purwanto, P., & Soeprobowati, T. R. (2014). Biokonsentrasi faktor logam berat Pb, Cd, Cr dan Cu pada ikan nila (*Oreochromis niloticus Linn*.) di karamba Danau Rawa Pening. Bioma: Berkala Ilmiah Biologi, 16(1), 1-9.
[7] Ratnapuri, V. V., Zainuri, M., Widowati, I., & Supriyanto, J. (2013). Kesuburan Perairan Berdasarkan Struktur Komunitas Fitoplankton Dalam Memprediksi Daerah Penangkapan Kerang Simping (*Amusium Pleuronectes*) Di Perairan Pemalang.
[8] Prabowo, R., & Subantoro, R. (2012). Kualitas Air dan Beban Pencemaran Pestisida di Sungai Babon Kota Semarang. Mediagro, 8(1).
[9] Warman, I. (2017). Uji kualitas air muara sungai Lais untuk perikanan di Bengkulu Utara. Jurnal Agroqua: Media Informasi Agronomi dan Budidaya Perairan, 13(2), 24-33.
[10] Zonneveld, N., Huisman, E. A., & Boon, J. H. (1991). Prinsip-prinsip budidaya ikan. PT Gramedia Pustaka Utama.
[11] Rahmawati, R., Fitria, L., & Syafitri, L. (2017). Correlation of Physical-Chemical Parameters to Total Coliform Value in Jawi River, Pontianak, West Kalimantan. Biosaintifika: Journal of Biology & Biology Education, 9(2), 370-379.
[12] Kurniawati, S., Nurjazuli, N., & Raharjo, M. (2017). Risiko Kesehatan Lingkungan Pencemaran Logam Berat Kromium Heksavalen (Cr VI) pada Ikan Nila (*Oreochromis niloticus*) di Aliran Sungai Garang Kota Semarang. Higiene: Jurnal Kesehatan Lingkungan, 3(3), 152-160.
[13] Usman, S., La Nafie, N., & Ramang, M. (2013). Distribusi kuantitatif logam berat Pb dalam air, sedimen dan ikan merah (Lutjanus erythropterus) di sekitar perairan pelabuhan Parepare. Marina Chimica Acta, 14(2).
[14] Gitarama, A. M., Krisanti, M., & Agungpriyono, D. R. (2016). Komunitas Makrozoobentos dan Akumulasi Kromium di Sungai Cimanuk Lama, Jawa Barat. Jurnal Ilmu Pertanian Indonesia, 21(1), 48-55.
[15] Bakti, L. M. (2010). Study of tidal inundation potential at Semarang City and its solutions. Diponegoro University.
[16] Kędra, M., & Wiejaczka, L. (2018). Climatic and dam-induced impacts on river water temperature: Assessment and management implications. Science of the Total Environment, 626, 1474-1483.
[17] Aburto-medina, A., Shahsavari, E., Salzman, S. A., Kramer, A., Ball, A. S., & Allinson, G.

(2019). Elucidation of the microbial diversity in rivers in south-west Victoria, Australia impacted by rural agricultural contamination (dairy farming). Ecotoxicology and Environmental Safety, 172, 356–363.
[18] Puspitasari, D. E. (2009). Dampak pencemaran air terhadap kesehatan lingkungan dalam perspektif hukum lingkungan (Studi kasus sungai Code di Kelurahan Wirogunan Kecamatan Mergangsan dan Kelurahan Prawirodirjan Kecamatan Gondomanan Yogyakarta). Mimbar Hukum-Fakultas Hukum Universitas Gadjah Mada, 21(1), 23-34.
[19] Tampubolon, R., Sanim, B., Saeni, M., & Boer, R. (2012). Analysis of Environmental Quality Changes of Citarum Watershed of West Java and their Effects on Operational Costs of Hydroelectric Power Plans and the Regional Drinking Water Companies (Case Study at Saguling, Cirata, and Jatiluhur Hydroelectric Power Pl.
[20] BenDor, T. K., Jordanova, T. V., & Miles, B. (2017). A geospatial analysis of land use and stormwater management on fecal coliform contamination in North Carolina streams. Science of The Total Environment, 603, 709-727.
[21] Reder, K., Flörke, M., & Alcamo, J. (2015). Modeling historical fecal coliform loadings to large European rivers and resulting in-stream concentrations. Environmental Modelling & Software, 63, 251-263.
[22] Widiyanti, N. L. P., & Ristiati, N. P. (2004). Qualitative analysis of coliform bacteria at some shops refilled drinking water in Singaraja Bali. Jurnal Ekologi Kesehatan, 3(1), 64-73.
[23] Pakpahan, R. S., Picauly, I., & Mahayasa, I. N. W. (2015). Cemaran Mikroba Escherichia coli dan Total Bakteri Koliform pada Air Minum Isi Ulang. Kesmas: National Public Health Journal, 9(4), 300-307.
[24] Divya, A. H., & Solomon, P. A. (2016). Effects of some water quality parameters especially total coliform and fecal coliform in surface water of Chalakudy river. Procedia Technology, 24, 631-638.
[25] An, Y. J., Kampbell, D. H., & Breidenbach, G. P. (2002). Escherichia coli and total coliforms in water and sediments at lake marinas. Environmental Pollution, 120(3), 771-778.
[26] Hong, H., Qiu, J., & Liang, Y. (2010). Environmental factors influencing the distribution of total and fecal coliform bacteria in six water storage reservoirs in the Pearl River Delta Region, China. Journal of Environmental Sciences, 22(5), 663-668.
[27] Ujianti, R. M. D., Anggoro, S., Bambang, A. N., Purwanti, F. & Androva, A. (2019). Environmental Study on Phytoplankton in Garang Watershed, Central Java, Indonesia and Its Water Quality, IOP Conference Series: Earth and Environmental Science, 246, 012070.