

Spatio-temporal distribution of chlorine in the upper Tondano Watershed North Sulawesi Indonesia

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Spatio-temporal distribution of chlorine in the upper Tondano Watershed North Sulawesi Indonesia

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Abstract. Water resources are one of the natural resources that are vital both for the life of organisms on the earth as well as for daily human needs in various sectors of life. Due to limited resources, water management becomes essential. A study in the spatial-temporal of chlorine on the Tondano watershed is important because domestic agricultural waste has the potential to cause residues and affect water quality degradation. This study aims to examine the spatial and temporal distribution of chlorine in the upper Tondano watershed throughout seven years (2013-2019). Water sampling was carried out using the composite sampling method on the river and irrigation channel outlets. Chlorine concentration was measured by UV-VIS Spectrophotometry method, and other water quality parameters such as pH and temperature were measured in the field. The chlorine concentration fluctuated for each month during 2013 – 2019 (0.02 mg/L to 0.59 mg/L, Quality Standard PP 82/2001 chlorine 0.03 mg/L). The highest values were in March, September, and November. The trend showed that chlorine levels were above the quality standard in March and November. The high concentration of chlorine in the Panasen River water bodies is partly due to the application of KCl fertilizers and, pesticides in rice fields and horticultural lands, as well as domestic waste.

1. Introduction

A watershed is a land area that is topographically bounded by ridges that collect and store rainwater and channel it to the sea through the main river. A watershed is an ecological system consisting of biotic and abiotic components that are integrated to form an organized unity [1]. Thus, in an ecosystem, each has a relationship with other components. As a dynamic component, humans in carrying out their activities often have an impact on the component of the aquatic environment as a result of domestic waste generated and thus affect the ecosystem as a whole. Chlorine compounds utilization is currently increasing, as in the use of chlorine in water treatment. Chlorine chemical compounds (CaOCl_2) at a low percentage can be used as water purifiers, bleach clothing, kill larvae, disinfectants for drinking water and industry, as well as the use of chlorine for pesticides and inorganic fertilizer KCl [2]. The physical and environmental conditions of the Tondano watershed are important to be examined in the aspect of chlorine distribution, both spatially and temporally. Settlement and agriculture activities in the watershed are potentially contributing to cause residues in the aquatic environment, in this case, is the Panasen River as one of the inlets of Lake Tondano. Some of the organochlorine compounds are carcinogenic at relatively high doses in animals. There thus may be a potential hazard in the lifetime consumption of drinking water with concentrations of a few g/L these disinfection by-products [9].



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Panasen River quality is assessed based on some criteria such as the limit or the level of living things, substance, energy, or components that exist or must exist and or pollutants tolerated in the water (The Law No. 82/2001 concerning the Management of Water Quality and Water Pollution Control). According to the law, water quality is classified into four grades, namely: (a). Grade 1, raw water that can be used for drinking and/or other usages that require the same water quality; (b). Grade 2, water that can be used for water recreation infrastructure/facilities, freshwater fish farming, livestock, irrigation, and/or other usages that require the same water quality; (c). Grade 3, water that can be used for freshwater fish farming, livestock farming, crop irrigation, and/or other usages which require the same water quality; (d). Grade 4, water that is designated for irrigating, planting and/or other usages, which require the same water quality [3]. The intensive agricultural activity in the Tondano watershed has been going on for many years and has resulted in agricultural residues that have the potential to reduce surface water quality. It is important to evaluate the spatial and temporal distribution of chlorine residues so that appropriate environmental management can be taken. This research aimed to examine the spatial and temporal distribution of chlorine in the upstream of the Tondano watershed.

2. Methods

Water sampling was carried out using the composite sampling method [4] in two locations of River Panasen (figure 1) which cross settlement and agricultural land. Data were obtained by measurement of some parameters in the field (pH and water temperature using portable instruments) and laboratory (chlorine concentration using UV-VIS Spectrophotometry method) from 2013 to 2019 (seven years). The water quality data were compared to the Indonesian Water Quality Standards (Law PP No. 82/2001 Class II concerning the Management of Water Quality and Water Pollution Control) [3]. Class II is water, which can be used for water recreation, infrastructure/facilities, freshwater fish farming, livestock farming, crop irrigation, and/or other uses that require the same water quality.

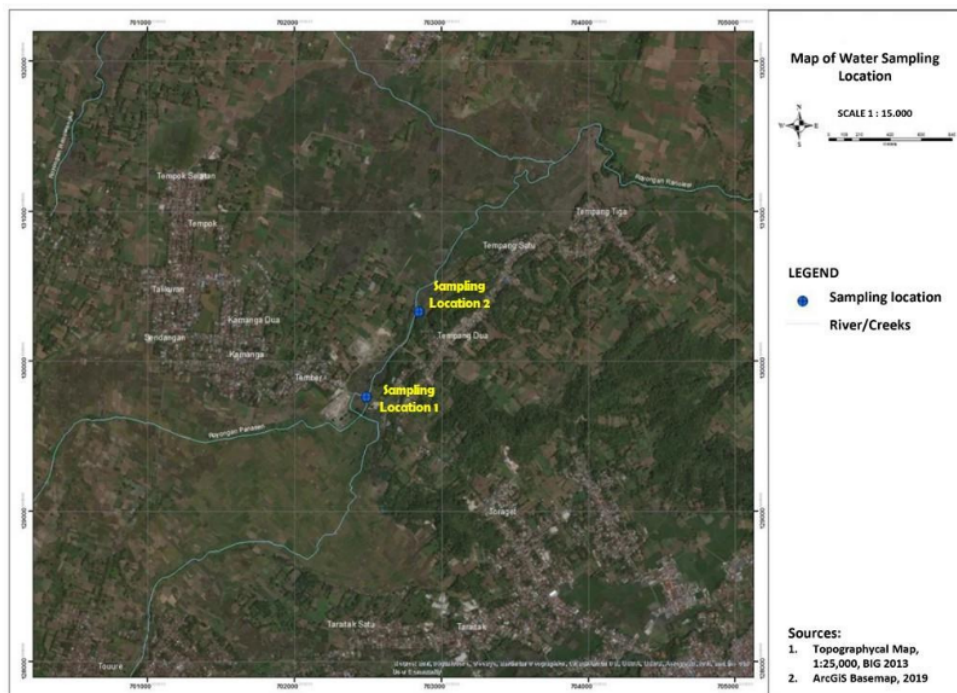


Figure 1. Map of water sampling location

3. Results and Discussion

The main problems in the Tondano River watershed are the existence of residual content of domestic and agricultural wastes. The seven years' observation (2013-2019) and twenty-one planting seasons showed that the amount of KCl fertilizer used was 50 Kg/ha. The dominant agricultural residues are leached during fertilization in agricultural activities. Around 77% of the catchment area is used for intensive agricultural cultivation, and the rest is in the form of forests, settlements, swamps, and solfatara [5]. High concentrations of chlorine are found spatially in the Panasen River (figure 1). These locations are located on the upper reaches of the Tondano watershed, which crosses through the settlements and agricultural land.

Figure 2 shows that the chlorine concentration fluctuated for each month in each of the years. The highest values were found in November 2014 (River Panasen 1= 0.44 mg/L, River Panasen 2 = 0.59 mg/L), November 2015 (River Panasen 1= 0.03 mg/L, River Panasen 2 = 0.26 mg/L), and November 2016 (River Panasen 1= 0.08 mg/L, River Panasen 2 = 0.06 mg/L) (referred to the Indonesian National Quality standard for chlorine concentration is 0.03 mg/ l). The results also showed that measured chlorine levels which exceeded the national quality standards occurred in March (2013, 2015, 2016, and 2019) and June 2019. The trend shows that chlorine levels were above the quality standard in March and November. According to the local farmers, fertilizing the land and spraying pesticides are generally carried out in March (when planting in February) and November (when planting in September) which the plants have been grown in 1.5 – 2 months. The high chlorine concentration in Panasen River water was partly due to the application of KCl fertilizer, pesticides on rice fields, and horticultural land. The southern region of Lake Tondano is dominated by wetland agricultural with a vast rice field area of about 2,924 ha [5]. Chloride inputs to watersheds are most often from

atmospheric deposition, road salt/chloride salt of sodium, calcium, magnesium and potassium, or agricultural fertilizer [6]. Also, it could be from some specific pollutants, such as chlorinated hydrocarbons produced from municipal and industrial waste [7]. Wastewater containing household effluent and human wastes is discharged directly to a natural drain or water body and open agriculture land [8]. Chlorine and its compounds are widely used for water disinfection because they are readily available as gas, liquid or powder and the prices in the market are generally low. Chlorine has a relatively high solubility (7,000 mg/L) that can leave a residual in solution, which can be harmful to humans and is very toxic to most microorganisms [9]. Chlorine can negatively affect the metabolic activity in organisms. Recently, domestic wastes contain many chlorine-substances such as household appliances, medical devices, paper, drugs and pharmaceutical products, refrigerants, cleaning sprays, solvents, and various other products [10]. Burning waste or solid waste containing chlorinated hydrocarbon compounds may cause the formation of harmful organochlorine compounds such as dioxin. The water supply management sector is responsible for resolving this problem by conducting a thorough water monitoring as well as using chlorine strictly to its standard limit for minimizing the harmful effect on the organisms [11]. Therefore the most appropriate management of water resources is needed. The proper management of water resources of the upper Tondano watershed is to minimize the residual of chlorine by implementing soil and water conservation.

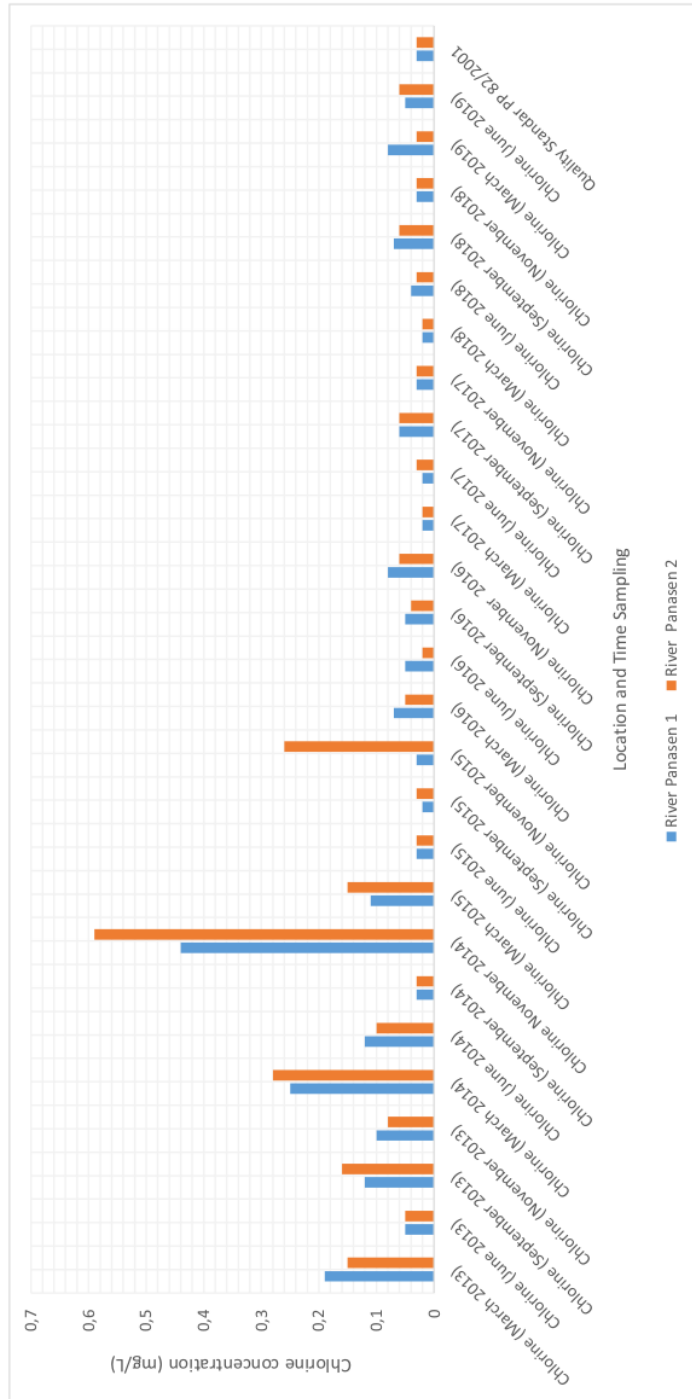


Figure 2. Chlorine concentration in the upstream of Tondano Watershed (Data 2013-2019).

4. Conclusion

The chlorine concentration in River Panasen has exceeded the threshold quality standards as the Government Regulation No. 82 of 2001 Class II on Water Quality Management and Water Pollution Control. The main sources of chlorine may come from fertilizers and pesticides, which the concentrations were fluctuated depending on the time of land fertilization and pesticide spraying which occurred in March and November. Land use and water management in the upper Tondano watershed is needed to protect the water ecosystem.

5. References

- [1] Asdak C 2004 *Hidrologi dan Pengelolaan Daerah Aliran Sungai* (Yogyakarta: Gadjah Mada University Press)
- [2] McGuire M J 2013 *The Chlorine Revolution Water Disinfection and The Fight to Save Lives* (Denver: American Water Works Association) p 359
- [3] Peraturan Pemerintah Nomor 82 tahun 2001 tanggal 14 Desember 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air .
- [4] Hadi A 2015 *Pengambilan Sampel Lingkungan* (Jakarta: Erlangga)
- [5] Luntungan J N 2014 *Dinamika Spasial Penggunaan Lahan Pertanian Berdasarkan Citra Penginderaan Jauh, Tinjauan Dalam Rangka Menuju Pertanian Lestari Di Daerah Aliran Sungai (DAS) Noongan dan Panasen Kabupaten Minahasa Provinsi Sulawesi Utara* (Disertasi (Yogyakarta: Program Pasca Sarjana Fakultas Geografi Universitas Gadjah Mada)
- [6] David M B C A, Mitchell L E, Gentry and Salemm R K 2016 *J. Environ. Qual.* **45** 341
- [7] Azizullah A, KhanKhattak M N, Richter P and Hader D P 2011 *J Environment International* **37** 479-497
- [8] Mesias A and Garrote L 2015 *J Agriculture Water Managemnet* **155** 113-124
- [9] Tebbutt T H Y 2002 *Principles of Water Quality Control (fifth edition)* (New York: Butterworth Heinemann) p 280
- [10] Hasan A 2006 *J. Tek.Ling* **7** 90
- [11] Abid K, Alamgir A, Zahid Y, Mahar K, Arif S, Zehra W, Hany O, Mehmood Kh and Sherwani S Kh 2014 *Jurnal Agric. & Environ. Sci* **14** 1317

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