

WATER QUALITY MODELING OF CINAMBO RIVER

TESIS



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**MASTER DOUBLE DEGREE PROGRAM BETWEEN
PARAHYANGAN CATHOLIC UNIVERSITY
AND HOHAI UNIVERSITY
INDONESIA-PR CHINA
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Proposed as one of the conditions to be able to follow thesis defense



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WATER QUALITY MODELING OF CINAMBO RIVER



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ABSTRACT

Water pollution is considered as one of the challenging problems to deal with in the future. Facts showed how bad water pollution has occurred in many countries especially in the developing countries. Some reports have indicated that many rivers in Indonesia are no longer safe for human contact. This study is aimed to promote how river water pollution can be managed by understanding deeper about the problem and implementing strategic policy based on mathematical modeling. Cinambo River is one of the Citarum River's tributaries which has a crucial role to supply raw water for drinking water and fisheries for the surrounding area. Due to its severe pollution, however, the water quality of Cinambo River has deteriorated significantly. This study has made use of HEC-RAS model in order to model the mass transport of contaminants resulted from the domestic wastewater discharged along the river. Because of limited data availability, this study focuses on a river reach that receives domestic wastewater from the two sources at the upstream. Some scenarios have been considered to understand the problem and simulate best option for water quality management of Cinambo River. Based on the result obtained, it is showed that the Dissolved Oxygen (DO) of Cinambo River will be decreased down to 2.28 mg/liter at maximum due to high concentration of organic wastes discharged into the river. While when the volume of wastewater is increased up to 3 times greater, the DO of Cinambo River will decrease to 1.05 mg/L. To restore the situation, domestic wastewaters discharges have to control until 40 l/s, so that DO increase to 6 mg/L.

Keywords: water pollution control, Cinambo River, domestic wastewater, HEC-RAS.

摘要

水污染是最具挑战性的环境问题之一，事实证明，当今世界上许多国家正面临严重的水污染问题，尤其是发展中国家。一些研究表明，印度尼西亚的许多河流对当地居民的生产生活来说已经不够安全。本文旨在通过深入分析问题并利用数学模型的方法，对如何治理河流污染提供重要参考意见。

Cinambo 河是 Citarum 河的支流之一，它的重要作用是促进周围地区的渔业发展并为当地居民提供饮用水。然而，由于污染加剧，Cinambo 河的水质已经严重恶化。

本文利用 HEC-RAS 模型，模拟了沿河流排放的生活污水所产生的大量污染物的浓度变化。由于数据有限，本文重点对受到上游两种生活污水影响的河段进行研究。同时，为便于理解，本文计算并分析了几种不同条件下污染物的浓度变化。结果表明，由于高浓度有机污水排入河中，Cinambo 河的溶解氧(DO)浓度将减少到 2.28 mg/L；当污水量增加到 3 倍以上时，Cinambo 河的溶解氧浓度将减少到 1.05 mg/L。为避免这种情况的发生，溶解氧的浓度需提升到 6mg/L，因此，本文建议应将生活污水的排放速率控制在 40L/s 以下。

关键词：水污染治理；Cinambo 河；生活污水；HEC-RAS

ABSTRAK

Pencemaran air dianggap sebagai salah satu masalah yang menantang untuk dihadapi di masa depan. Fakta menunjukkan bagaimana polusi air yang buruk telah terjadi di banyak negara terutama di negara-negara berkembang. Beberapa laporan menunjukkan bahwa banyak sungai di Indonesia tidak lagi aman untuk kontak manusia. Penelitian ini bertujuan untuk mempromosikan bagaimana pencemaran air sungai dapat dikelola dengan memahami lebih dalam tentang masalah dan menerapkan kebijakan strategis berdasarkan pemodelan matematika. Sungai Cinambo adalah salah satu anak sungai Sungai Citarum yang memiliki peran penting untuk memasok air baku untuk air minum dan perikanan untuk daerah sekitarnya. Karena polusi yang parah kualitas air Sungai Cinambo telah memburuk secara signifikan. Studi ini telah menggunakan model HEC-RAS untuk memodelkan transportasi massal kontaminan yang dihasilkan dari air limbah domestik yang dibuang di sepanjang sungai. Karena keterbatasan ketersediaan data, penelitian ini berfokus pada jangkauan sungai yang menerima air limbah domestik dari dua sumber di hulu. Beberapa skenario telah dipertimbangkan untuk memahami masalah dan mensimulasikan opsi terbaik untuk pengelolaan kualitas air Sungai Cinambo. Berdasarkan hasil yang diperoleh, menunjukkan bahwa *Dissolved Oxygen* (DO) dari Sungai Cinambo akan menurun hingga 2,28 mg/liter pada kondisi maksimum karena konsentrasi tinggi limbah organik dibuang ke sungai. Sementara ketika volume air limbah meningkat hingga 3 kali lebih besar, DO dari Sungai Cinambo akan turun menjadi 1,05 mg/liter. Untuk memulihkan situasi, pembuangan air limbah domestik harus dikontrol hingga batas maksimal 40 liter/detik, sehingga DO meningkat menjadi 6 mg/liter.

Kata Kunci : pengendalian polusi air, sungai cinambo, limbah domestik, HEC-RAS

PREFACE

In the name of Allah SWT, the Most Gracious, the Most Pious, We praise and thank God for His presence, who has bestowed His grace, guidance, and inayah on us so that we can finish a paper on Water Quality Modeling of Cinambo River using the HEC-RAS Software.

This thesis we have compiled with the maximum and get help from various parties so as to facilitate the making of this paper. To that end, we extend our gratitude to all those who have contributed in the making of this paper.

Apart from that, we are fully aware that there are still shortcomings in terms of both sentence and grammatical arrangements. Therefore with open arms, we receive all the suggestions and criticism from our readers so that we can improve this scientific paper.

Finally, we hope that the paper on waste and its benefits for the community can provide benefits and inspiration to the readers.

Bandung, August 4th, 2017
The Author

Adhita Prasetya

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CHAPTER 1

INTRODUCTION

1.1 Background

Water is the source of life of all beings on earth, water flows from the spring at the mountain through the rivers and ends at the sea. The flowing water provides great benefits for human life, especially for agriculture, farm, fishery, sanitation and other. Based on Bruins in 2000, it was estimated that there will be water scarcity problems in 118 countries by end of 2025. Approximately 1 billion people face absolute water scarcity because they live in arid regions that lack sufficient water resources. Another 348 million people face severe water scarcity because they live in regions where existing water resources require high-cost water-acquisition developments such as dams, wells, reservoirs, and aqueducts to tap their potential (Bruins, 2000).

United Nation, on the other hand, has reported that the water quality of many rivers worldwide has been decreased significantly. The degradation of water quality can be happened due to various activities of humans, industries, agricultures, farming, improper sanitation, et cetera in form of point source or non-point source of pollutions (Yudianto, 2007). In form of point source, the pollution may come from one specific place such as outfall which it is practically easier to be identified. While non-point of pollution in general comes from a vast area such as agriculture, storm run-off, et cetera which much harder to trace.

Water pollution control is a crucial action to do as it would endanger the aquatic life and cause not only water borne disease but also death of human being.

How severe the impact of this pollution can be basically identified from the concentration of some water quality parameters, such as Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonium (NH₃), Total Phosphorus (TP), Total Nitrogen (TN), et cetera.

Urbanization is a major problem in water resources management. This problem is generally faced by the Bandung City, with rapidly growing urban population growth and concentrated in marginal areas. Thus, land conversion for settlements in urban areas of urban agglomeration is intensified. This rapid development in most cases is not followed by adequate sanitation systems, resulting in various water pollutions.

The development of Gedebage District with total area of 712.36 ha is projected by the Bandung City government to have various functions, covering the development of business facilities, commercial, sport, shelter, and recreation. At present, the existing facilities surrounding the region are container terminals that are local, regional and national (Bandung spatial plan of 2011 - 2031). The area also has high accessibility both from major regional roads, access from toll roads, and rail accessibility. In addition, there are plans to build inter-provincial bus terminal, the sub-terminal of city transportation as well as regional passenger train station facilities. All those infrastructures will be built on the existing paddy field.

To do so, the Bandung City government has conducted several studies such as the Study of Area Arrangement of Gedebage and Ujung Berung (2001), Artificial River Intersection Building Planning Ticketing and Artificial Lake Gedebage (2001), Integrated Terminal Termination Plan Gedebage Bandung

(2001), Feasibility Study Access Tol Gedebage Bandung (2002), Planning of the Sports Stadium, RTBL Integrated Terminal Gedebage (2002), Development Vision / Master plan Gedebage (2003), Scenario of Development of Trade and Service Centers of East Bandung Area (2003), Cisaranten River Improvement Plan (2003).

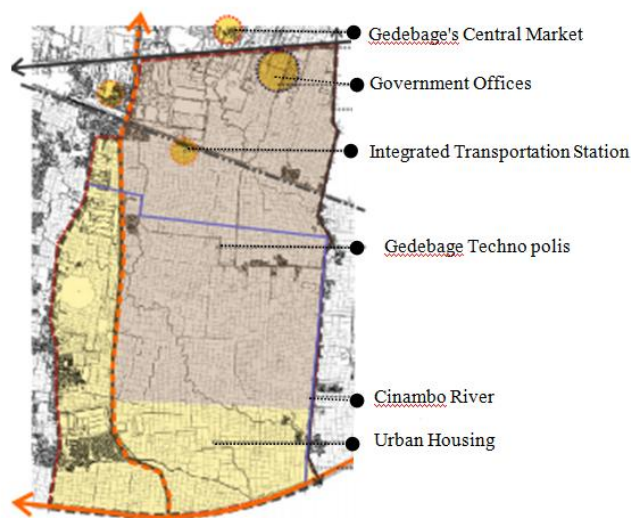


Figure 1. 1 Masterplan of Gedebage technopolis area

Based on the conducted studies, it is known that the development of Gedebage District will have a serious impact on environmental degradation even though it is in general has a positive contribution to the economic aspects. One of negative impacts on the environment is degradation of river water quality due to change of land use for developing urban housing and commercial area (azamiah et. al, 2016). Cinambo River is one of the most impacted rivers as it is located within the Gedebage development area. This river so far has been used as receiving water body for all domestic waste from the related area before it then flows to Cisaranten River as one of the tributaries of Citarum River. In this study, the selected reach of Cinambo River is mainly located in Cimencrang Village.

This river reach is selected since it is located in the downstream area and receives most domestic waste. Clear location and scheme of the selected river reach are presented in the following Figure 1.2 and Figure 1.3. While as a description of the river condition at present time, as presented in the Figure 1.4, it can be noticed that the Cinambo River at the selected reach is badly polluted with a very dark black colour.

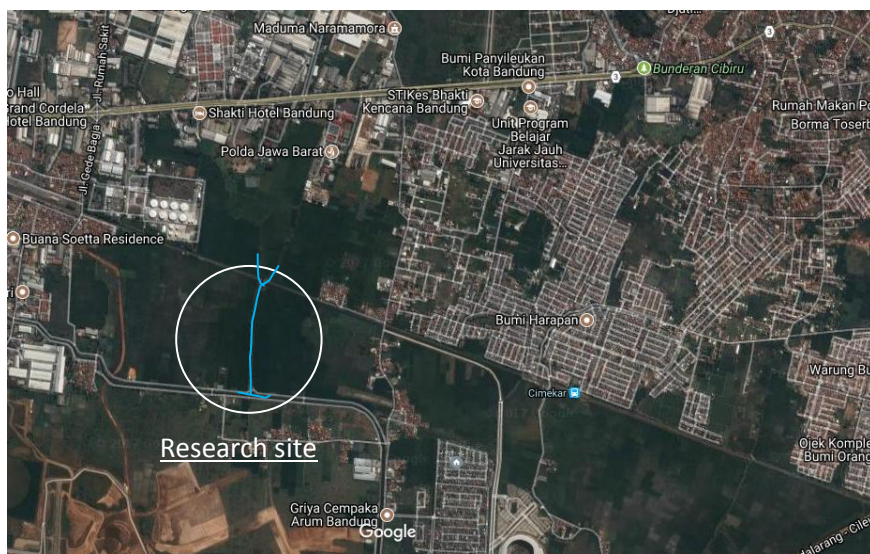


Figure 1. 2 Detail location of Cinambo River

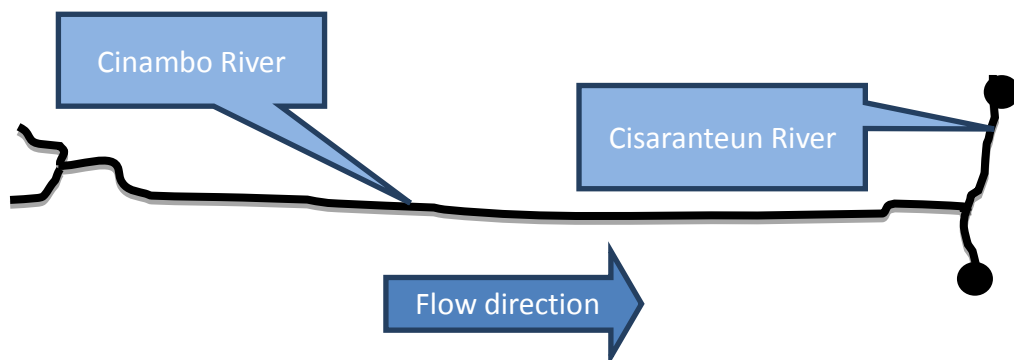


Figure 1. 3 Scheme of Cinambo River System



Figure 1. 4 Description of downstream of Cinambo River

Based on the reason above, this study is aimed to identify the dominant source of pollution in Cinambo River and simulate its condition under several scenarios, and propose a solution as regard to the pollution control of Cinambo River.

1.2 Degradation of River Water Quality in Cinambo River

According to the water quality test at some of the tributaries of Citarum River, as presented in Table 1.1., it is showed that there has been a significant decrease of river water quality parameters in upstream rivers such as pH, DO, BOD, COD, TP, and NH_3 . Although all of those tributaries contain considerable concentration of DO, but both Citarik River and Cinambo River showed a poor water quality in terms of BOD. Referring to the water quality standard of class III which describes raw water for irrigation and fisheries, the BOD concentration of both rivers is below the required standard.

Table 1.1 Results of water quality test at upstream tributaries of Citarum River

Parameter	unit	Concentration				
		Standard (class 3, PP No. 82/2001)	Outlet Situ Cisanti	Majalaya	Citarik	Cinambo (2017)
Organic Chemistry						
pH		6-9	7.9	8.9	8.2	8.1
DO	mg/L	≥ 3	5	5	5	5.1
BOD	mg/L	6	2.8	7	21	20
COD	mg/L	50	<7	14	50	-
NH ₃ -N	mg/L	(-)	0.1	8	0.51	2
TP	mg/L	0.2	-	-	-	0.18

Source: Perum Jasa Tirta II

1.3 Research Objectives

As mentioned above, this study basically aimed to water quality modeling due to the increased value of BOD parameter. Some specific objectives are given as follow:

- To identify source of domestic wastewater along the Cinambo River
- To identify the Cinambo River's ability to promote its self purification process due to maximum load of domestic waste
- To propose a solution to control the water pollution in Cinambo River

1.4 Research Urgency

As explained above, the Cinambo River has been suffering from serious water pollution. Since there will be a massive land development of Gedebage District next to the Cinambo River, the water pollution may get even worse if it is not facilitated with a strategic water pollution policy. This study is aimed to provide a solution designated to the related decision maker in order to restore and enhance the sustainability of Cinambo River.