BOD-DO System Dynamic Modeling of The Ciliwung River Second Segmenr

by Ramadhani Yanidar

PROCEEDING

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THE 3rd INTERNATIONAL SEMINAR ON SUSTAINABLE URBAN DEVELOPMENT

Trisakti University

17 September 2014, Jakarta - Indonesia

THE DYNAMICS OF URBAN AND ENVIRONMENT TOWARDS CLIMATE CHANGE: PLANS, STRATEGIES AND PRACTICES

Faculty of Landscape Architecture and Environmental Technology, Trisakti University

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BOD-DO SYSTEM DYNAMIC MODELING of THE CILIWUNG RIVER SECOND SEGMENT

Ramadhani Yanidar[1], Budi Rahayu Kosasih[2], Sunlita Citra Tanggyono[3]

Environmental Engineering,
Faculty of Lanscape Architecture and Environmental Technology, Trisakti University
Jl. Kyai Tapa No. 1, Jakarta 11440, Indonesia

E-mail : r.yanidar@gmail.com, kosasih_b@ymail.com, sunlitacitra@yahoo.com

Abstract

Ciliwung River with total length ±117 km is one of the most important rivers in West Java. The second segment of Ciliwung River which is across the Kabupaten and Kota Bogor has the length of watershed reaches approximately 16 km from the Sindang Rasa District to the Cibuluh District. Along that segment, there are various domestic and non domestic activities as a potential source of contaminants. The main indicators of river pollution which deals with the oxygen domestic conditions of the river are Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO). A system dynamic model was constructed using the POWERSIM software, and used to describe the tendency of river water quality fluctuation at certain part. The population data and sanitation coverage was used to estimate for the analysis of point source pollution in terms of BOD and DO concentration. The validation of accuracy performance has been tested. The data show that error percentages of the simulation results of river water quality using this model are 27.89% for BOD parameter and 21.99% for DO parameter. Further it has been compared to the scenario if implemented involves 100% sanitation service percentage for all domestic wastewater sources. In the second scenario, there is a communal wastewater treatment plant covering all the domestic wastewater from the first part to the sixth part of the river with average sanitation service percentage and 85% BOD removal efficiency. Even though both scenarios give rather similar results, the second scenario shows a more stable result with relatively smaller BOD concentration compared with the first scenario.

Keywords : BOD, DO, System Dynamic, POWERSIM, Ciliwung River Second Segment

1. Introduction

Ciliwung River with total length ±117 km is one of the most important rivers in West Java. Its upstream comes from Telaga Mandalawangi Mountain at Bogor District and its downstream locates at Jakarta Bay. Ciliwung River divided into five segments based on the administrative area which are first segment (Bogor District), second segment (Bogor City), third segment (Bogor District), fourth segment (Depok City), fifth segment (Jakarta) (based on: Rejuvenation Masterplan of Ciliwung River Water Quality in 2005). Ciliwung River second segment with total length approximately 16 km pass through Bogor City from Sindang Rasa District to Sukaresmi District.

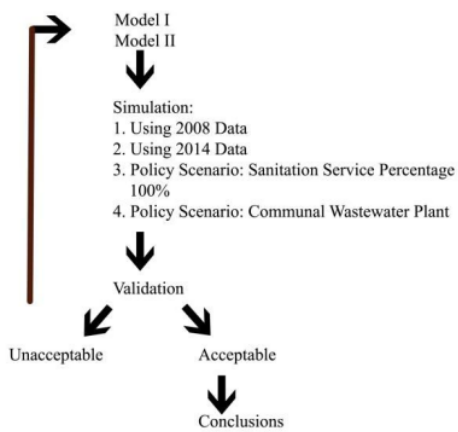
Total domestic population near the area of Ciliwung River second segment relatively enormous. Actually, domestic sewage is usually disposed of, without any kind of treatment, into streams and rivers that flow into the river, thus affecting their water quality. This phenomenon affects on the river's concentrations of BOD (Biochemical Oxygen Demand) and DO (Dissolved Oxygen). Higher BOD concentration will lead into lower DO concentration. When the processes related to the consumption of DO exceed the processes contributing to the DO in the river, the DO levels can reach to very low values. Low DO levels or anaerobic conditions can kill fishes and cause unbalanced aquatic ecosystems.

System dynamic modelling applies mathematic principles to define changes of calculation results within the time period. Therefore, system dynamic modelling able to calculate various different interaction factors to understand possibilities that will happen in the future when river water quality component changed and predict the river water quality in the future with applied scenarios.

A System dynamic model is used to illustrate the changing tendency of Ciliwung River second segment water quality. It has been constructed a model of BOD and DO concentration in Ciliwung River second segment in order to understand the effects of domestic wastewater input towards the patterns of BOD and DO concentrations along the river segment. Domestic wastewater sources divided into two kinds of sources which are the population with sanitation services and the population without sanitation services. The construction process of the system dynamic modelling was done using POWERSIM software. Simulation based on BOD domestic input was done to understand the effects of increasing sanitation service percentages which contribute to reduce the wastewater concentration inputs toward Ciliwung River water quality. Simulation is also based on policy scenario to reduce domestic wastewater concentrations and related policies that could be implemented using system dynamic model of BOD and DO concentrations that had developed.

2. Method

This research methodology consists of the steps listed at Picture 1 including model formulation based on literature study, gathering primary and secondary data, defining model boundaries, verification, model simulation based on data from the year of 2008 and 2014, and also validation using primary data of BOD and DO concentrations from sampling results in June 2014. The model was developed with changes of natural constants values to get model results more similar with that primary data. Exploring the future with scenarios was done in the expectation to select an optimal strategy for changing the problem in the desired direction. Selecting an optimal strategy for changing the problem is done by comparing the assumed effect by interventions with the desired situation.



Picture 1. Research Methodology Diagram

Hannon, 1994 [7] developed system dynamic model titled "River Toxins" about the self purification of a river towards a pollution concentration that monitored through six part of the river. Based on that model, this research model was constructed by dividing River Ciliwung second segment into 12 part according sampling locations of secondary data. This condition is in accordance with the secondary data about Qual2K model with the same research object by Budiman, 2011 [10].

1

River is assumed as a rectangle plug flow reactor. Under this condition, a control volume is defined as a cross section of the river with a thickness of Δx along the flow axis of the river. This control volume is assumed to be well mixed. The river is flowing at a velocity u, and the entire well-mixed volume is pictured as moving downstream at that velocity. If the cross-section of flow is A, then the volume of the plug is $A\Delta x$. Pollutant sources are domestic wastewater from district population around the area of River Ciliwung second segment that divided into 12 part and 11 points of pollutant sources [2].

The variable of the model are deoxygenation coefficient (K_1) and reoxygenation coefficient (K_2) as an auxiliaries that calculated from primary and secondary data of river physical conditions based on the following formula [2].

$$K_1 = k + \frac{v}{H} n \,, \; K_{20} = 3.93 \times \frac{v^{0.5}}{H^{1.5}} \,, K2 = K_{20} \times \theta^{T-20} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

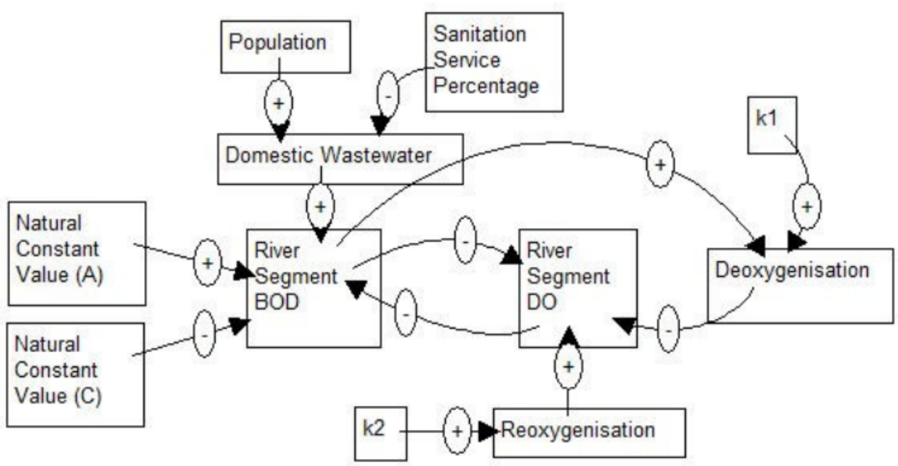
Where

- K_1 = deoxygenation coefficient
- K_2 = reoxygenation coefficient
- K_{20} = reoxygenation coefficient pada 20° C
- v = velocity
- H = water depth

The system dynamics method is based on the hypothesis of feedback processes. In a system dynamic, first, the model is created using four main components to show the cause and effect relationship between the all the components involved in the model. The four components are: level, flow, arrow, and auxiliaries. The level is used to describe the DO and BOD parameters, and the component has a cumulative behavior. The flow shows the processes that make storage full or empty by entering the storage into or discharge from it. Arrows are used to show relationships between variables in the model, and their direction indicates how the parameters are dependent.

The concept of dissolved oxygen model and oxygen deficiency [6] is the foundation of system infrastructure for BOD and DO parameters that influenced by deoxygenation and reoxygenation. The variables' relationships explained through the concentration level of BOD in every river part in the model that influenced by domestic wastewater where level of discharge and domestic wastewater concentration itself depend on the quantity of population and sanitation service percentages. Concentration level of BOD in the river also affected by natural constants values [6] which notated as constant A and C, where constant A adds the BOD values while constant C reduces the BOD values in the river. DO values in the river also affected by reoxygenation and deoxygenation processes [5] which are very affected by each constant value K_1 and K_2. Hence, the higher level of BOD results in lower level of DO [4].

Based on the model boundaries and system thinking of BOD and DO interactional in a river, the relationships among variables illustrated as causal loop at Picture 2 as foundation to create flowing diagram of the basic model.



Picture 2. Causal Loop of BOD and DO System Dynamic Model

3. Result and Discussion

Data and Processing Stages

The level of BOD parameter in every river part of this model will be influenced by domestic wastewater sources. The total population and sanitation service coverage is shown in the following Table 1 and Table 2.

Table 1. Total Population in Catchment Area of Ciliwung River Second Segment in the Year of 2008 and 2012

District	Village	Total Population (people)		Total Families (Families)		Growth Percentage
		2008	2012	2008	2012	
Bogor Timur	Sindangrasa	9,591	14,386	2,678	3,425	50%
	Katulampa	24,995	29,656	6,468	7,061	19%
	Tajur	6,072	6,689	1,472	1,672	10%
	Sukasari	11,350	11,509	2,538	2,828	1%
	Baranangsiang	24,457	27,459	5,948	6,617	12%
Bogor Tengah	Babakan Pasar	11,317	10,130	3,058	2,412	-10%
	Paledang	12,493	11,804	3,138	2,810	-6%
	Sempur	10,686	8,205	2,909	1,954	-23%
	Pabaton	5,760	2,885	1,603	730	-50%
Tanah Sareal	Kebon Pedes	20,429	22,559	4,564	5,246	10%
	Kedung Badak	28,710	28,684	6,876	6,996	0%
TOTAL		**165,860**	**173,966**	**41,252**	**41,751**	

Source : Year 2008 (Berdi Sumantri), Year 2012 (Bogor dalam Angka)

Tabel 2 Data of Sanitation Service at Villages in Catchment Area of Ciliwung River Second Segment in the Year of 2008 and 2012

District	Village	Personal Toilet (Families)		Public Toilet (Families)		Without Toilet (Families)		Total (Families)		Sanitation Service % (%)	
	Year	2008	2012	2008	2012	2008	2012	2008	2012	2008	2012
Bogor Timur	Sindangrasa	1,502	2,916	7	231	1,169	278	2,678	3,425	56.35	91.88
	Katulampa	4,671	5,838	14	483	1,783	740	6,468	7,061	72.43	89.52
	Tajur	746	1,365	9	274	717	33	1,472	1,672	51.29	98.03
	Sukasari	612	1,962	11	733	1,915	133	2,538	2,828	24.55	95.30
	Baranangsiang	4,085	5,652	12	821	1,851	144	5,948	6,617	68.88	97.82
Bogor Tengah	Babakan Pasar	560	1,906	16	176	2,482	330	3,058	2,412	18.84	86.32
Tanah Sareal	Paledang	2,414	1,855	0	289	724	666	3,138	2,810	76.93	76.30
	Sempur	526	1,451	16	476	2,367	27	2,909	1,954	18.63	98.62
	Pabaton	1,563	668	1	32	39	30	1,603	730	97.57	95.89
	Kebon Pedes	3,179	4,590	13	584	1,372	72	4,564	5,246	69.94	98.63
	Kedung Badak	4,367	6,261	3	448	2,506	287	6,876	6,996	63.55	95.90

Source : Year 2008 (Berdi Sumantri), Year 2012 (Bogor dalam Angka)

Data of domestic wastewater are model data input which will affect the patterns of BOD and DO concentration along the river. The calculation of domestic wastewater reconstructed in model flowing diagram as constants and auxiliaries which will process the data and count them automatically. However, manual calculations of model data input presented in Table 3 in order to understand the patterns results.

Table 3. Recapitulation of Domestic Wastewater in the Year of 2008 & 2012

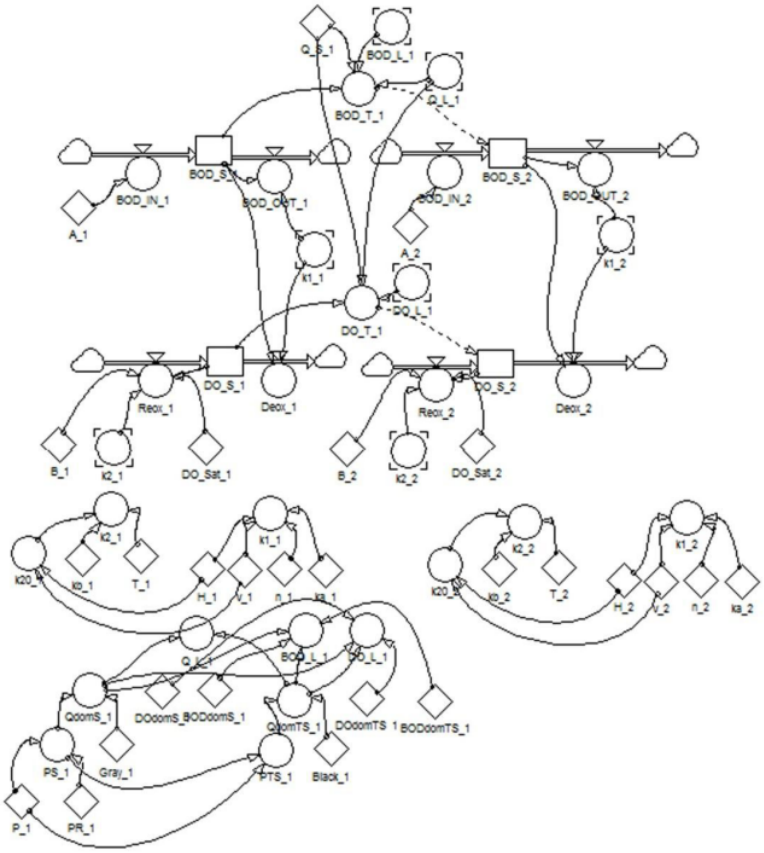
Com-partmen	Village	Domestic DO		Domestic BOD		Domestic BOD Loading		Q Waste Water Domestic	
		(mg/L)		(mg/L)		(kg/day)		(L/sec)	
		2008*)	2012**)	2008*)	2012**)	2008*)	2012**)	2008*)	2012**)
S1	Sindangrasa	3.29	3.93	150.81	110.54	111.84	110.24	8.58	11.54
S2	Katulampa	3.56	3.88	133.66	113.5	246.23	235.14	21.32	23.98
S3	Tajur	3.21	4.06	155.87	102.61	74.26	46.64	5.51	5.26
S4	Sukasari	2.81	4.00	180.39	106.17	172.96	83.77	11.1	9.13
S5	Baranangsiang	3.5	4.05	137.59	102.88	250.71	192.07	21.09	21.61
S6	Babakan Pasar	2.74	3.82	185.18	117.45	179.72	83.97	11.23	8.27
S7	Paledang	3.64	3.63	128.57	129.29	116.75	111.15	10.51	9.95
S8	Sempur Keler	2.73	4.07	185.34	101.83	169.95	56.66	10.61	6.44
S9	Pabaton	4.05	4.01	103.22	105.41	40.46	20.81	4.54	2.28
S10	Kebon Pedes	3.52	4.07	136.43	101.82	206.98	155.76	17.56	17.7
S11	Kedung Badak	3.41	4.01	143.33	105.4	311.51	206.86	25.15	22.72

(Sumber:) Budiman, 2011, **) Writer calculations)*

Model Structure Development

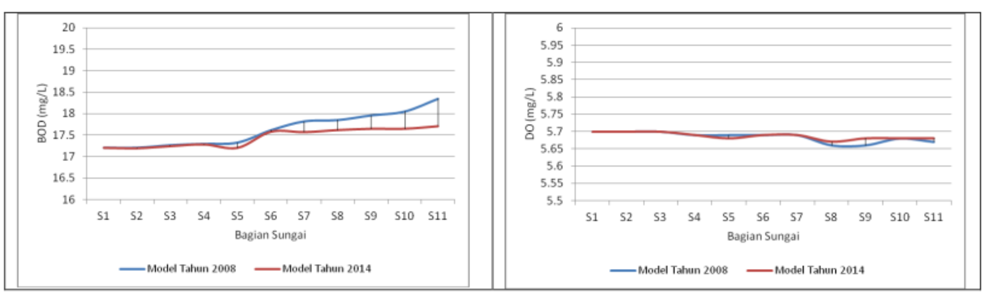
The basic model of 1 discharge point illustrates a simple system dynamic model that covers two river parts and one discharge mixing point of BOD and DO due to domestic wastewater that going into the river. This model is a foundation before the whole 11 discharge points model was made. In this model, there is a river current S1 (the first river part) which meets the process of reoxygenation and deoxygenation [5] The river part S1 then mixes with wastewater discharge (Q_L_1) where BOD and DO concentration noted as BOD_L_1 and DO_L_1. The values of this mix concentrations are the level of BOD and DO in the second river part (BOD_S_2 and DO_S_2). The water in the second river part has experienced the reoxygenation and deoxygenation due to self purification during the process from the first river part (S1) to the second river part (S2) and these processes depend on the velocity and physical conditions of the river part itself [5]. The flowing diagram of the basic model of a part (a segment) of the river is illustrated in Picture 3 below.

The basic model of a discharge point developed into the whole basic model with 11 discharge points and 12 compartement of the river. The 12^{th} river compartment is a dummy that made similarly with 11^{th} river compartment within 1 km distance. This dummy river part was made to become a complementary where this part used to show the results after the mixing process between 11^{th} river part with 11th wastewater discharge point.



Picture 3. The Basic Model of a Part (a Segment) of the River Flowing Diagram

Simulation Result



Picture 4. Simulation Result of the BOD and DO Concentration in 2008 and 2014

Results of the simulation model provide a description of the BOD and DO concentration which change over time in each *level* that consists of 11 compartments. These values are related to Microsoft Excel software in the form of data tables on the calculation of the level values over 0,001 to 0.2 days due to the velocity and the distance betwens compartments. Data processing is performed to obtain an overview of the BOD and DO concentration in the graphic representation after reaching streams compartment.

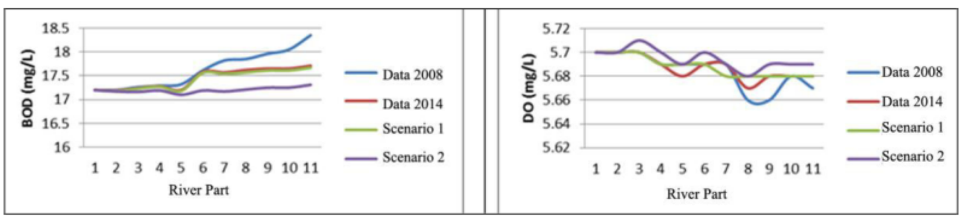
The results of running model shows that in year of 2008, the Katulampa and Baranangsiang village generate domestic wastewater discharge is nearly as large, but can be seen that the concentration of BOD in the river increased significantly after the Baranangsiang Village (S5 compartment) until Kedung-Badak village which is the downstream of Ciliwung River Second Segment (Picture 4). Although the polutant loads due to the discharge of domestic wastewater in the S6 and S7 have been reduced, but the river's BOD concentration can not be stabilized or even reduced because of the existing river's velocity. The concentration of BOD in the Ciliwung river second segment due to the domestic wastewater discharge data in 2012 has a pattern similar to the result simulation data in year of 2008, however the BOD concentration is increase siginificantly after 5th compartment (S5) and begin to decline in segment 6 (S6) because of the increase ability of reaeration caused by the increasing of S4, S6 and S10 river part's velocity.

Results of the running model showed that the BOD concentration caused by domestic effluent does not provide a significant effect on the quality of river water. Improved sanitation coverage only gives a decrease less than 1 mg/l BOD concentration of and less than 0.05 mg/l for DO concentration in river (see Picture 4).

Scenario Planning and Analysis

Two policy scenarios were conducted on a model in this research. The first scenario is the policy of increasing the services of domestic individual sanitation until 100%. This means the disposal of domestic waste water into the river only the grey water. The second scenario is the policy to build the communal waste water treatment plant that covering all (100%) the domestic wastewater which will be collected domestic waste water from the first village (Sindangrasa) to the sixth village (Babakan Pasar) in order to 85% BOD removal efficiency. Both scenarios are carried out in accordance with the policy considerations that may be applicable to the system and helped to understand why the behavior was occuring and the process of understanding the phenomena that occur in the system.

The system dynamics approach demonstrated that improved individual sanitation services could decrease the concentration of BOD in the river (see Picture 5). However the increase until 100% services in 2014 did not provide siginificant impact on decreasing the river's BOD concentration. The second scenario shows that river's BOD concentrations decreased significantly begin the sixth parts of the Ciliwung River Second Segment and tends to be stable in the next section of the river's downstrem. It shows that the communal WWTP is quite effective to reduce the river's BOD concentration.

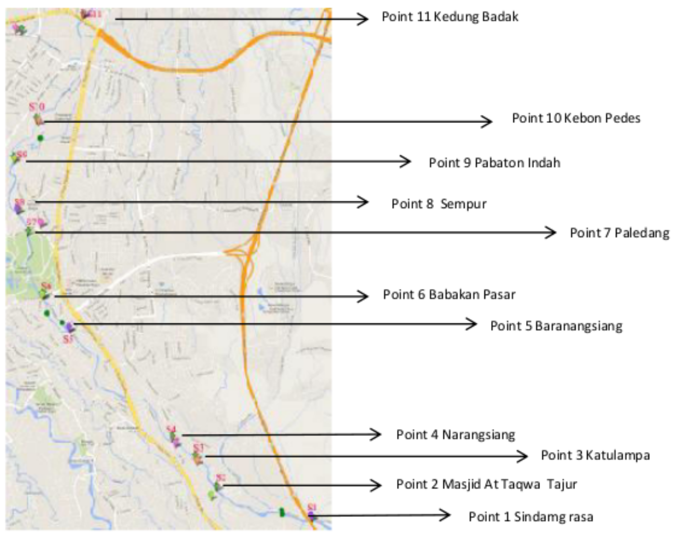


Picture 5. Simulation Results of the concentration BOD and DO Model of the Ciliwung Rivers Second Segment

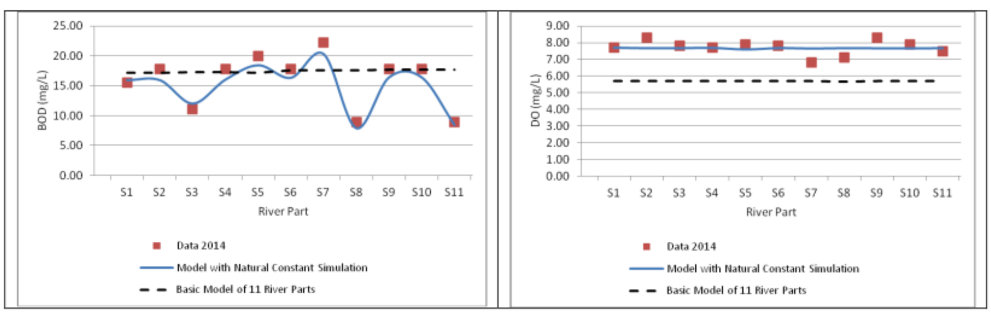
Model Validation

Validation is used to indicate that the model is valid and able to be used for subsequent processes and simulation future scenarios. Validation was done by obtaining primary data for a river water quality parameters of BOD and DO which were conducted in June 2014 at the 11 point corresponding parts division in 2014 (the location sampling can be seen at Picture 6). Validation utilizes the percentage deviation calculation which shows the percentage difference between the results of running model with the primary data analysis in the Environmental Laboratory Trisakti University.

Model validation shows that the deviation of the results of running model of the water quality of the Ciliwung River Second Segment at 2014, with the results of samples river water quality measurement that are the concentration of BOD and DO at the Environmental Laboratory Trisakti University is 27.89% for BOD parameter and 21.99% for DO parameter (see Picture 7).



Picture 6. Sampling Locations of River Water Quality for Validation



Picture 7. Graphic Ciliwung River Second Segment's of BOD and DO

Model Development Based on Validation Results

Deviation can be minimized by means of simulation models that resemble tendency BOD and DO concentration fluctuations that occur in river. The model development with a constant value of nature is intended to allow the results of running model can be more accurately and more understanding the by determining the components of the model which have great impact on the fluctuations concentration of both parameters. This is achieved in two ways: changing values DO_S_1 and BOD_S_1 according to the average value of BOD and DO samples, as well as changing the value of the constants of nature.

A natural constant value indicates the addition of BOD concentration due to natural factors inflow of effluent organic and natural death or decomposition of organic plants and animals in certain parts of water. [6]. This inflow is independent from DO and BOD existing concentration, because it is more influenced by the type of existing ecosystem. The constant C is a constant that is created as a form of simulation models to natural factors such as independent constants A, but plays a role in reducing the concentration of BOD. The value of the constants of nature were change for the value of the river 3^{rd}, 5^{th},7^{th}, 8^{th} and 11^{th} parts with value C_3 (180), A_5 (20), A_7 (200), C_8 (180), and C_11 (800) .

The result of model validation with changes the value of natural constant shows that the deviation was 7.81% for BOD and 3, 71% for the parameters DO. The Graph of the validation results of the model with changes in the value of the natural constants for Ciliwung River Second Segment showed that changes could improve the simulation result and more similar to the fluctuations of the BOD concentration primary data (picture 8). This shows that the natural constants more able to similar with every kind primary data of Ciliwung River Second Segment. However, it is necessary to develop a model and should be investigated what kind of natural contants which are considering because of there are several other processes natural that affect dissolved oxygen in rivers, include nitrogenous oxygen demand which is exerted by reduced nitrogen compounds, primarily ammonia which is used by nitrifying bacteriaas an energy source, and sediment oxygen demand (S) is exerted by particulate organics in river sediments and background oxygen demand, photosynthesis and also respiration Nitrogenous oxygen demand (N)

4. Conclusion

Decreasing the BOD and DO's concentration in the Ciliwung River Second Segment enhancement is not only influenced by reducing the domestik waste water source which coming into the river, but also influenced by the physical condition of the river e.g the water depth and flow velocity of the river which provides the capability of re-aeration. The information that came from the system dynamics process above is the water quality improvement for Ciliwung River Second Segment must be improved on previous river segments, ie the fisrt segments. Efforts to improve and maintain river's water quality must be done comprehensively and systematically.

References

Journals

[1]. Sehlke, Gerald dan Jake Jacobson. 2005. "System Dynamics Modeling of Transboundary Systems: The Bear River Basin Model" dalam Jurnal Ground Water Vol. 43, No. 5 September-Oktober 2005.

Electronic Publications

[2]. Bennoit, Anthony. Modeling Oxygen Depeletion in Running Water, ENVE 279 etc, *http://environmentalet.hypermart.net/env2101/rivers.pdf*, 2014.

[3]. Dr. Dorien J. et.al & Prof. dr. Harm 't Hart, 1996, "Using system dynamic MODELING techniques for constructing scenarios of societal problems" *http://www.complexitycourse.org/detombesystem_dynamic.html*, 2014.

Proceedings

[1]. Fischer, Hugo B. 1981. Transport Models for Inland and Coastal Waters: Proceedings of a Symposium on Predictive Ability. Academic Press, Inc.: New York (1981).

Books

[1]. Chapra, Steven C. Surface Water-Quality Modeling. The McGraw-Hill Companies, Inc.: Singapore. ,1997.

[2]. Deaton, Michael L. 2000. Dynamic Modeling of Environmental Systems. Springer-Verlag New York, Inc.: New York, 2000 .

[3]. Forrester, Jay W. 1979. World Dynamics. Wright-Allen Press: Cambridge, 1979.

[4]. Hannon, Bruce dan Matthias Ruth., Dynamic Modeling. Springer-Verlag New York Inc.: New York, 1994 .

[5]. Malczynski, Leonard A. Best Practices for System Dynamics Model Design and Construction with Powersim Studio. Sandia National Laboratories: Albuquerque, New Mexico, 2011.

[6]. Richardson, George P. Introduction to System Dynamics Modeling. Pegasus Communications: Waltham. 1981.

Dissertations

[1]. Budiman, Arif. 2011. "Pemodelan Kualitas Air dengan Parameter BOD dan DO pada Sungai Ciliwung Segmen 2" sebagai Tugas Akhir Jurusan Teknik Lingkungan Fakultas Arsitektur Lansekap dan Teknologi Lingkungan. Universitas Trisakti: Jakarta, 2011.

[2]. Soemantri, Berdi,"Identifikasi Sumber dan Jenis Pencemar DAS Ciliwung Segmen Dua Serta Upaya Penanggulangannya" sebagai Tugas Akhir Jurusan Teknik Lingkungan Fakultas Arsitektur Lansekap dan Teknologi Lingkungan. Universitas Trisakti: Jakarta, 2008.

Papers and reports

[1]. Bulagao, B.F.R., P.R.N. Pulvera, dan J.C.O. Relampagos. 2013. System Dynamics Model of Dissolved Oxygen in Butuanon River, Mandaue City, Cebu Using Stella™. Philippine Science High School Central Visayas Campus: Argao, Cebu.

Teams or anonyms

[1]. Anonyms ”Data Sanitasi Kelurahan di Kota Bogor Tahun 2012”. Badan Pusat Statistik Kota Bogor: Bogor.

[2]. Anonyms, ”Data Sanitasi Kelurahan di Kota Bogor Tahun 2012”. Badan Pusat Statistik Kota Bogor: Bogor (2014)

[3]. Anonyms, “Buku Putih Sanitasi Kota Bogor Tahun 2010. Bappeda Bogor: Bogor (2010)

[4]. Anonyms, “Kementerian Lingkungan Hidup No. 110 Tahun 2003 tentang Pedoman Penetapan Daya Tampung Beban Pencemaran Air pada Sumber Air

[5]. Anonyms, Fakultas Arsitektur Lansekap dan Teknologi Lingkungan. “Pedoman Praktikum Laboratorium Lingkungan 1”. Universitas Trisakti: Jakarta.

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