cek turnitin - jurnal - Physical Oceanography and Hydrodynamic Modelling in Tembesi Reservoir Waters, Batam

by Cek Turnitin Jurnal

Submission date: 26-Mar-2023 03:10PM (UTC+0700)
Submission ID: 2046663495
File name: lubis2020.pdf (1.34M)
Word count: 2842
Character count: 14829

Physical Oceanography and Hydrodynamic Modelling in Tembesi Reservoir Waters, Batam

Muhammad Zainuddin Lubis
Geomatics Engineering
Politeknik Negeri Batam
Batam, Indonesia
zainuddinlubis@polibatam.ac.id

Budiana
Electrical Engineering
Politeknik Negeri Batam
Batam, Indonesia
budiana@polibatam.ac.id

Oktavianto Gustin
Geomatics Engineering
Politeknik Negeri Batam
Batam, Indonesia
oktavianto@polibatam.ac.id

Widya Rika Puspita
Electrical Engineering
Politeknik Negeri Batam
Batam, Indonesia
widya@polibatam.ac.id

Amandangi Wahyuning Hastuti
Graduate School of Sciences and Technology for Innovation
Yamaguchi University Ube City, Japan
amandangi.wahyuning@gamil.com

Satria Antoni
Marine Geology
King Abdulaziz University
Jeddah, Saudi Arabia
suddin@stu.kau.edu.sa

Insaniah Rahimah
Socio-economic fishery
Matauli College of Fisheries and Marine
Sibolga, Indonesia
insaniah.rahimah@gmail.com

Husnul Kausarian
Department of Geology Engineering
Universitas Islam Riau
Riau, Indonesia
husnulkausarian@eng.uir.ac.id

Budhi Agung Prasetyo
Marine Environmental Science
Institut Teknologi Sumatera
Lampung, Indonesia
budhi.prasetyo@sll.itera.ac.id

2020 3rd International Conference on Applied Engineering (ICAE) | 978-1-7281-9917-7/20/$31.00 ©2020 IEEE | DOI: 10.1109/ICAE50557.2020.9350549

***Abstract*— Land areas in the territorial waters will often be affected by sea-level flooding or commonly referred to as *rob*. This research was conducted to see the physical condition of the waters and to do a hydrodynamic model (2D) in the waters of the Tembesi Reservoir, Batam, Indonesia. This research was conducted using primary and secondary data to produce physical conditions of waters and hydrodynamic (2D) models. The results showed the depth of waters has a minimum value of depth of -1.05 meters and a maximum value of depth of -5.95 meters. The percentage of wind speed below 1 Knot is 3.23%, and the independent variable in the percentage of wind data processing is 1.61%, with the lowest wind speed in the range of 0.1-1 Knots. Water level models produced in conditions during the filling process before the water discharge from the outlet is 0.023 meters and relatively small currents range from 0.0012 cm/s. Elevation of the final water level to the final flow when the conditions during the filling process before the water is discharged, resulting in highest water elevation, compared to when the water condition in the reservoir has been discharged from the outlet into the sea.**

***Keywords*— physical Oceanography, hydrodynamic modelling, Tembesi reservoir, wind speed, water level**

I. Introduction

Batam Island is rapidly developing as an industrial area. Several studies have been carried out related to the physical condition in Batam waters to see the relationship between temperature and chlorophyll-a [1-3]. Besides that, there is a lot of research that needs to be done in the coastal and seawater to analyze the environmental problems caused by human and natural activities. One of the problems that occurred is tidal floods or commonly referred as *rob* (a phenomenon where the seawater is overflowing into the mainland by tides). This problem is occurring at the northeast of Barelang Bridge, Batam Island and causes the formation of reservoirs by natural processes with a range of time around 2014-2019. The effect of this process can cause every building and agricultural land around the area to be inundated by *rob*.

Starting from 2014 to 2019, the water level of this reservoir is increasing. The study to analyze the water level can be performed by hydrodynamic studies or remote sensing. Hydrodynamic studies can be done through measuring data directly in the areas that undergoes the *rob*, while remote sensing can observe and analyze without direct contact. Another efficient method can be reached through the application of numerical models. This numerical model will require data for validation purposes only so that it is more efficient in terms of time, cost, and energy [4]. This modeling is very important to analyze the increasing of reservoir water level that can be daily influenced by rainfall and hydrological processes [5].

The main causes of tidal floods include storm surge, tsunami, inland flooding, and shallow coastal flooding. Storm surge is a process where an increase in sea level is caused by a storm. If the storm surge coincides with the rising tide, it will cause a very large influence on the tidal floods [6-7]. This research was conducted to obtain the value of reservoir water level, reservoir water depth, wind conditions, and 2D hydrodynamic models, and their relationship to the infrastructure position, namely the SUTT tower located in Tembesi reservoir waters, Batam.

II. Research Methods

A. Location, Tools and Research Material

The study was conducted on October 16-18, 2019 in the Tembesi reservoir area with the coordinate 104.024583 E and 1.025067 N, which can be seen on Fig.1. Primary data such as water level were acquired by water level measurement gauge, SUTT tower location by GPS, and bathymetry by Garmin GPSMAP 585. While, the secondary data include wind data was obtained from *European Center for Medium-Range Weather Forecasts* (ECMWF). Modeling data was processed using MIKE 21 software and carried out with different conditions. First, during the water filling process by the river, rainfall etc. Before the water discharge from the outlet and the second when the water in the reservoir has been discharged from the outlet into the sea.

978-1-7281-4203-6/20/$31.00 ©2020 IEEE

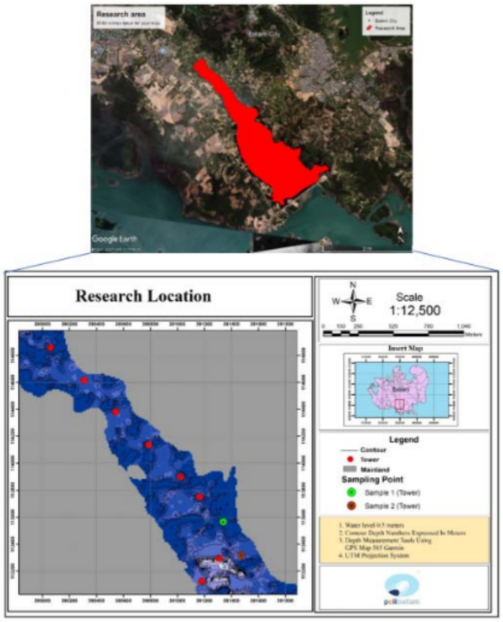


Fig. 1. Map of research location.

B. *The Basic Equation of Hydrodynamics*

Water is an incompressible fluid, which means that its density (ρ) is constant. The water density can change by pressure and temperature [8]. The equation of continuity and momentum for water flow if written in Cartesian coordinates [9] is:

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0 \quad (1)$$

$$\frac{\partial u}{\partial t}+\frac{\partial uu}{\partial x}+\frac{\partial uv}{\partial y}+\frac{\partial uw}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\frac{1}{\rho}\frac{\partial \tau_{xx}}{\partial x}+\frac{1}{\rho}\frac{\partial \tau_{yx}}{\partial y}+\frac{1}{\rho}\frac{\partial \tau_{zx}}{\partial z}+g_x \quad (2)$$

$$\frac{\partial v}{\partial t}+\frac{\partial vu}{\partial x}+\frac{\partial vv}{\partial y}+\frac{\partial vw}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial y}+\frac{1}{\rho}\frac{\partial \tau_{xy}}{\partial x}+\frac{1}{\rho}\frac{\partial \tau_{yy}}{\partial y}+\frac{1}{\rho}\frac{\partial \tau_{zy}}{\partial z}+g_y \quad (3)$$

$$\frac{\partial w}{\partial t}+\frac{\partial wu}{\partial x}+\frac{\partial wv}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial z}+\frac{1}{\rho}\frac{\partial \tau_{xz}}{\partial x}+\frac{1}{\rho}\frac{\partial \tau_{yz}}{\partial y}+\frac{1}{\rho}\frac{\partial \tau_{zz}}{\partial z}+g_z \quad (4)$$

In the above equation t is time, x, y, and z are the coordinate axes that have longitudinal, transverse, and vertical directions, u, v, and w are the velocity that exists for a moment the direction of x, y, and z, p is the pressure, τij (i, j = x, y, z) is the shear stress (a function of water velocity and viscosity) the direction of j acting in the perpendicular plane of the axis i, and gx, gy, and gz are the gravitational acceleration in the x, y, and z.

The equations above, the continuity equation 1, and the momentum equation (Eq. 2, 3, 4), are known as the Navier-Stokes Equation. Historically the Navier-Stokes equation is the momentum equation in fact. However, in the modern CFD literature, the terminology of the Navier-Stokes equation is broadened to include not only the momentum equation, but also the continuity equation and energy equation.

III. RESULTS AND DISCUSSION

A. *Water Condition (Water Level)*

The water level is very influential in generating currents and also determines the extent of exposed tidal flats, especially in shallow areas. The daily average of water level has been collected from water level measurement for 3 days from 9 a.m. to 7 p.m. The average of water level obtained on the 1st day is 0.316 meters, the 2nd day with 0.310 meters, and the 3rd day is 0.326 meters. The graph of the measurement of water level can be seen on Fig. 2-4.

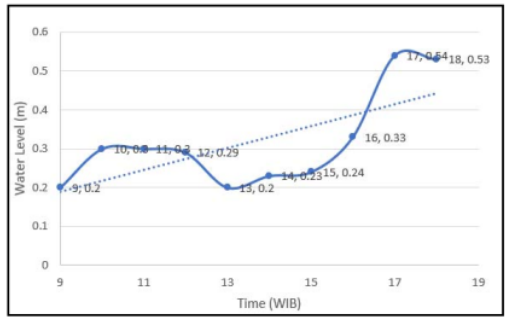


Fig. 2. The value of the water level for the first day of measurement.

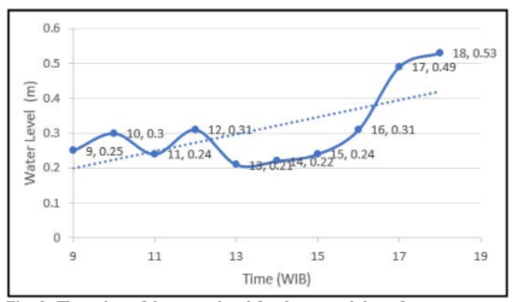


Fig. 3. The value of the water level for the second day of measurement.

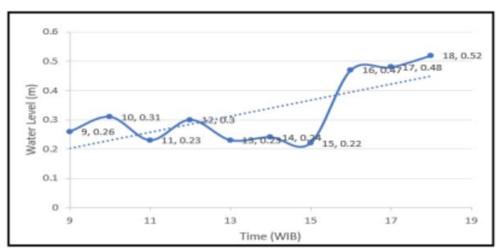


Fig. 4. The value of the water level for the third day of measurement.

B. *Depth of Water*

The mapping of bathymetry was used Garmin GPSMAP 585, which equipped with the ability to detect the bathymetry on each point in the Tembesi reservoir, especially in the Bright Batam SUTT tower area. The range of water depth is -1.05 until -5.99 meters (Fig. 5). The information on the water depth is important to make the hydrodynamic model that will be carried out in the existing condition of the Tembesi reservoir.

978-1-7281-4203-6/20/$31.00 ©2020 IEEE

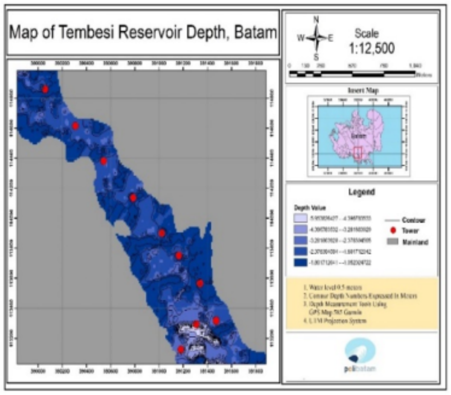


Fig. 5. Map of the depth of the Tembesi reservoir, Batam.

C. *Wind Roses and Hydrodynamic Model (2D)*

Based on the wind rose (Fig. 6), the wind is dominant towards to the northern region with value 51.60% and wind speeds ranging from 1-4 Knots. The percentage of wind speed below 1 Knot is 3.23%, and the independent variable in the percentage of wind data processing is 1.61%, with the lowest wind speed in the range of 0.1-1 Knots. In the Fig. 6 also shows the frequency distribution table of the speed and wind direction.

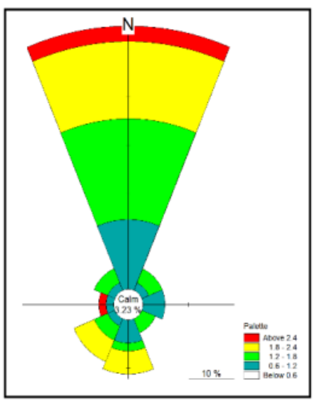


Fig. 6. Wind roses around Tembesi reservoir waters, Batam.

In general, the 2D hydrodynamic simulation model is able to represent the hydrodynamic conditions in the coastal area to see the process and time occurrence of the tidal flood [10,14-16]. The elevation modeling of the water surface and water currents was done during the water filling process by the river, rainfall etc before the water discharge from the outlet and the second when the water in the reservoir has been discharged from the outlet into the sea. According to [11], the process involves several factors, namely:

1. The volume of drainage water discharge into the reservoir
2. The volume of run-off water affected by the watershed around the reservoir
3. Rainfall

The factors that are mentioned above are very influential on the dynamics of the waters in the reservoir. The bottom morphology of the reservoir can be greatly affected by the water current conditions. The water level and flow-rate are modeled with hydrodynamic models. The hydrodynamic model will be simulated for 18 days with the assumption that the extreme condition of the water level and current flow-rate will be obtained on the western season (October). The results of this 2D Hydrodynamic modeling are carried out by:

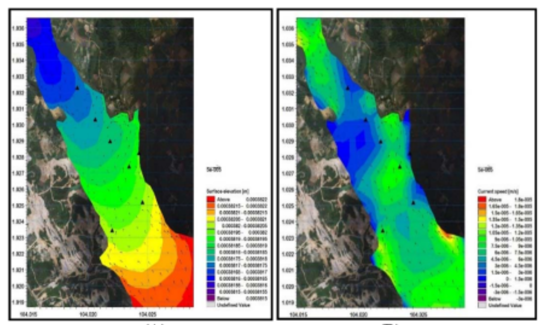
a. Modeling the beginning water level elevation to the current flow during water filling process before the water discharge from the outlet.

b. Modeling the beginning water surface elevation to the current flow at the final stage during water filling process before the water discharge from the outlet.

c. Modeling the final water surface elevation to the current flow when the water in the reservoir has been discharged from the outlet into the sea.

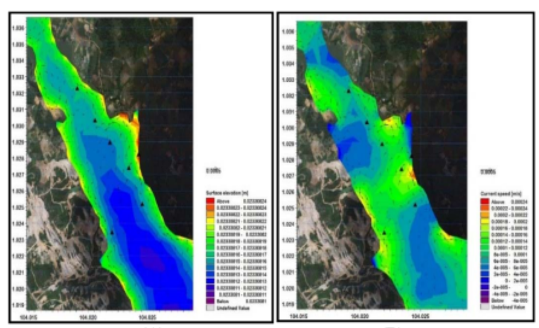
d. Modeling the final water surface elevation to the initial current flow when the water in the reservoir has been discharged from the outlet into the sea.

This is consistent with the results of research [12] which shows that the flow pattern in the Porong waters region changes continuously in accordance with the water level that occurs at the location of these waters. The results of 2D hydrodynamic modeling carried out in Tembesi reservoir waters are shown on Fig. 7-10.



(A) **(B)**

Fig. 7. Modeling of the beginning (A) water surface elevation, (B) current flow during water filling process before the water discharge from the outlet.



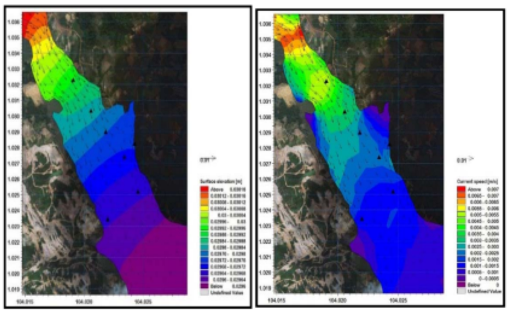
(A) **(B)**

Fig. 8. Modeling of the final (A) water surface elevation, (B) current flow during water filling process before the water discharge from the outlet.

The SUTT tower is located in the reservoir areas that are marked by the black triangle that as shown in the figure. The results of 2D hydrodynamic modeling clearly seen that the

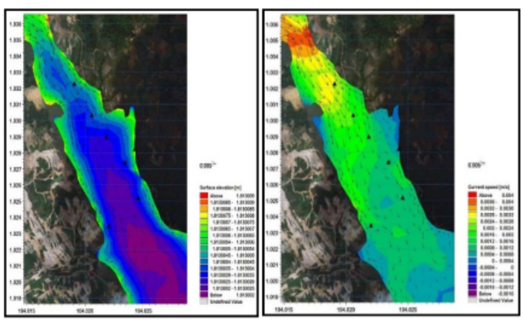
978-1-7281-4203-6/20/$31.00 ©2020 IEEE

water elevation modeling which is produced during filling process before the water is discharge from the outlet is 0.023 meters (Fig. 7). This result is equivalent with the relatively of small current flow-rate ranging from 0.0012 cm/s. This can be caused by the decreasing of current flow-rate or due to the reduction of current speed and the deflected of the direction because of the beach building as a barrier to the current [13].



(A) (B)

Fig. 9. Modeling of the beginning (A) water surface elevation, (B) current flow when the water in the reservoir has been discharged from the outlet into the sea.



(A) (B)

Fig. 10. Modeling of the final (A) water surface elevation, (B) current flow when the water in the reservoir has been discharged from the outlet into the sea.

The modeling with the beginning surface water level and current flow when the water in the reservoir has been discharge from the outlet into the sea proceed water level with 0.029 meters with range of current speed is 0.03 - 0.035 m/s (Fig. 9). While the modeling of the final treatment in which the condition when the water elevation in the reservoir has been discharged has the highest value of current speed than other conditions (Fig. 10). From this result, it can be stated that the water level is an important parameter in this model. The value of water level around the tower is 1.81 meters, with the current speed range 0.0008 - 0.0024 m/s.

IV. Conclusion

The results of the final water elevation during the filling process are generating water elevation which higher compared when the water in the reservoir has been discharged from the outlet into the sea. The water elevation to the current flow at the final condition when the water in the reservoir has been discharged from the outlet into the sea has the highest value compared with other conditions. This can be stated that the water level is an important value in making the model. The entire SUTT tower location was all submerged and flooded, especially the tower which located in the south of the Tembesi Reservoir, Batam.

Acknowledgment

The author would like to thank Politeknik Negeri Batam that facilitated this research, Bright PLN Batam that has funded this research, and Batam Polytechnic Engineering Geomatics students, namely: Ganda Surya, Risky Ade Tia Hendri, Muhammad Ghazali, and Irvan, who collected the field data.

References

[1] S. Antoni, R. A. Bantan, T. A. Al-Dubai, M. Z. Lubis, W. Anurogo, and R. D. Silaban, "Chlorophyll-a, and Sea Surface Temperature (SST) as proxies for Climate Changes: Case Study in Batu Ampar waters, Riau Islands," in IOP Conference Series: Earth and Environmental Science, vol. 273, 2019.

[2] M. Z. Lubis, W. Anurogo, M. Mufida, H. M. Taki, S. Antoni, and R. A. Lubis, "Physical condition of the ocean to global climate change variability: Case Study in The Batam waters, Indonesia," in 2018 International Conference on Applied Engineering (ICAE), 2018.

[3] M. Z. Lubis, W. Anurogo, S. N. Chayati, L. R. Sari, H. M. Taki, and S. Pujiyati, "Side-scan sonar investigations and marine seismic of identification object," J Phys. Conf. Ser., vol. 1442, pp. 012004, 2020.

[4] M. Wibowo, "Pemodelan sebaran pencemaran tumpahan minyak di perairan cilacap," Jurnal Teknologi Lingkungan, vol. 19 (2), pp. 191, 2018.

[5] L. Indeswari, T. Hariyanto, and C. B. Pribadi, "Pemetaan Sebaran Total Suspended Solid (TSS) Menggunakan Citra Landsat Multitemporal dan Data In Situ (Studi Kasus : Perairan Muara Sungai Porong, Sidoarjo)," Jurnal Teknik ITS, vol. 7, no. 1, 2018.

[6] M. N. Habibie, A. Hartoko, N. S. Ningsih, M. Helmi, S. Siswanto, R. Kurniawan, A. Ramdhani, and R. S. S. Sudewi, "Simulasi Rob Di Semarang Menggunakan Model Hidrodinamika 2D," Jurnal Meteorologi dan Geofisika, vol. 13, no. 2, 2012.

[7] R. A. Pasaribu, N. Cakasana, H. Maduppa, B. Subhan, D. Arafat, M. S. Sangadji, and M. S. Savana, "Mangrove density level and area change analysis in small islands case study: Untung Jawa Island, Seribu Islands, DKI Jakarta," in IOP Conference Series: Earth and Environmental Science, vol. 429, 2020.

[8] T. Kimura, N. Ozaki, T. Sano, T. Okuchi, T. Sano, K. Shimizu, K. Miyanishi, T. Terai, T. Kakeshita, Y. Sakawa, and R. Kodama, "P-ρ-T measurements of H2O up to 260 GPa under laser-driven shock loading," J. Chem. Phys., vol. 142 (16), pp. 164504, 2015.

[9] V. Udoewa and V. Kumar, "Computational Fluid Dynamics," Applied Computational Fluid Dynamics, 2012.

[10] R. C. Dewi, O. S. Hakim, and E. L. Siadari, "Pemodelan Mike21 dalam kejadian banjir rob menjelang gerhana bulan di pesisir Semarang," JMG, vol. 5 (3), pp. 46–52, 2019.

[11] M. Gufran and M. Mawardi, "Dampak pembuangan limbah domestik terhadap pencemaran air Tanah di Kabupaten Pidie Jaya," J Serambi Eng., vol. 4 (1), pp. 416, 2019.

[12] N. F. Yunita and M. Zikra, "Variability of sea surface temperature in Indonesia Based on Aqua Modis Satellite Data," IPTEK Journal of Engineering, vol. 3 (3), 2017.

[13] S. Purwaningsih and A. Pamungkas, "Analisis kondisi hidrologi daerah aliran Sungai Kedurus untuk mengurangi banjir menggunakan model hidrologi SWAT," Jurnal Teknik ITS, vol. 6 (2), 2017.

[14] Y. Rzayev and E. Ismayilov, "Hydrodynamic model of de-emulsification processes of layer' fluids flow," in 2012 IV International Conference "Problems of Cybernetics and Informatics" (PCI), 2012.

[15] L. K. Rosenfeld, "In-situ Evaluation of Oceanographic Products for the METOC Community - Wrap-up," 2001.

[16] J. Kim and J. Park, "Visualizing Marine Environmental Changes to the Saemangeum Coast," IEEE Computer Graphics and Applications, vol. 32 (6), pp. 82–87, 2012.

cek turnitin - jurnal - Physical Oceanography and Hydrodynamic Modelling in Tembesi Reservoir Waters, Batam

ORIGINALITY REPORT

9%	7%	7%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

3%

★ repository.pnj.ac.id

Internet Source

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		