International Journal of Engineering Research and Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 22, Issue 2 (February 2026), PP 05-08

Analysis of Determining the Influence of Tides on Intake Locations in the Borang River

Achmad Syarifudin[1]; M Edward Nopriansyah[2]
[1]*Post Graduate of Civil Engineering, Faculty of Engineering, Universitas Bina Darma, Indonesia*
[2]*Post Graduate of Civil Engineering, Faculty of Engineering, Universtas Bina Darma, Indonesia*
Corresponding Author: achmad.syarifudin@binadarma.ac.id

Abstract
This study aims to analyze the tidal characteristics of the Borang River, Palembang City, and determine the safe elevation for the planned raw water intake. The main issues raised include the impact of tides on the planned location of the additional raw water intake, the elevation characteristics during the highest and lowest tide peaks, and the safety of the intake structure against important tidal elevations. The scope of the study includes tidal observations for 15 days with hourly measurements to obtain accurate data. The method used in this study is harmonic analysis with the Least Square method, which allows the calculation of the amplitude and phase of tidal components. The required data include primary data taken from field observations and secondary data from Perumda Tirta Musi. The analysis was performed using Microsoft Excel software with Visual Basic for Applications (VBA) programming to facilitate calculations. The results show that the tidal type in the Borang River is a mixed type tending to double daily, with Formzahl values of 2.8693 for the first period (rainy season) and 1.6107 for the second period (dry season), respectively. Evaluation of tidal characteristic elevations indicated that the highest water level (MHW) in the first period was +5,392 meters and +4,826 meters in the second period, while the lowest elevations (MLW) were +2,858 meters and +2,809 meters, respectively. The study concluded that the intake structure elevation did not meet safety criteria, with a difference of 30 cm below the lowest elevation, potentially disrupting pump operation. Recommendations included the need for data processing using other methods, such as Admiralty, to enrich the analysis, and the collection of tidal data over a period of more than one year for more accurate and representative results.
Keywords*: Borang river, Tides, Least Square method, Water intake*

Date of Submission: 24-01-2026 Date of acceptance: 06-02-2026

I. INTRODUCTION

The province of South Sumatra, specifically the city of Palembang, is one of the regions in Indonesia divided by a river into two parts: the upstream and downstream areas. This indicates that this area is prone to tidal events. According to (Poerbandono & Djunarsjah E, 2005), ocean tides are the periodic rise and fall of seawater due to the gravitational force of celestial bodies, particularly the moon and sun. In addition to causing ebb and flow, gravitational forces also cause changes in the shape of the Earth and atmosphere.

The type of tide is determined by the frequency of high and low tides each day. If a body of water experiences one high tide and one low tide per day, the area is said to have diurnal tides. However, if there are two high tides and two low tides per day, the tide type is called semidiurnal tides. Another type of tide, a transition between the single and double tides, is called mixed tides. These are classified into two types: mixed (double-dominated) and mixed (single-dominated). In addition to viewing tidal data plotted graphically, tidal type can also be determined based on the Formzahl number (F).

Due to the periodic nature of tides, they can be predicted. Tide forecasting requires amplitude and phase difference data for each tidal generating component. The main tidal components consist of the diurnal and the diurnal components. The Moon orbits the Earth once every 24 hours and 51 minutes, thus each tidal cycle experiences a 51-minute delay each day (Musrifin, 2011).

To determine the type of tide in an area, a tidal analysis is necessary. Tidal analysis requires data on tidal amplitude and height for two weeks per tidal cycle. This study aims to analyze tides using the Least Squares method and then determine the tidal type in the Borang River. It is hoped that the results of this study will be useful, especially for future plans for the development of the Borang raw water intake.Palembang City is crossed by 108 river branches. Of all these rivers, the four largest are Musi, Komering, Ogan, and Keramasan.

The Musi River is the widest river among them, with an average width of around 504 meters and reaching up to 1,350 meters in the area near Kemaro Island. (Syarifudin A, 2018). Only 18 of the 21 sub-districts in Palembang City actually end in the Musi River according to the DAS category. The following sub-districts are included in the map: Rengas Lacak, Gandus, Lambidaro, Boang, Sekanak, Bendung, Lawang Kidul, Buah, Juaro, Batang, Sei Lincah, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring, and Plaju.

The government is facing difficulties in evaluating drainage infrastructure due to flooding in Palembang City. Reassessment and further development are needed, although drainage channels are already available. The Sekanak River, with a watershed area of 11.78 km², functions as a vital drainage channel in Palembang City. This river used to be a natural channel, now it has turned into an artificial system that flows into the Musi River. Simulations with various scenarios show seven locations that are classified as flooded under current conditions.

Because of its position in the center of Palembang City, the Sekanak River plays an important role. In 2021, research on flood control of the Sekanak-Lambidaro River in Palembang City was partially completed by the Sumatra VIII River Basin Center (BBWS Sumatra VIII) of the Directorate General of Water Resources, part of the Ministry of Public Works and Public Housing (PUPR). Among the various retention ponds along the Sekanak River sub-watershed is the Siti Khadijah Retention Pond.

In addition to rainfall data, surface runoff is one of the important factors in the transport system of various materials that will be carried into river flow. If the intensity of rainfall exceeds the infiltration rate, then excess water begins to accumulate as surface reserves. If the surface reserve capacity is exceeded, then surface runoff begins as a thin layer flow. Surface runoff is the part of the runoff that passes above the land surface towards the river channel. (Achmad Syarifudin, 2018).

Another term for surface runoff that is often used by some experts is runoff on land or runoff water. The duration of rain, intensity and distribution of rain affect the rate and volume of surface runoff. The total surface runoff for a rain is directly related to the duration of rain for a certain rainfall intensity. Rain with the same intensity and for a longer time will produce greater surface runoff. Rain intensity will affect the rate and volume of surface runoff. (Achmad Syarifudin, 2018)

In high intensity rain, the total volume of surface runoff will be greater than with low intensity even though the total rainfall received is the same. Topographic forms such as land slope will affect surface runoff. Watersheds with high slopes will produce greater surface runoff. The presence of vegetation can increase the amount of water retained on the surface, thereby reducing the rate of surface runoff. (Achmad Syarifudin, 2018).

II. MATERIAL AND METHODS

2.1. Research Location

This research is located in the Borang River. The data used in this study was taken from the planned location for the addition of the Borang Raw Water Intake with coordinates 2^{0}55’15’’ S, and 104^{o}48’14’’ E. The research location is in Palembang City.

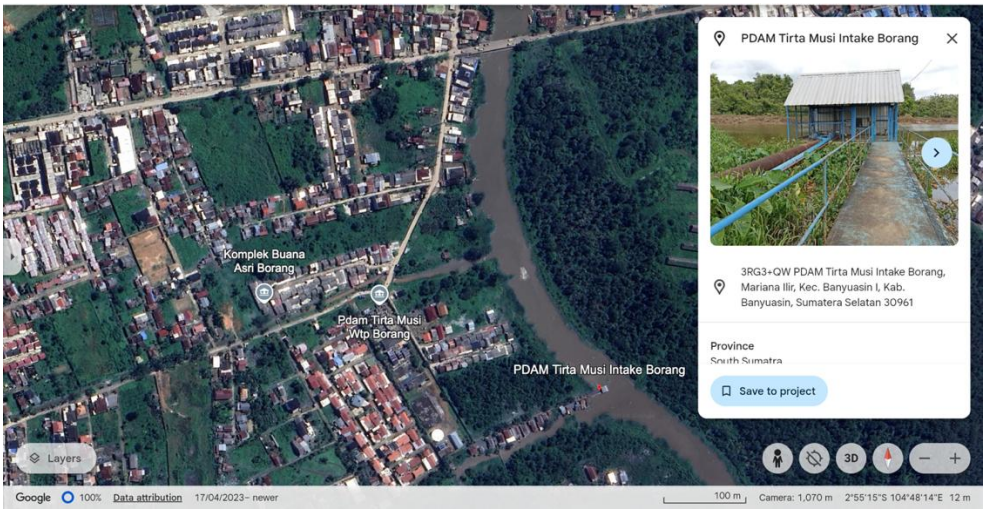

Figure 1: Research location

2.2. Data Collection Techniques

The data required for this study consist of primary and secondary data. Primary data were collected through direct tidal observations in the field. Tidal observations were conducted at the mouth of the existing Borang Intake, with an observation period of 15 x 24 hours for one tidal cycle. However, this study will be conducted over two tidal cycles.

The first observation was conducted during the rainy season and the second during the dry season to allow for a comparison of elevations across the two months. Observations were conducted using a water level gauge, which was read hourly. The elevations obtained from the water level observations were then recorded at a fixed point (benchmark). The equipment needed for primary data collection included a scale, a camera, a watch, and writing utensils.

The secondary data used are the elevation data of the Existing Intake Borang building at + 4,780 m, the elevation of the top of the submersible pump at + 3,109 m, the original land elevation at + 4,106 m, the elevation of the river bed at the pump point + 1,706 m, and others. Secondary data were obtained from PERUMDA Tirta Musi Palembang, observations and measurements in the field.Research Tools and Materials

III. RESULTS AND DISCUSSION

3.1. Least square method

The results of the analysis using the least square method as table 3.1.

Table 1: Tidal Harmonic Constant Table for Period 1

Final result										
	S_0	M_2	S_2	N_2	K_2	K_1	O_1	P_1	M_4	MS_4
A (m)	4,1933	0,343	0,490	0,096	0,586	1,862	0,530	1,429	0,003	0,038
g °		175,132	196,102	141,200	342,285	209,370	238,876	48,138	123,279	218,768

Table 2: Tidal Harmonic Constant Table for Period 2

HASIL AKHIR										
	S_0	M_2	S_2	N_2	K_2	K_1	O_1	P_1	M_4	MS_4
A (m)	3,7601	0,107	1,510	0,119	1,511	2,401	0,204	2,927	0,010	0,018
g °		61,387	350,151	302,505	151,477	131,923	187,668	325,957	124,631	211,113

3.2 Tide Type Results

After obtaining the final results from the tidal data calculation using the Least Square method, a tidal analysis can be performed based on the tidal harmonic constant. Therefore, the tidal types for the Borang River Raw Water Intake area in Palembang City, based on observations over two tidal periods, are as follows:

 In the first period (rainy season) (March 10-25, 2025), the Formzal value was 2.8683, indicating that the tidal type at the study site is a Mixed-Diurnal Tide.

 In the second period (rainy season) (June 6-20, 2025), the Formzal value was 1.6107, indicating that the tidal type at the study site is a Mixed-Diurnal Tide.

Table 3: Tidal Type Analysis Results

-	0,00 – 0,25	Semi Diurnal
-	0,26 – 1,50	*Mixed Semi – Diurnal*
2,8693 (Period 1) 1,6107 (Period 2)	1,51 – 3,00	*Mixed – Diurnal*
-	0,00 – 0,25	*Diurnal*

3.3 Tidal Graph

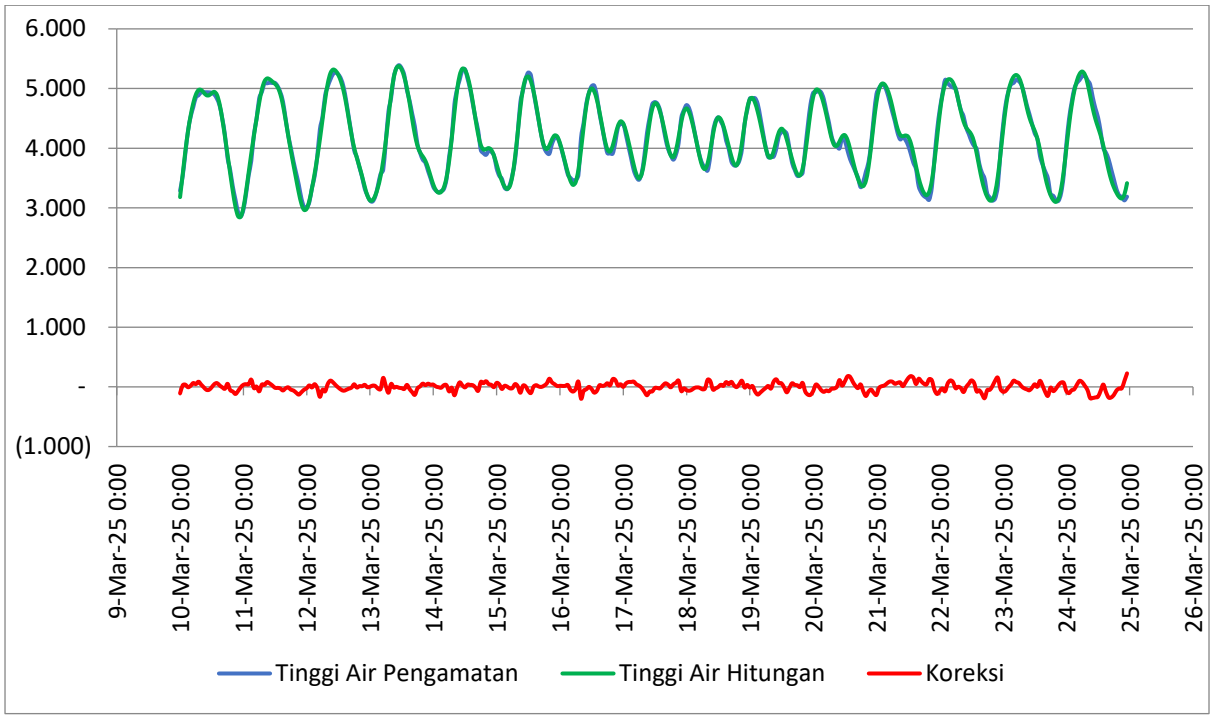

Figure 2: Tidal Graph Period 1

IV. CONCLUSION

Based on the data analysis and discussion, the conclusions of this study are as follows:

1. The final results of the tidal analysis of the Borang River using the Least Squares Method for two tidal periods yielded Formzahl values of 2.8693 and 1.6107, indicating that the tidal type at the study site is a Mixed-Diurnal Tide.
2. The elevation evaluation of the lowest and highest tidal characteristics at the study site is as follows: Mean High Water (MHW) / highest water level elevation in the first period of +5.392 meters and in the second period of +4.826 meters; Mean Sea Level (MSL) / average water level elevation in the first period of +4.189 meters and in the second period of +3.746 meters; MLW (Mean Low Water) / lowest water level elevation in the 1st period +2,858 meters and the 2nd period +2,809 meters; HHWL (Higher High Water Level) / highest water level elevation in the second tide for the 1st period +5,323 meters and the 2nd period +4,796 meters; LLWL (Lower Low Water Level) / lowest water level elevation during the second low tide for the first period was +3,138 meters and for the second period +3,086 meters.

REFERENCES

[1]. Defant, A. (1958). Ebb and Flow: The Tides of Earth, Air, and Water. Ann Arbor, University of Michigan.
[2]. Gross, M. G. (1990). Oceanography : A View of Earth. Prentice Hall. Inc. Englewood Cliff. New Jersey.
[3]. King, C. A. M. (1966). An Introduction to Oceanography. McGraw Hill Book Company, Inc. New York. San Francisco.
[4]. Mac Milan, C. D. H. (1966). Tides Fenomena Pasut. American Elsevier Publishing Company, Inc., New York.
[5]. Musrifin. (2011). Analisis Pasang Surut Perairan Muara Sungai Mesjid Dumai. Dalam Jurnal Perikanan dan Kelautan (Vol. 16).
[6]. Nontji, A. (1987). Lautan Nusantara. Djambatan Jakarta.
[7]. Poerbandono, & Djunarsjah E. (2005). Survey Hidrologi. Jurnal Oseanografi, 6, 166–166.
[8]. Pond dan Pickard. (1978). Introductory to Dynamic Oceanography. Pergamon Press, Oxford.
[9]. Wyrtki, K. (1961). Physical Oceanography of The Southeast Asian Waters (Naga Report, Vol. 2). The University of California. California.Andikha, F., 2017, Penerapan Sistem Ecodrainage Dalam Mengurangi Potensi Banjir (Studi Kasus di Kabupaten Sampang) (Doctoral dissertation, Institut Teknologi Sepuluh Nopember)