The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/QRWCN

RELATION SEA WATER QUALITY IN FLORES SEA WATERS OF BANTAENG REGENCY AT HIGH TIDE AND LOW TIDE USING POLLUTION INDEX METHOD AND SPSS

FAISAL[1]*, ACHMAD ZUBAIR[2] and ROSLINDA IBRAHIM[3]

[1, 2, 3] Department of Environmental Engineering, Faculty of Engineering, Hasanuddin University, Gowa, South Sulawesi, Indonesia. *Correspondence Author Email: faisalskolah@gmail.com

Abstract

Industrial development shows a very significant progress for the development of the Indonesian economy, but the impact that may arise due to industrial activities is the problem of waste. This study aims to analyze the quality of seawater in the Flores Sea Waters of Bantaeng Regency using the IP and SPSS methods. This research is guided by SNI, namely sampling at ten stations and sampling points using a vandorn water sampler tool based on a predetermined depth. Analysis of water quality using SNI, knowing the level of pollution using the IP method and SPSS to determine whether there are significant differences during high and low tide conditions. The results of the analysis of the pollution index method for marine biota designation are at an unpolluted level while the designation for marine tourism is lightly polluted. SPSS shows that only the temperature parameter has a significant difference between high and low tide. Reveals that seawater quality is affected or has a relationship with the movement of high and low tides.

Keywords: Water Quality; Nickel; Hexavalent Chromium; Pollution.

1. INTRODUCTION

Industrial development shows a very significant progress for the development of the Indonesian economy, but the impact that may arise due to industrial activities is the problem of waste. The problem has received serious attention from the government or national and international environmental agencies. Governments are constantly trying to develop environmentally clean industries and develop research on the use and improvement of the usability of industrial waste [1]. In Indonesia there are several nickel mining and management companies today, one of which was built in an area of 3,150 hectares in the Bantaeng Industrial Estate area. Where the company started its investment in the nickel mineral processing and refining industry. Nickel is an excavation material that has high economic value because in the present and future the need for nickel is increasing in addition to other needs whose supply is increasingly limited [2].

Especially for Bantaeng Regency, the development of the industrial sector is very likely in the future, the impact is very positive because in addition to increasing regional income it also absorbs a lot of local labor. However, the problem of waste is a major concern where the waste of nickel ore smelting (Slag) which is stockpiled in the industrial area is very worrying because it is overloaded. This will certainly slowly but surely have a negative impact on the surrounding residential areas and marine ecosystems in Bantaeng sea waters. in the industrial area, it is very worrying because it is overloaded, considering that the waste contains toxins and chemicals which are certainly very dangerous for human health and marine biota [3].

The Seybold REPORT
ISSN 1533-9211
DOI 10.17605/OSF.IO/QRWCN

2. METHODOLOGY

A. Research Location

The location of sampling uses purposive sampling method based on the location or area that is suspected to have activities that have the potential to contribute waste to marine bodies in the waters of the Bantaeng Industrial Estate (KIBA) [7]. There are 10 seawater sampling locations, 1 station consists of 1 sampling point which is carried out with a repeat of 4 times. Details of the location of each station are: (outfall, ST1, ST2) coastal area, (ST3) less populated residential area, (ST4, ST5) mid-dock, (ST6, ST9) seaweed pond area presented in figure 1.

Figure 1: Seawater sampling location

B. Material and Sampling Method

Sampling was carried out at high tide and low tide 3 times in 3 months, namely December, January and February. Sampling of seawater for water quality tests was carried out using a vandorn water sampler based on SNI 6964.8: 2015 [8]. The initial stage of sampling is done by measuring the depth of the sample point seawater using a weight that is lowered until it reaches the seabed. Calculations were carried out by multiplying the depth (D) that had been obtained by predetermined numbers such as (0,2 . D), (0,4 . D), (0,6 . D) and (0,8 . D). Four times the water is taken using the Vandorn water sampler tool with the depth value that has been obtained. The seawater samples obtained were then transferred to a container in the form of a bucket as a temporary container. The final stage is the in situ measurement of pH (SNI 6989.11-2019) [9] and temperature (SNI 06-6989.23-2005) [10] of the seawater samples before being put into bottles which will later be taken to the laboratory for further measurement (ex situ). Ex situ measurement of water quality samples of nickel parameters using the method (SNI 6989.84.2019) [6] and hexavalent chromium using the method (SNI 6989.71.2009) [7]. The results of the measurement analysis of all these parameters are presented in tables (1 and 2) and figures (2, 3, 4 and 5). Tables (1 and 2) and figures (2, 3, 4 and 5) can be seen that the code P1 indicates the first sampling, P2 the second sampling and P3 the third sampling. This is done to make it easier for researchers to categorize data.

C. Data Analysis

Data analysis using the pollution index method is used to determine the level of pollution of the Flores Sea Waters of Bantaeng Regency.

Calculations were carried out using the pollution index method according to the quality standards of the South Sulawesi governor's regulation number: 69 of 2010 concerning quality standards and environmental damage criteria [4], with the following formula:

$$Pij = \sqrt{\frac{(Ci/Lij)^2M \; + (Ci/Lij)^2R}{2}}$$

Dimana:

Pij = Pollution Index

Ci = Parameter Value

Li = Quality Standard Value

R = Average Value

M = Maximum Value

Determination of the PI calculation result:

0 < Pij < 1,0	:	meet quality standards
1,0 < PIj< 5,0	:	lightly polluted
5,0 < PIj < 10	:	medium polluted
PIj > 10	:	heavily polluted

Data analysis was conducted using statistical tests through the Statistical Package for Social Science (SPSS) version 25 software to determine significant differences in water quality variables, including temperature (°C), pH (mg/L), Ni (mg/L), $Cr6^{+}$ (mg/L) during tidal conditions using the Man Whitney test.

3. RESULTS AND DISCUSSION

A. Results of Water Quality Test

This research examines 4 parameters namely Ph, temperature (in situ measurement), nickel and hexavalent chromium (ex situ measurement) which can be seen in tables (1 and 2). The figures (2, 3, 4 and 5) are graphs showing the comparison of the values of all parameters with the reference quality standards of the South Sulawesi governor's regulation number: 69 of 2010 concerning quality standards and environmental damage criteria.

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/QRWCN

Table 1: Test results of seawater quality parameters at high tide

(High Tide)					
Sampling	**Station**	**Ni**	**Cr6⁺**	**pH**	**Temperature**
P1	OUTFALL	-0,131	0,002	7,5	30,5
	ST1	-0,102	0,006	7,5	30,4
	ST2	-0,114	0,002	7,5	30,4
	ST3	-0,097	0,002	7,6	30,6
	ST4	-0,072	-0,003	7,5	30,4
	ST5	-0,128	-0,002	7,6	30,5
	ST6	-0,125	0,004	7,6	31,2
	ST7	-0,131	0,002	7,6	30,9
	ST8	-0,167	0,005	7,6	30,7
	ST9	-0,126	0,005	7,6	30,9
P2	OUTFALL	-0,064	0,001	7,8	30,9
	ST1	-0,138	0,003	7,8	31,1
	ST2	0,021	0,021	7,9	31,4
	ST3	-0,076	0,004	7,9	31
	ST4	-0,136	0,006	7,9	30.9
	ST5	-0,102	-0,002	7,8	31,1
	ST6	-0,121	0,008	7,8	30,9
	ST7	-0,104	0,001	7,9	29,9
	ST8	-0,059	0,001	7,9	30,3
	ST9	-0,023	-0,0004	7,9	30,1
P3	OUTFALL	-0,0118	0,0102	8,0	28,4
	ST1	-0,0067	0,0128	8,0	28,9
	ST2	0,0185	0,0035	8,1	28,5
	ST3	0,0012	0,0068	8,1	28,6
	ST4	0,014	0,0253	8,0	28,6
	ST5	-0,0063	0,0025	8,1	28,9
	ST6	0,0041	0,0033	8,0	28,7
	ST7	-0,0146	0,0032	8,1	29,4
	ST8	-0,0112	0,0032	8,1	29,2
	ST9	-0,0164	0,0014	8,2	28,9
Quality Standard (Marine Tourism)*		0,075	0,002	7-8,5	-
Quality Standard (Marine life)*		0,05	0,005	7-8,5	-

Table 2: Test results of seawater quality parameters at low tide

(Low Tide)					
Sampling	**Station**	**Ni**	**Cr6⁺**	**pH**	**Temperature**
P1	OUTFALL	-0,076	0,002	7,5	30,1
	ST1	-0,087	-0,001	7,4	30,2
	ST2	-0,065	-0,002	7,5	30,1
	ST3	-0,013	0,001	7,6	30,3
	ST4	-0,102	-0,001	7,6	30,2
	ST5	-0,069	0,001	7,6	30,6
	ST6	-0,054	-0,001	7,6	30,2
	ST7	-0,045	0,004	7,5	30,3
	ST8	-0,066	-0,002	7,6	30,8

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/QRWCN

	ST9	-0,066	0,002	7,6	30,5
P2	OUTFALL	-0,149	0,001	7,7	30,4
	ST1	-0,053	0,007	7,8	30,6
	ST2	-0,082	-0,003	7,8	31,0
	ST3	-0,075	-0,003	7,8	30,4
	ST4	-0,035	0,001	7,8	30,5
	ST5	-0,107	0,004	7,9	30,8
	ST6	-0,103	0,001	7,8	30,5
	ST7	-0,099	0,003	7,8	29,4
	ST8	0,002	-0,004	7,9	29,6
	ST9	-0,135	0,005	7,9	29,5
P3	OUTFALL	-0,0134	0,0086	8,0	27,7
	ST1	0,0047	0,0075	8,0	27,9
	ST2	-0,0052	0,0027	8.0	28,0
	ST3	0,0177	0,0041	8,1	28,2
	ST4	0,0021	0,0105	8,1	28,7
	ST5	0,0055	0,0022	8,1	28,6
	ST6	0,0153	0,0022	8,0	28,8
	ST7	0,0041	0,0059	8,0	28,5
	ST8	0,0067	0,0122	8,1	28,4
	ST9	0,0037	0,0114	8,1	28,1
Quality Standard (Marine Tourism)*		0,075	0,002	7-8,5	-
Quality Standard (Marine life)*		0,05	0,005	7-8,5	-

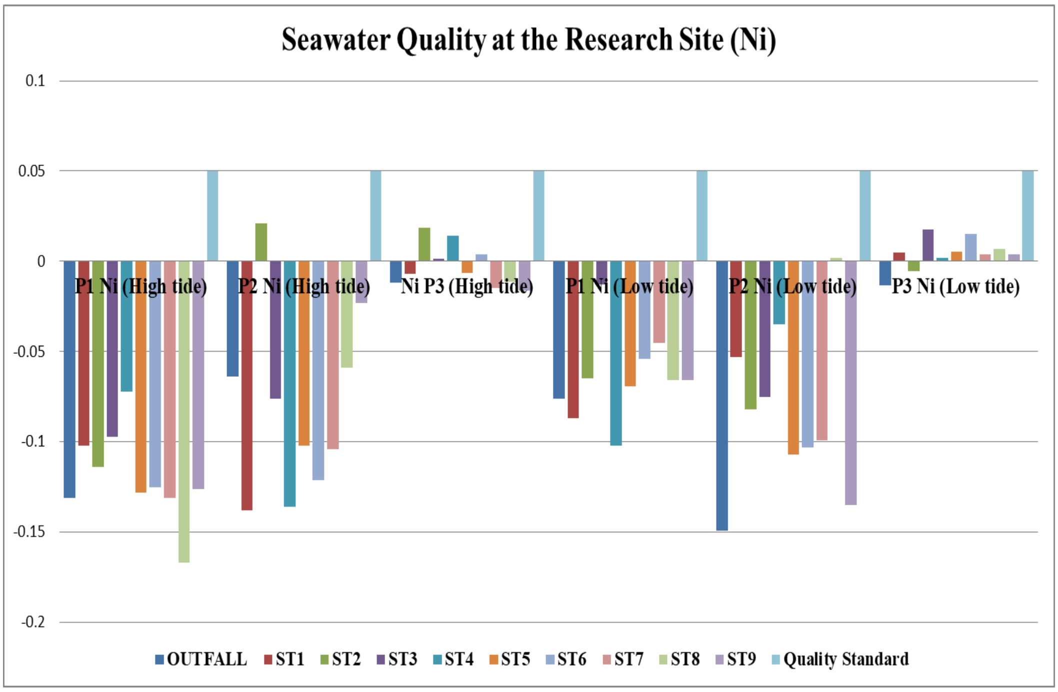

Figure 2: Graph of nickel parameter values

ISSN 1533-9211
DOI 10.17605/OSF.IO/QRWCN

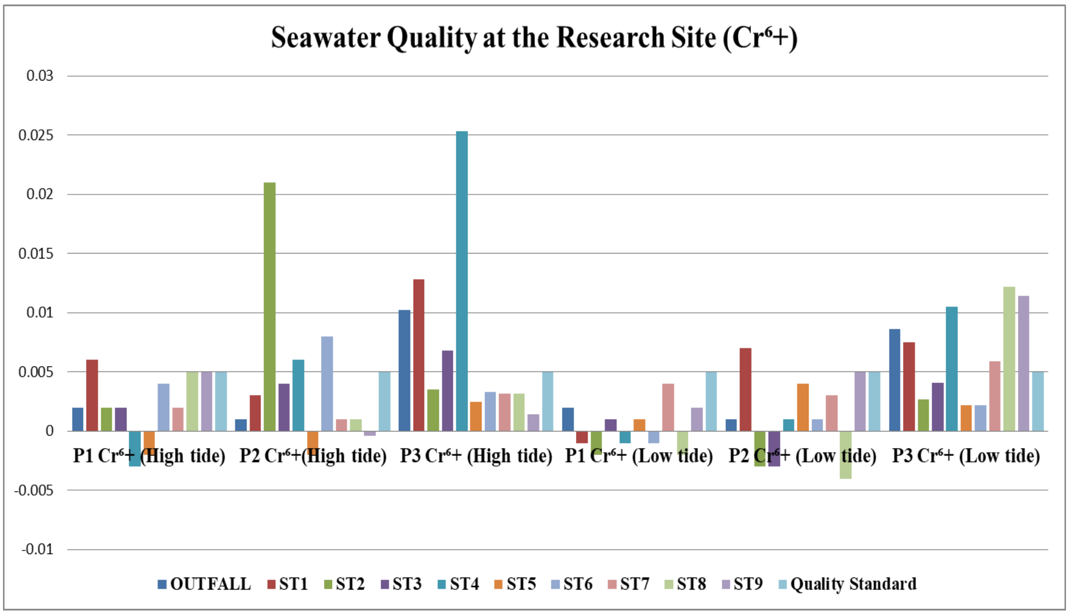

Figure 3: Graph of hexavalent chromium parameter value

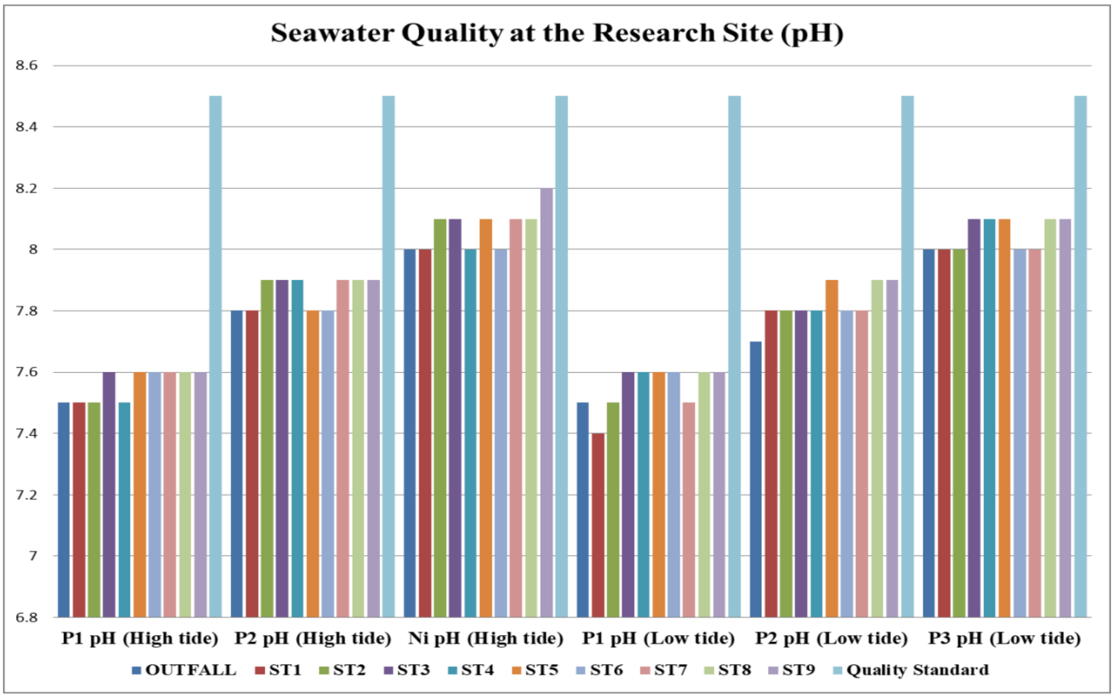

Figure 4: Graph of pH parameter value

ISSN 1533-9211
DOI 10.17605/OSF.IO/QRWCN

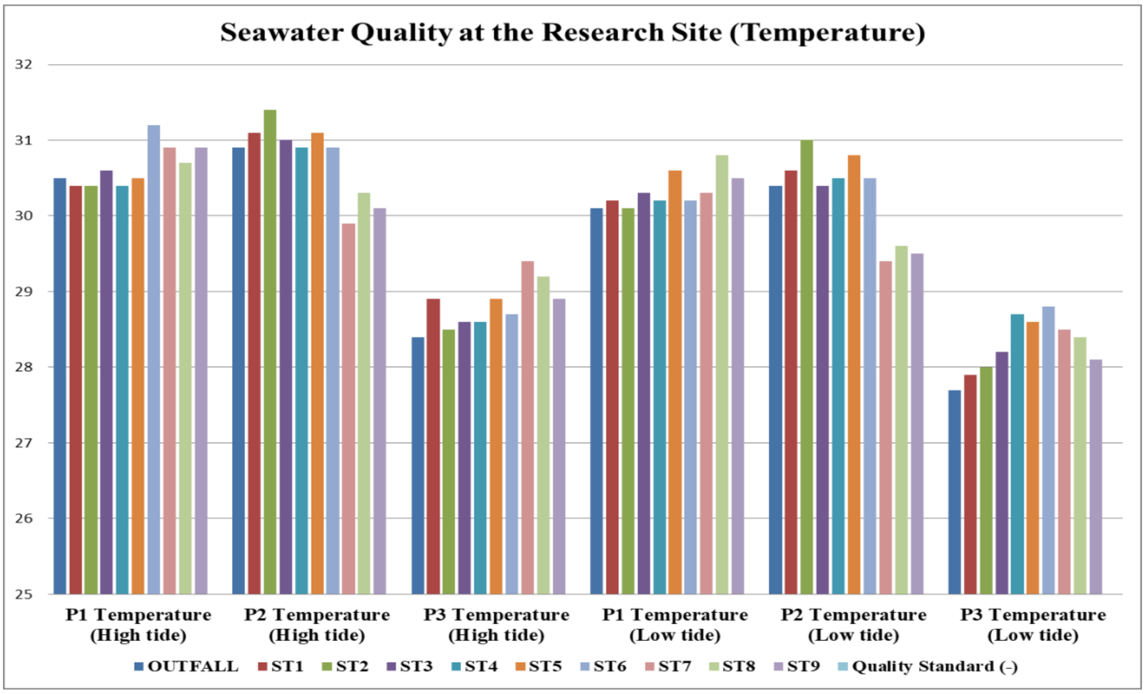

Figure 5: Graph of temperature parameter value

B. Pollution index

Evaluation of the calculation of the pollution index based on the parameter values of pH, temperature, nickel and hexavalent chromium shows the level of pollution for marine tourism designation at high tide is 1,9643 > 1 and low tide 1,1812 > 1 or lightly polluted while the designation of marine biota at high tide is 0,6353 < 1 and low tide 0,3762 < 1 or in the category of not polluted. This is in accordance with the evaluation of the pollution index in South Sulawesi Governor Regulation No. 69 of 2010 concerning Quality Standards and Criteria for Environmental Damage Appendix I Letter B Method of Determining Water Quality Status with the Pollution Index method. The results of the calculation of the Flores Sea Waters pollution index at high and low tides for marine tourism and marine biota can be seen in tables 3, 4, 5 and 6.

Table 3: Pollution index of Flores Sea Waters at high tide for marine tourism purposes

No	Parameters	Average Value/Field Value (Ci)	Quality Standards (Lij)	Ci / Lij	New Ci / Lij	Pollution Index
1	Nickel (Ni)	-0,0675	0,075	-0,8996	-0,8996	1,9643
2	Hexavalent Chromium ($Cr6^{+}$)	0,0046	0,002	2,2967	2,8055	
3	pH	7,83	7-8,5	-0,1067	-0,1067	
4	Temperature	30,07	27-32	-0,2293	-0,2293	
Average Ci / Li j					0,3925	
Maximum Ci / Li j					2,8055	

The Seybold REPORT
ISSN 1533-9211
DOI 10.17605/OSF.IO/QRWCN

Table 4: Pollution index of Flores Sea Waters at low tide for marine tourism purposes

No	Parameters	Average Value/Field Value (Ci)	Quality Standards (Lij)	Ci / Lij	New Ci / Lij	Pollution Index
1	Nickel (Ni)	-0,0479	0,075	-0,6390	-0,6390	**1,1812**
2	Hexavalent Chromium ($Cr6^{+}$)	0,0027	0,002	1,3717	1,6862	
3	pH	7,81	7-8,5	-0,0756	-0,0756	
4	Temperature	29,63	27-32	-0,0520	-0,0520	
Average Ci / Li j					0,2299	
Maximum Ci / Li j					1,6862	

Table 5: Pollution index of Flores Sea Waters at high tide by marine life designation

No	Parameters	Average Value/Field Value (Ci)	Quality Standards (Lij)	Ci / Lij	New Ci / Lij	Pollution Index
1	Nickel (Ni)	-0,0675	0,05	-1,3495	-1,3495	**0,6353**
2	Hexavalent Chromium ($Cr6^{+}$)	0,0046	0,005	0,9187	0,9187	
3	pH	7,83	7-8,5	-0,1067	-0,1067	
4	Temperature	30,07	27-32	0,2293	0,2293	
Average Ci / Li j					-0,1917	
Maximum Ci / Li j					0,9187	

Table 6: Pollution index of Flores Sea Waters at low tide by marine life designation

No	Parameters	Average Value/Field Value (Ci)	Quality Standards (Lij)	Ci / Lij	New Ci / Lij	Pollution Index
1	Nikel (Ni)	-0,0479	0,050	-0,9585	-0,9585	**0,3762**
2	Hexavalent Chromium ($Cr6^{+}$)	0,0027	0,005	0,5487	0,5487	
3	pH	7,81	7-8,5	-0,0756	-0,0756	
4	Temperature	29,63	27-32	-0,0520	-0,0520	
Average Ci / Li j					-0,1344	
Maximum Ci / Li j					0,5487	

C. *Software Statistical Package for Social Science* (SPSS)

To find out whether there is a significant difference in the data values of all parameters at high and low tide, a statistical test was conducted using the Man Whitney test. First, a data normality test is conducted to determine whether the data is normally distributed or not which can be seen in Table 7 before conducting the Man Whitney test.

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/QRWCN

Table 7: Normality test results for parameters of nickel, hexavalent chromium, pH and temperature

Group		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Nickel Result	Nickel high tide	0,175	30	0,020	0,901	30	0,009
	Nickel low tide	0,163	30	0,040	0,927	30	0,041
Hexavalent Chromium Result	Hexavalent Chromium high tide	0,209	30	0,002	0,787	30	0,000
	hexavalent chromium low tide	0,117	30	,200*	0,951	30	0,180
pH Result	pH high tide	0,185	30	0,010	0,910	30	0,015
	pH low tide	0,163	30	0,040	0,921	30	0,028
Temperature Result	Temperature high tide	0,198	30	0,004	0,875	30	0,002
	Temperature low tide	0,241	30	0,000	0,877	30	0,002
a. Lilliefors Significance Correction							

Table 8: Man Whitney test results for parameters of nickel, hexavalent chromium, pH and temperature

	Nickel Result	Hexavalent Chromium Result	pH Result	Temperature Result
Mann-Whitney U	348	370	423,5	310,5
Wilcoxon W	813	835	888,5	775,5
Z	-1,508	-1,185	-0,397	-2065
Asymp. Sig. (2-tailed)	0,132	0,236	0,691	0,039
a. Grouping Variable: Group				

The Man Whitney test results in table 8 show that the nickel parameter has no significant difference during high and low tide conditions as indicated by a significance value of 0,132 > 0,05. Hexavalent chromium has no significant difference during high and low tide conditions with a significance value of 0,236 > 0,05. pH there is no significant difference during high and low tide conditions with a significance value of 0,691 > 0,05. Temperature there is a significant difference during high and low tide conditions with a significance value of 0,039 < 0,05.

4. CONCLUSION

The research that has been conducted by researchers reveals that seawater quality is affected or has a relationship with the movement of high and low tides. This can be seen from the increase or decrease in the value of all parameters. For marine tourism designation, it needs attention from the government because it is included in the lightly polluted category considering that the Bantaeng Industrial Estate is only ± 2.5 km from the marina beach, one of the marine tourism owned by Bantaeng Regency. Meanwhile, the designation of marine biota is still safe because it is in the unpolluted category. There is a significant difference in temperature parameter data at high and low tide. However, there is no significant difference in the parameters of nickel, hexavalent chromium and pH at the research site at high and low tide conditions.

Acknowledgment

The author is grateful to Mr. Muh Sadlie Samad as the branch manager of PT Global Environment Laboratory who has assisted in the presentation of data for the analysis of this research.

References

1) A. Harlia, (2016), Study on Utilization of Nickel Dregs Waste of PT Antam Pomalaa for Concrete Construction, Islam Negeri Alauddin University of Makassar, Gowa.

2) Sugiri, Saptahari. (2005) "Use of Nickel Slag as Aggregate and Cement Admixture for High Quality Concrete" Journal of Civil Engineering Vol. 1. No. 1, 2005.

3) Ichsan Invanni Baharuddin, A M Imran, Adi Maulana, Alimuddin Hamzah, (2021). Physical and Chemical Characterization of Ferronickel Slag Pomalaa District Southeast Sulawesi. Journal of Natural and Environmental Sciences. 12 (1), (2021). - 16.

4) South Sulawesi Province. (2010). South Sulawesi Governor Regulation Number 69 of 2010 concerning Quality Standards and Criteria for Environmental Damage. Makassar.

5) Water and wastewater Section 84: Method of assay for dissolved and total metals by Atomic Absorption Spectrometry (SSA) - flame. SNI 6989-84:2019.

6) Water and wastewater - Part 71: Test method for hexavalent chromium (Cr-VI) in test samples spectrophotometrically. SNI 6989.71:2009.

7) Sugiyono. 2012. Understanding Qualitative Research. Bandung: Alfabeta.

8) Seawater Quality - Part 8: Seawater test sampling methods. SNI 6964.8:2015.

9) Water and wastewater - Part 11: How to test for acidity (pH) using a pH meter using a pH meter. SNI 6989.11:2019.

10) Water and wastewater Section 23: How to test temperature with a thermometer. SNI 06-6989.23-2005.