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STUDY OF POLLUTION LEVEL, POLLUTION LOAD AND ASSIMILATIVE CAPACITY OF TALLO RIVER ESTUARY IN MAKASSAR URBAN OF SOUTH SULAWESI

Muhammad Yusuf[1], Achmad Fahrudin[2], Mukhlis Kamal[2], Cecep Kusmana[3]

[1]Doctor Candidate, Study Program of Natural Resource and Environmental Management, Bogor Agricultural University, Bogor, Indonesia
[2]Lecturer, Bogor Agricultural University, Bogor, Indonesia
[3]Prof, Bogor Agricultural University, Bogor, Indonesia

ABSTRACT

Pressure on the estuary waters due to waste from household activities (organic and non-organic wastes), industrial activities (organic, non-organic, hot water waste, hazardous and toxic materials), agricultural and aquaculture activities (pesticides and sediment) and various domestic activities others, will put pressure directly on the estuary waters and resources. This study aims to (1) know the pollution level or waters quality, (2) measurment of pollution load, and (3) measurment of assimilative capacity. The results showed that waters condition of Tallo river estuary classified as contaminated was the pollutant index (7.94 to 9.60). Differences season showed no significant changes, average of PIj value on the rainy season (8.64) and on the dry season (8.37). The highest pollution load is TSS (33216.79 mg/sec) on the rainy season, and TSS (22436.00 mg/sec) on the dry season. While the assimilative capacity of TSS is 24157.66 mg/sec on the rainy season, and TSS is 22436.00 mg/sec on the dry season. It shows that the volume of TSS pollution load exceeds the capacity of assimilation.

Keywords : Pollution index, pollution load, assimilative capacity and Tallo Estuary Waters

1. Introduction

Estuary is semi-enclosed waters associated freely with the sea, extends to the river as far as the boundary tide, and mixed with fresh water, which comes from land drainage (Dyer 1997). According to Pritchard in Leeder (1982) estuary is a semi-enclosed coastal which a body of water associated freely with the open sea and water content dissolved in the fresh water from river. In general, these definitions can represent the conditions of Tallo river estuary waters. At the region occur mixing between the sea water with fresh water from mainland, so it becomes brackish. The region includes the estuaries and deltas, mangrove forests, mudflats and sand wide. This region can also be regarded as a region is very dynamic, because it always occur processes and changes, both physical and biological environment. The mixing of sea water with fresh water makes estuaries region has unique characteristics, namely the brackish formation with salinity fluctuates. The role of the estuary waters known as the waters which has high productivity for supporting the growth of plankton.

According to Odum (1971) that the estuary waters is a nutrient trap that causes high productivity so it is nursery ground of organisms. It is consistent with Mc Connughey (1974) that about 90% of adult fish utilize estuary waters as spawning, nursery and feeding grounds. The flow of fresh water occurs continuously from upstream and tidal currents that transport minerals, organic matter and sediment bring about productivity of estuary waters exceed seas and freshwater productivities.

The role of estuaries is most important, due to the very high productivity. According to Hutabarat and Evans (1985) that there are 4 factors that cause estuaries experiencing high productivity values, are; 1) the addition of organic materials are constantly coming from the river flow, 2) the estuary waters is shallow generally so that acceptance of sunlight occurs fully on the waters to life support of organism, 3) the estuary waters is a relatively small area receives wave so that detritus can accumulate therein, 4) the tides always stirred organic materials therein. The other side, estuariy waters

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are also very vulnerable of pollution, both from land as well as from the sea.

Pressure on estuary waters due to waste from household activities (organic and non-organic wastes), industrial activities (organic, non-organic, hot water waste, hazardous and toxic materials), agricultural and aquaculture activities (pesticides and sediment) and various domestic activities others, will put pressure directly on estuary waters and resources. Based on this, the study of pollution level, pollution load and assimilative capacity becomes very important.

2. Research Method

2.1. Time and Location of Reseach

This study was carried out in Tallo River Estuary of Makassar Urban, South Sulawesi Province. Starting from June 2013 until January 2014. More details of research location as shown in Figure 1.

2.2. Kinds and Sources of Data

The data collected in this study is consist of field measurements and sampling for subsequent laboratory analyzes. More details as follows in Table 1.

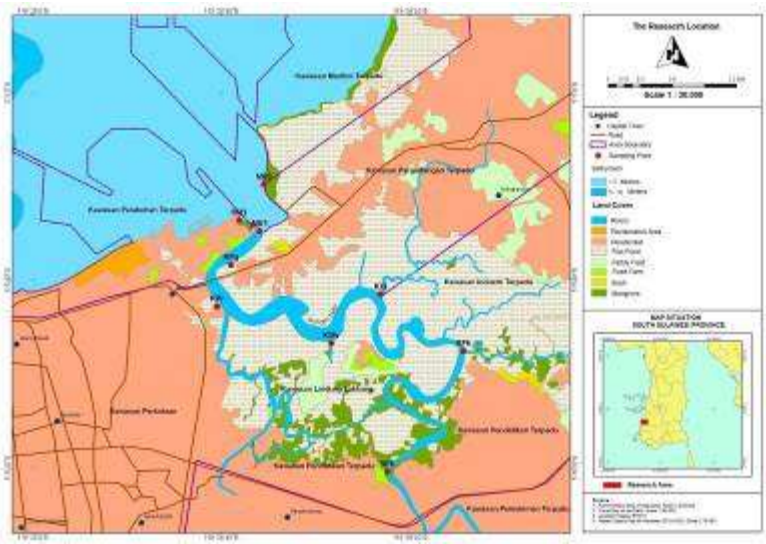

Figure 1 The research location
(Source: Administration Map of Makassar, 2014)

Table 1 Kinds and Sources of Data

Parameter	Units	Method/Tools	Remarks
A. Physical (water)			
1. Waste	-	Visual	In Situ
2. Temperature	°C	Thermometer	In Situ
3. Turbidity	Nephelometric Turbidity Units (NTU)	Turbidimeter	Laboratory
4. Suspended Solid	mg/l	Gravimetrix	Laboratory
5. Oil Layer	-	Visual	In Situ
B. Chemical (water)			
1. pH	-	pH-meter	In Situ
2. Salinity	Practical Salinity Unit (PSU)	Refractometer	In Situ
3. Dissolved Oxygen (DO)	mg/l	DO-meter	In Situ
4. BOD5	mg/l	SNI 6989.72:2009	Laboratory
5. Phosphate (PO4-P)	mg/l	SNI 7554.5:2011	Laboratory
6. Nitrate (NO3-N)	mg/l	SNI 6989.79:2011	Laboratory
7. Total Ammonia (NH3-N)	mg/l	SNI 6989.30:2005	Laboratory
8. Copper (Cu)	mg/l	SNI 6989.6:2009	Laboratory
9. Zinc (Zn)	mg/l	SNI 6989.7:2009	Laboratory
10. Pesticide	mg/l	SNI 6989.53:2010	Laboratory

11. Lead (Pb)	mg/l	SNI 6989.46:2009	Laboratory
12. Nickel (Ni)	mg/l	SNI 6989.18:2009	Laboratory
13. Cadmium (Cd)	mg/l	SNI 6989.16:2009	Laboratory
14. Surfactant	mg/l	SNI 6989.52:2010	Laboratory
15. Oil and Fat	mg/l	SNI 6989.50:2009	Laboratory
16. Total Coliform	mg/l	SNI 6989.52:2011	Laboratory

Source: Environmental Ministry Decree No.51/2004

1.1. Data Analysis Method

Data analysis method adapted to the purpose of research. Such methods include; pollution index analysis, pollution load analysis, and assimilative capacity analysis. More details as follows :

Table 2 Data Analysis Method

Goal	Variable	Analysis Method	Output
Pollution Level	Waters Quality (parameters based on Environmental Decree, No.51/2004)	Pollution Index Analysis	Pollution Level (not polluted, lightly, or heavily polluted)
Pollution Load	Parameters that exceed environmental quality standards based on Environmental Decree, No.51/2004	Pollution Load Analysis	Pollution load (ton/months)
Assimilative Capacity	Parameters that exceed environmental quality standards based on Environmental Decree, No.51/2004	Assimilative Capacity Analysis	Assimilative Capacity (ton/months)

Source: Research design, 2014

1.1.1. Pollution Index Analysis

Pollution index analysis conducted in accordance with Environmental Ministry Decree No.115/2003 on guidelines for the determination of water quality status. Pollution index is value or index that used to determine contamination level of waters (Nemerow, 1974). Pollution Index (PI) can provide input in the decision-making or policy management of waters, in order to assess of water quality for an allotment as well as measures to improve the environment quality, in the event of loss of water quality due to pollution. Pollution index analysis is evaluation of water quality is done by comparing the results of water quality analysis with standard of water quality for estuarine which refers to the Environmental Ministry Decree No.51/2004 on marine water quality standards for marine organism. The decision referred to in view of water quality standards for the estuary are not in Indonesia, so the quality standard that comes closest to the characteristics of the estuary are sea waters.

The analysis method of water samples were performed based on analysis procedures i.e. Indonesian National Standard (SNI) of water and wastewater refers to Standard Methods for the Examination of Water and Wastewater (APHA/AWWA/WPCF, 2005). The analysis steps of water quality status is as follows:

- If Lij is concentration of water quality parameters (j) accordance with the standard, and Ci is concentrations of water quality parameters (i) that measurement results, thus the PIj is Pollution Index for parameter (j) which is a function of Ci/Lij.

$$PIj = \sum(C1/L2j, C2/L2j, \ldots\ldots Ci/Lij)$$

Where,

PIj = Pollutan Index for parameter (j)

- Each value of Ci/Lij shows the relative pollution that caused by water quality parameters. This ratio does not have a unit. Ci/Lij Value = 1.0 is critical value, because this value is expected to be met for a designation of water quality standards. If Ci/Lij>1.0 for a parameter, thus concentration of parameter should be reduced or set aside, if the water body is

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used for designation (j). However, if the parameter is a parameter that is intended to designation, thus processing absolutely must be done.

- PI model used a variety of water quality parameters, then use is required average value of of Ci/Lij value total as benchmark of pollution, but this value will not be meaningful if one of Ci/Lij value is >1. So index this should include maximum value of Ci/Lij.

$$PIj = \{(Ci/Lij)R, (Ci/Lij)M\}$$

Where:
(Ci/Lij)R : Average value of Ci/Lij
(Ci/Lij)M : Maximum value of Ci/Lij

- If (Ci/Lij) R is coordinate and (Ci / Lij) M is axis, then PIj is intersection of (Ci/Lij) R and (Ci/Lij) M in areas bounded by two axes.
- Water will be contaminated for a designation (j) if value of (Ci/Lij) R or (Ci/Lij) M is >1.0 and if maximum value of Ci/Lij and or average value of Ci/Lij increase, the pollution level of a water body will be better. So length of line from base point to PIj point, then namely as a pollution level.

$$PIj = m\sqrt{(Ci/Lij)^2 M + (Ci/Lij)^2 R}$$

Where, m: balancing factor

- The critical state used to calculate of m value, PIj = 1.0 if value of Ci/Lij is maximum = 1.0 and value of Ci/Lij mean = 1.0 i.e.

$$PIj = m\sqrt{(Ci/Lij)^2 + (Ci/Lij)^2}$$
$$1{,}0 = m\sqrt{(1)^2 + (1)^2}$$
$$m = 1/\sqrt{2}$$

So;

$$PIj = m\sqrt{(Ci/Lij)^2 M + (Ci/Lij)^2 R}$$

Thus;

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

- This method can directly connect with pollution level between allocation of river with value of parameters. Evaluation of PIj value is as follows:

Table 3 Evaluation of Pij Value and Category

Pij Values	Category
$0 \le PIj \le 1.0$	meet the standard quality
$1.0 \le PIj \le 5.0$	slightly polluted
$5.0 \le PIj \le 10.0$	moderately polluted
$PIj \le 10.0$	heavily polluted

Source : Environmental Ministry Decree No.115/2003

1.1.2. Pollution Load

Pollution load expressed in units of pollutant load amount per unit time. The pollution load value is calculated by multiplying concentration of sewage and river flow (Tebbut, 1990). Pollution load is calculated using equation of Mitsch and Gosselink (1993) as follows:

$$BP = Q.C$$

Where:
BP = Pollution load or waste load for a parameter
Q = River flow (m^3/sec)
C = concentration of waste which is result of measurement (mg/l)

The River flow or stream flow is flow volume flowing through a cross section of the river/canal per unit time (Asdak, 2002). River flow is obtained by using equation by Gordon et al (1992), i.e:

$$Q = V.A$$

Where:
Q = River flow (m^3/sec)
V = Flow rate of river/canal (m/sec)
A = Sectional area of the river/canal (m^2)

To obtain value of pollution load in time units of months or years, the conversion is done by multiplying by 10^{-6} x 3600 x 24 x 30 in tonnes/month and 10^{-6} x 3600 x 24 x 360 in tonnes/year.

1.1.3. Assimilative Capacity

Assimilative capacity is ability of waters to receive and absorb pollutants load (waste) without impact or destroying aquatic organisms (water resources). Value of assimilative capacity is obtained by making a

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graph between concentration of each parameter with pollutant load of these parameters and subsequently analyzed by connecting with a line of water quality standards.

Regression analysis was used as an auxiliary method for determining tangent line or inter-section line between pollutants load with the quality standards required for each parameter. Pollution load are used as independent variables and pollution concentration as dependent variable. The mathematically has the following equation i.e:

$$y = f(x)$$

or regression equation is:

$$y = a + bx$$

Where:
y = Parametera of pollution conccentration
x = Parameters of pollution load
a = Intersep/ intersection with the vertical axis (mean/total average)
b = Slope/gradient (regression coefficient for parameters)

The use of a simple linear regression equation is expected to answer, what parameter concentration is influenced by the pollutant load, with some assumptions as follows:

- Pollutants materials from the land are all considered to be flowing into the river/canal.
- The higher the pollution load that entering, then higher the concentration in the waters.
- Concentration value of measurement results is value that has been reflecting water dynamics.
- Assimilative capacity value obtained is only valid in the research area.

2. Result and Discussion

2.1. Pollution Level

Analysis of pollution index was conducted to determine of pollution level of the Tallo River Estuary based on water quality parameters are allowed, in this case refers to Environmental Ministry Decree 51/2004 on marine water quality standards for marine organism. In this analysis used 13 parameters of physic-chemical quality for 2 (two) seasons measurements on nine (9) sampling points (station). Analysis results of pollution index as follows:

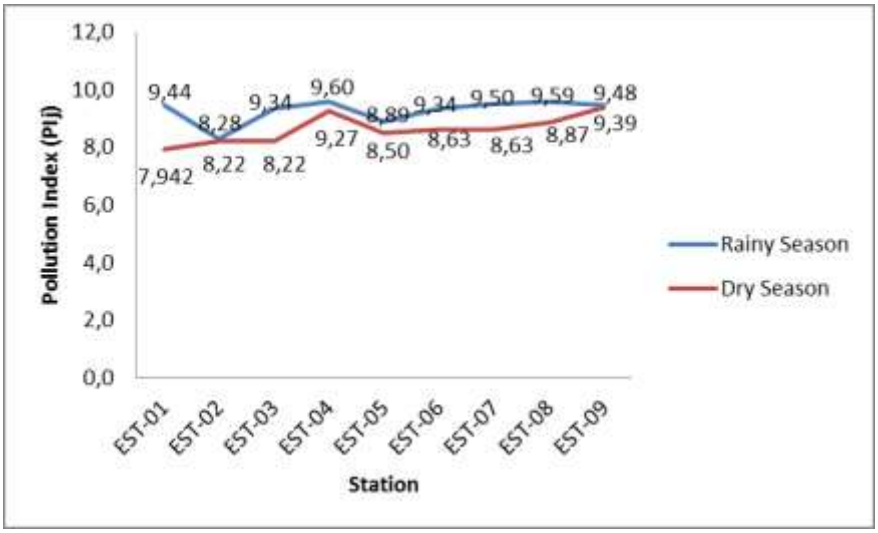

Figure 2 Chart of Pollution Index of Tallo River Estuary
(Source: Pollution Index Analysis, 2014)

The analysis results showed that waters of the Tallo River estuary have polluted with pollution index ranges from 7.94 to 9.60. This value is not much different from the results Rastina (2012) the IP ranged from 7.02 to 9.01. The effect of different seasons showed no significant changes, where conditions remain relatively polluted waters being. PIj value in rainy season was 8.64 and dry season is 8.37. When explored further, then the parameters of TSS, BOD, DO, Phosphate (PO_4-P), nitrate (NO_3-N), and the surfactant is a parameter that gives the highest contribution to pollution in Tallo River estuary.

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2.2. Volume of Pollution Load

The pollution load of Tallo River estuary was estimated based on the value of some parameters/indicators of pollution and river flow on two (2) seasons measurement. Pollutant parameters, consist of; TSS, BOD, DO, NH_3-N, NO_3-N, PO_4-P, Cd, Pb, Cu, Zn, pesticides, surfactants, oils and fats. Pollutant load calculation aims to determine pollutant sources, types of pollutants, and the magnitude of pollutants into the waters. The analysis results of pollution load as follows:

Table 4 Pollution Load Analysis of of Tallo River Estuary

Parameters	Results of Measurement (mg/l)		Rivers Flow (l/sec)		Pollution Load (mg/sec)	
	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season
TSS	110,0	80,0	301,97	280,45	33.216,79	22.436,00
BOD	1,3	6,0	301,97	280,45	392,56	1.682,70
DO	4,5	4,5	301,97	280,45	1.358,87	1.262,03
NH_3-N	0,03	0,030	301,97	280,45	9,06	8,41
NO_3-N	0,416	2,000	301,97	280,45	125,62	560,90
PO_4-P	1,500	0,40	301,97	280,45	452,96	112,18
Cd	0,030	0,003	301,97	280,45	9,06	0,84
Pb	0,012	0,002	301,97	280,45	3,62	0,56
Cu	0,012	0,012	301,97	280,45	3,62	3,37
Zn	0,014	0,014	301,97	280,45	4,23	3,93
Pestisida	0,010	0,010	301,97	280,45	3,02	2,80
Surfaktan	1,0	1,00	301,97	280,45	301,97	280,45
Minyak dan Lemak	0,015	0,005	301,97	280,45	4,53	1,40

Source: Results of Pollution Index Analysis, 2014

The analysis results of pollution load in rainy season show that highest pollution load is TSS (33216.79 mg/sec) or 86097.91 tons per month. The main source of TSS is derived from terrestrial (land-based source), it is evident from the massive land use change activities (land conversion) as well as various domestic activities on land, such as; land conversion to be aquaculture areas, residential, office, mall and warehousing. In addition, many small rivers that goes into the, to be run off for domestic waste. Besides TSS, other pollutant load which is also quite high is DO ie approximately 1358.87 mg/sec or 3522.19 tons per month. The high of DO pollution load caused by high TSS into the waters. In addition there are 4 other parameters are also provided pollutant loads are high enough; BOD, NO_3-N, PO_4-P and surfactants. Although BOD and DO parameters are classified high category, but both are still under assimilative capacity.

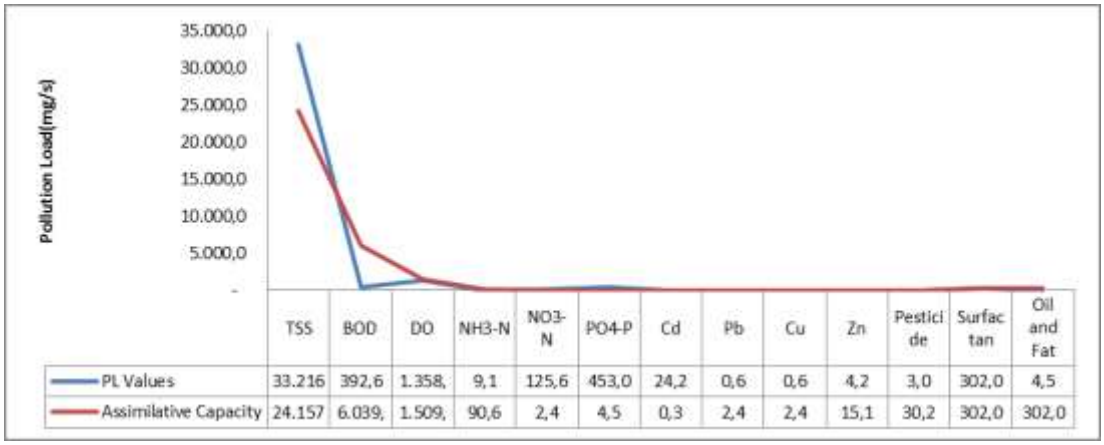

Figure 3 Chart of Pollution Load in Tallo Rivers Estuary (Rainy Season)
(Source: Results of Pollution Index Analysis, 2014)

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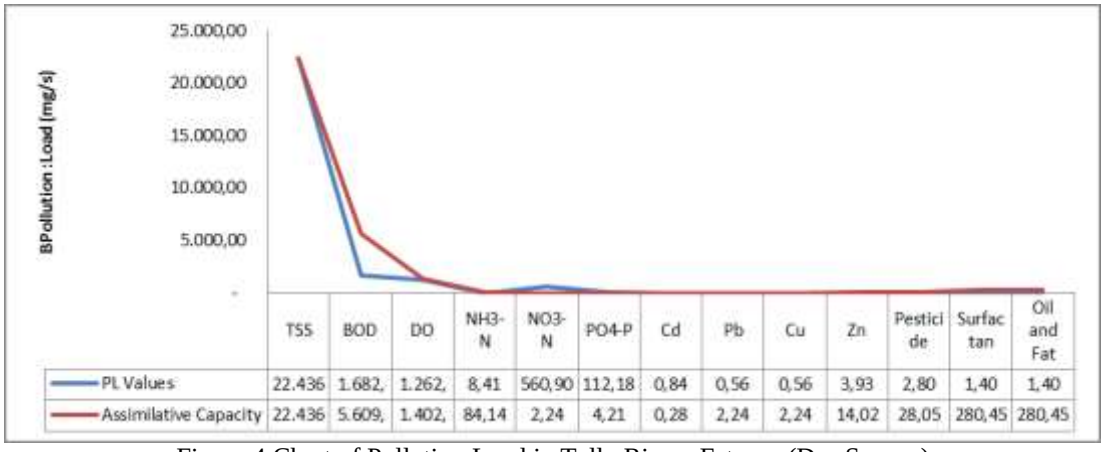
While based on the calculation of pollution load on dry season shows that highest pollutant load also is TSS. The pollutant load content of TSS is 22436.00 mg /sec or 58154.11 tons per month, due to high concentration of TSS into the waters as a results of massive land conversion activities and community activities (domestic waste). High concentration of pollutant load of TSS cause decrease of water quality is high, so as to disrupt photosynthesis process and respiration of organisms, conduce decrease of primary productivity of waters. In addition to TSS, the value of other pollutant load is high enough, BOD, DO, NO_3-N, PO_4-P and surfactants. BOD pollutant load value reached 1,682.70 mg / sec and pollutant load value DO is 1,262.03 mg / sec. However, both of these parameters is still below the assimilation capacity. Assimilation capacity of BOD and DO was 280.45 mg / sec.

In addition to TSS, the value of other pollution load is high are BOD, DO, NO_3-N, PO_4-P and surfactants. Value of BOD pollution load was 1682.70 mg/sec and DO is 1262.03 mg/sec. However, both of these parameters is still under assimilative capacity, where assimilative capacity of BOD and DO was 280.45 mg/sec.



	TSS	BOD	DO	NH3-N	NO3-N	PO4-P	Cd	Pb	Cu	Zn	Pesticide	Surfactan	Oil and Fat
PL Values	22.436	1.682,	1.262,	8,41	560,90	112,18	0,84	0,56	0,56	3,93	2,80	1,40	1,40
Assimilative Capacity	22.436	5.609,	1.402,	84,14	2,24	4,21	0,28	2,24	2,24	14,02	28,05	280,45	280,45

Figure 4 Chart of Pollution Load in Tallo Rivers Estuary (Dry Season)
(Source: Results of Pollution Index Analysis, 2014)

2.3. Assimilative Capacity

Assimilative capacity is relationship between the parameters concentration of waste with a total load of waste in the waters. The analysis of assimilative capacity is estimated based on measurement results of parameters for 2 (two) seasons i.e rainy season and dry season, and is associated with the total pollution load of parameters.

Table 5 Assimilative Capacity Analysis of Tallo Rivers Estuary (Rainy Season)

Parameters	Regression Equation	R^2	Assimilative Capacity (mg/sec)
TSS	y = 0,0028x + 16,300	0,9573	24.157,66
BOD	y = 0,006x + 2,4317	0,5980	6.039,42
DO	y = 0,0017x + 2,8732	0,4714	1.509,85
NH_3-N	y = 0,001x + 0,0205	0,5742	90,59
NO_3-N	y = 0,0028x + 0,194	0,5636	2,42
PO_4-P	y = 0,0008x + 0,9105	0,2191	4,53
Cd	y = 0,007x + 0,0086	0,8346	0,30
Pb	y = 0,0046x + 0,0009	0,9612	2,42
Cu	y = 0,0034x + 0,0069	0,0948	2,42
Zn	y = 0,0021x + 0,0079	0,7935	15,10
Pestisida	y = 0,0084x + 0,0062	0,9802	30,20
Surfaktan	y = 0,0017x + 1,0852	0,1509	301,97

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Parameters	Regression Equation	R^2	Assimilative Capacity (mg/sec)
Minyak dan Lemak	y = 0,0031x + 0,0033	0,3873	301,97

Source: Results of Assimilative Capacity Analysis, 2014

The calculation results of assimilative capacity in Tallo River estuary waters on the rainy season shows that there are some parameters that have exceeded assimilative capacity, i.e. TSS, NO_3-N, PO_4-P, Cd, and surfactants.

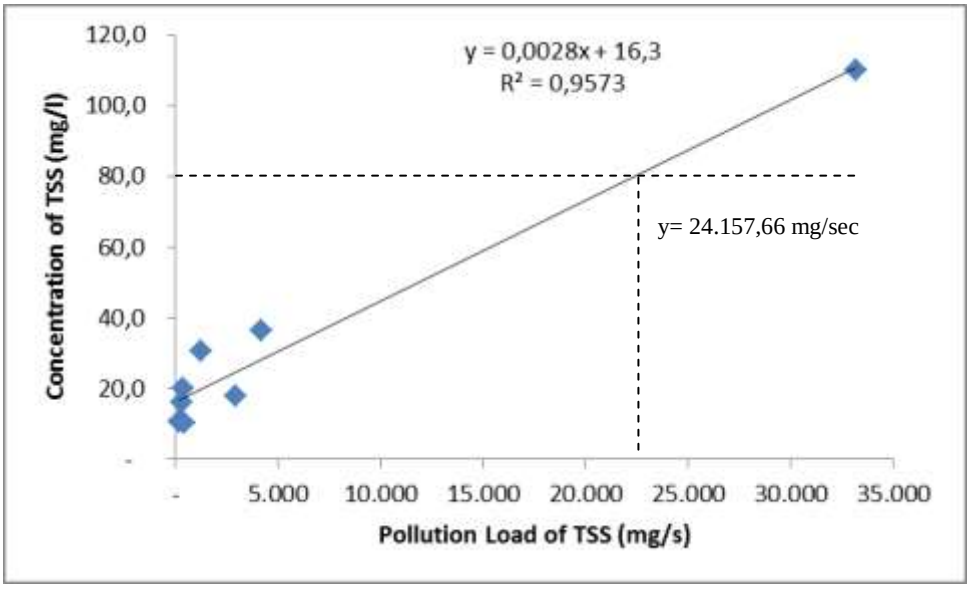

Figure 5 Chart of relationship between TSS concentration (mg/l) with pollution load volume of TSS (mg/s) in Tallo Rivers Estuary
(Source: Results of Assimilative Capacity Analysis, 2014)

The value of TSS assimilation capacity is 24157.66 mg/sec, while volume of TSS pollution load is 33216.79 mg/sec, thus these conditions indicate pollution load has exceeded of assimilative capacity.

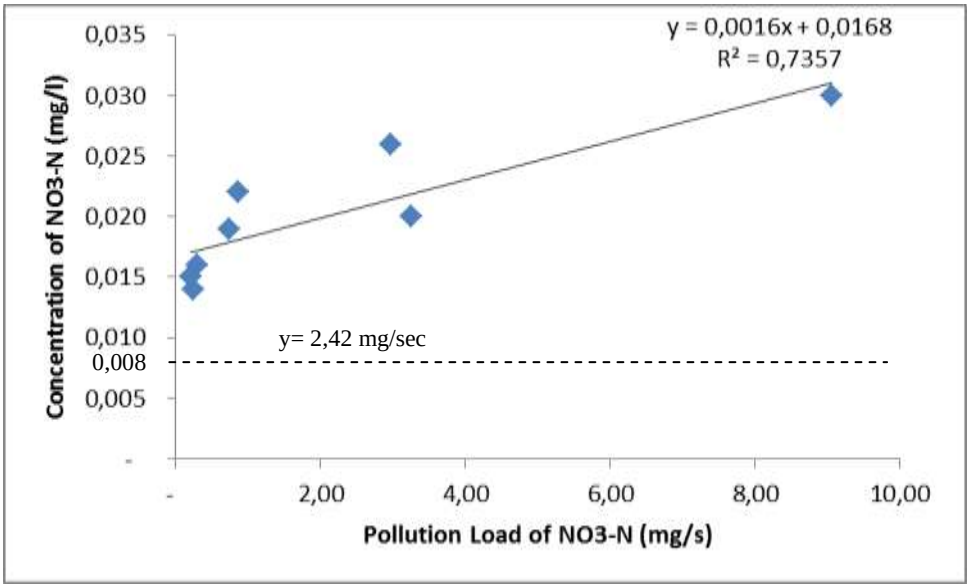

Figure 6 Chart of relationship between NO_3-N concentration (mg/l) with pollution load volume of NO_3-N (mg/s) in Tallo Rivers Estuary

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(Source: Results of Assimilative Capacity Analysis, 2014)

The results of assimilative capacity of NO_3-N parameter on rainy season was 2.42 mg/sec or 6.25 tons/month or about 75.4 tons/year. This condition indicates that assimilative capacity has been exceeded of pollution load that enter on the waters is 9.06 mg/sec or 23.48 tons/month or about 281.77 tons/year. Thus, in terms of NO_3-N parameter can be concluded that contamination in Tallo River waters are high that volume of pollution load into waters has been exceeded of assimilative capacity.

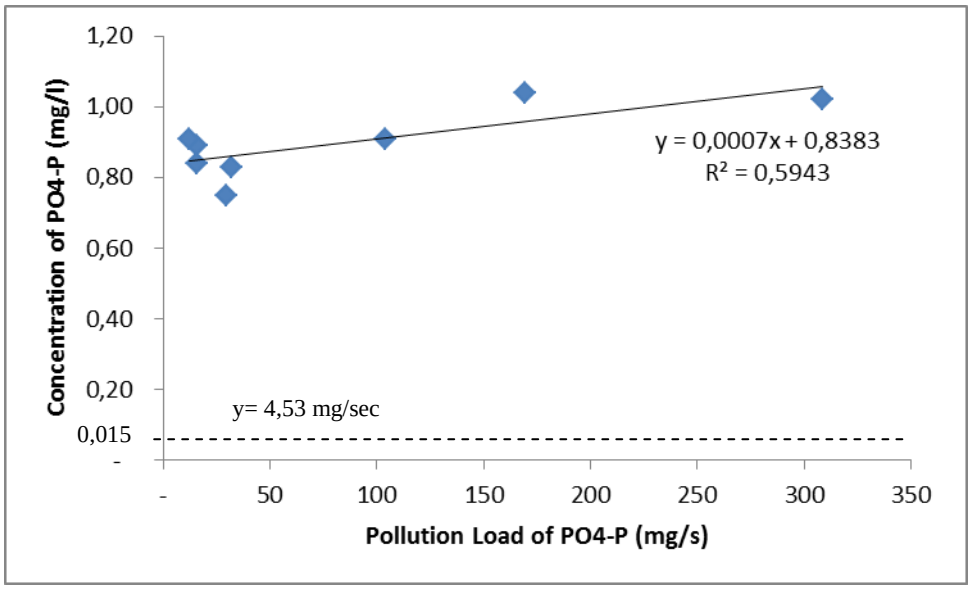

Figure 7 Chart of relationship between PO4-P concentration (mg/l) with pollution load volume of PO4-P (mg/s) in Tallo Rivers Estuary
(Source: Results of Assimilative Capacity Analysis, 2014)

The results of assimilative capacity of PO_4-P parameter on rainy season was 4.53 mg/sec or 11.74 tons/month or about 140.89 tons/year. This condition indicates that assimilative capacity has been exceeded of pollution load that enter on the waters is 308.31 mg/sec or 799.15 tons/month or about 9589.74 tons/year. Thus, in terms of PO_4-P parameter can be concluded that contamination in Tallo River waters are high that volume of pollution load into waters has been exceeded of assimilative capacity.

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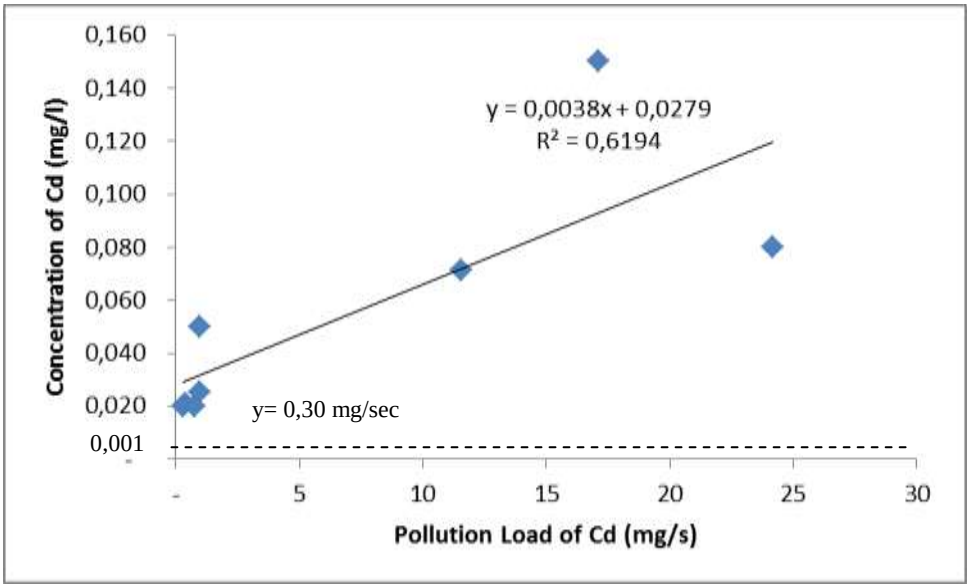

Figure 8 Chart of relationship between Cd concentration (mg/l) with pollution load volume of Cd (mg/s) in Tallo Rivers Estuary
(Source: Results of Assimilative Capacity Analysis, 2014)

The results of assimilative capacity of Cd parameter on rainy season was 0.3 mg/sec or 0.78 tons/month or about 9.39 tons/year. This condition indicates that assimilative capacity has been exceeded of pollution load that enter on the waters is 24.16 mg/sec or 62.62 tons/month or about 751.40 tons/year. Thus, in terms of Cd parameter can be concluded that contamination in Tallo River waters are high that volume of pollution load into waters has been exceeded of assimilative capacity.

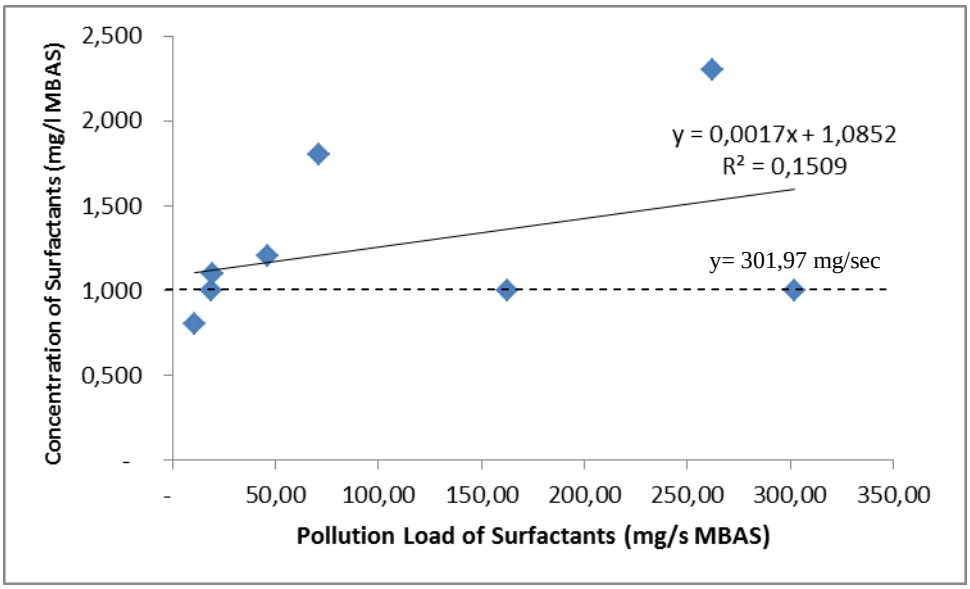

Figure 9 Chart of relationship between Surfactants concentration (mg/l MBAS) with pollution load volume of Surfactants (mg/sec MBAS) in Tallo Rivers Estuary
(Source: Results of Assimilative Capacity Analysis, 2014)

The results of assimilative capacity of surfactant parameter on rainy season was 301,97 mg/sec or 782.71 tons/month or about

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9291.50 tons/year. This condition indicates that pollution load is equal with assimilative capacity. Thus, the waters classified as still able to assimilate pollution load that into the waters.

Table 6 Assimilative Capacity Analysis of Tallo Rivers Estuary (Dry Season)

Parameter	Persamaan Regresi	R^2	Kapasitas Asimilasi (mg/dtk)
TSS	y = 0,0028x + 16,627	0,8919	22.436,00
BOD	y = 0,0027x + 3,1202	0,477	5.609,00
DO	y = 0,002x + 2,4170	0,7863	1.402,25
NH_3-N	y = 0,001x + 0,0207	0,5547	84,14
NO_3-N	y = 0,0021x + 1,121	0,6726	2,24
PO_4-P	y = 0,0023x + 0,168	0,8431	4,21
Cd	y = 0,002x + 0,0013	0,7745	0,28
Pb	y = -0,0047x + 0,0039	0,0602	2,24
Cu	y = 0,004x + 0,0016	0,832	2,24
Zn	y = 0,0014x + 0,0086	0,5899	14,02
Pestisida	y = 0,0009x + 0,014	0,0528	28,05
Surfaktan	y = 0,0024x + 0,0018	0,4569	280,45
Minyak dan Lemak	y = 0,0024x + 0,0018	0,4569	280,45

Source: Results of Assimilative Capacity Analysis, 2014

The same conditions occur for measurement of the dry season, which is the result of assimilative capacity showed that there are some parameters that have exceeded the assimilative capacity of Tallo River estuary waters. These parameters are; TSS, NO_3-N, PO_4-P, and Cd. These parameters have pollution load that exceeds the assimilitive capacity.

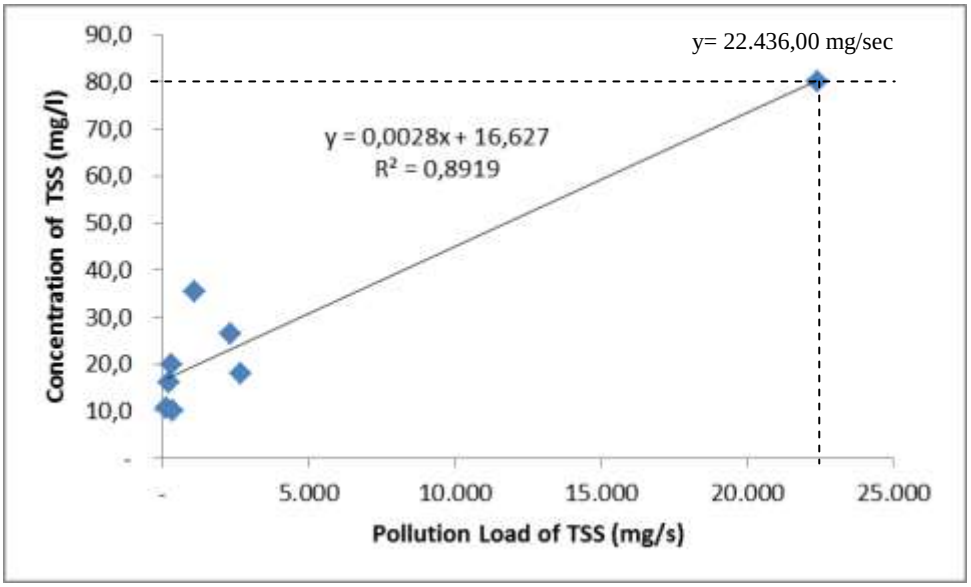

Figure 10 Chart of relationship between TSS concentration (mg/l) with pollution load volume of TSS (mg/s) in Tallo Rivers Estuary
(Source: Results of Assimilative Capacity Analysis, 2014)

The value of TSS assimilative capacity is 22436.00 mg/sec, which the value is equal to volume of pollutant loads into the waters. This condition shown that the pollution load has been exceeded its assimilative capacity. Thus the volume of pollution load is the highest volume that can be tolerated by the waters. On the other hand, waters conditions classified as partially mixed estuary, characterized by fresh water from the river is equal the sea water. Surface water is so salty than the bottom waters. Mixing water enters

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from bottom and out through surface waters occurs along estuaries. It is characterized by parameters of lower salinity in the surface rather than bottom.

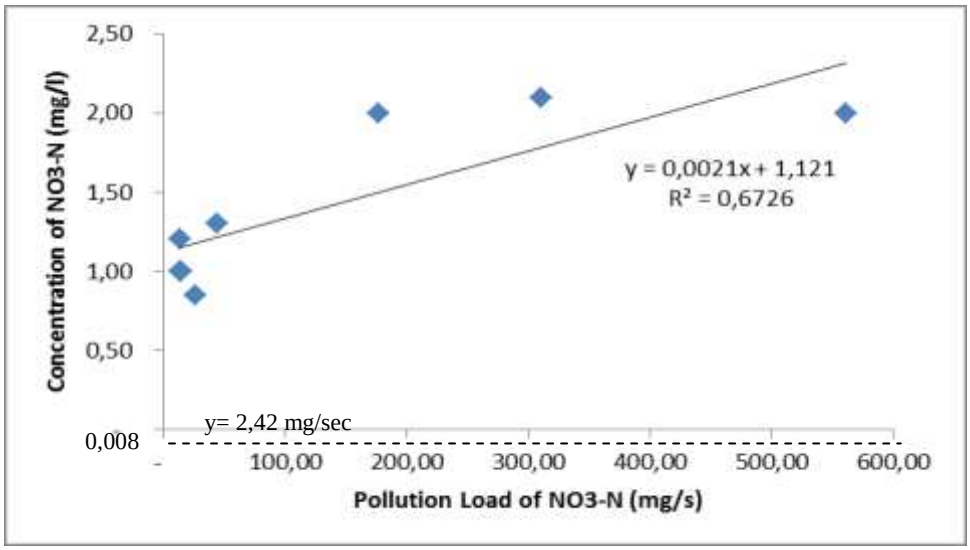

Figure 11 Chart of relationship between NO_3-N concentration (mg/l) with pollution load volume of NO_3-N (mg/s) in Tallo Rivers Estuary
(Source: Results of Assimilative Capacity Analysis, 2014)

The results of assimilative capacity of NO_3-N was 2.42 mg/sec or 6.25 tons/month or about 75.4 tons/year. This condition indicates that assimilative capacity has been exceeded by pollution load that into the waters is 560.90 mg/sec or 1453.85 tons/month or 17446.23 tons/year. It can be concluded that Tallo River estuary heavily polluted from the parameter NO_3-N on the dry season. Volume of pollution load NO_3-N is highly in the waters can be sourced from organic waste of domestic activities. Waste containing organic material may decompose due to microbial activities in the waters. Organic Nitrogen early decomposed be ammonia, then oxidised be nitrate (NO_3) and nitrite (NO_2). Nitrogen Nitrate is very easy suspended in the waters and relatively stable. This compound is produced from oxidation process perfectly in the waters. Nitrogen contents >0.2 mg/ltr indicates occuring eutrophication in the waters. Eutrophication is waters condition the excess nutrients. Such conditions can be algae blooming.

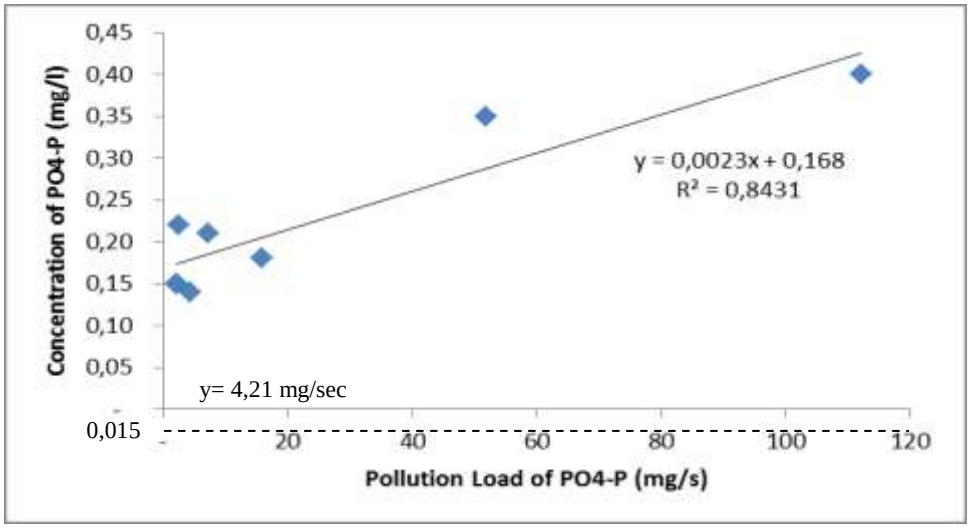

Figure 12 Chart of relationship between PO_4-P concentration (mg/l) with pollution load volume of PO_4-P (mg/s) in Tallo Rivers Estuary
(Source: Results of Assimilative Capacity Analysis, 2014)

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The results of assimilative capacity of PO_4-P is 4.21 mg/sec or 10.90 tons/month or about 130.85 tons/year. This condition indicates that assimilative capacity has been exceeded by pollution load that into the waters is 12.18 mg/sec or 290.77 tons/month or 3489.25 tons/year. It can be concluded that waters heavily polluted.

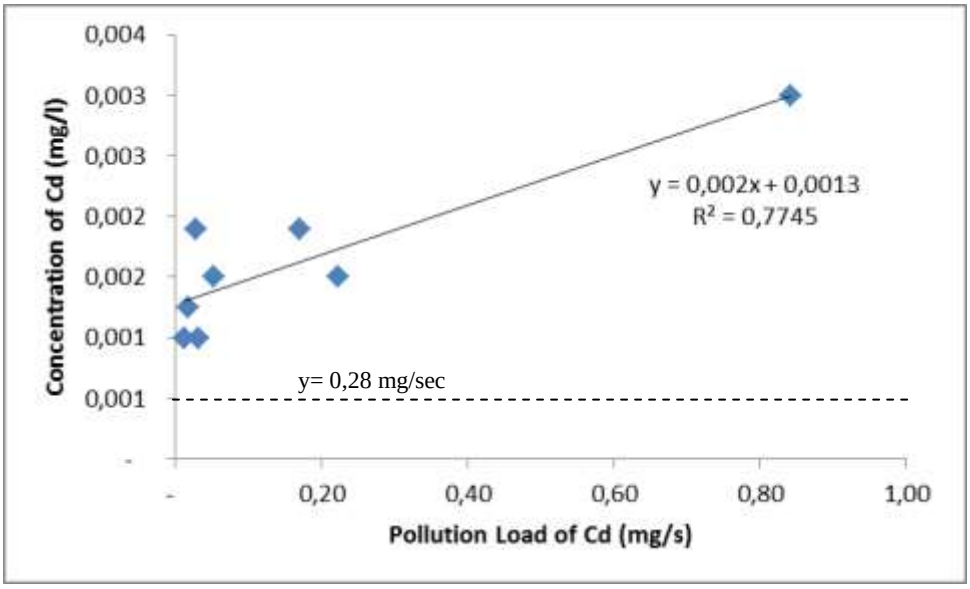

Figure 13 Chart of relationship between Cd concentration (mg/l) with pollution load volume of Cd (mg/s) in Tallo Rivers Estuary
(Source: Results of Assimilative Capacity Analysis, 2014)

The results of assimilative capacity of Cd is 0.28 mg/sec or 0.73 tons/month or about 8.72 tons/year. This condition indicates that assimilative capacity has been exceeded by pollution load that into the waters is 0.84 mg/sec or 2.18 tons/month or 26.17 tons/year. It can be concluded that waters heavily polluted.

3. Conclusion

1. There are 7 (seven) parameters that have exceeded the water quality, i.e; TSS, BOD, DO, Phosphate (PO_4-P), Nitrate (NO_3-N), and Surfactant.
2. The Conditions of Tallo River Estuary waters classified as being contaminated with pollutants index are 7.94 to 9.60. Differences season showed no significant changes, PIj value on rainy season (8.64) and dry season (8.37).
3. The highest pollution load in the waters is TSS (33,216.79 mg/sec) on the rainy season, and TSS (22,436.00 mg/sec) on the dry season.
4. The assimilative capacity of TSS on the rainy season is 24157.66 mg/sec, and dry season is 22436.00 mg/sec.

References

1. Asdak,C. 2002. *Hydrology and Watershed Management*. Gajah Mada University Press, Yogyakarta.
2. APHA (American Public Healt Association). 2005. *Standard Methods for the Examination of Waste Water. 17ed.* AWWA (American Water Association) and WPCF (Water Pollution Control Federation). Washinton D.C.
3. Dyer K.R. 1986. *Coastal and Estuarine Sediment Dynamic*. New York: John Wiley dan Sons Ltd.
4. Environmental Ministry Decree No.115 of 2003 on Guidelines for the Determination of Water Quality Status. Jakarta.
5. Environmental Ministry Decree No.51 of 2004 on Marine Water Quality Standards for Marine Organism. Jakarta.
6. Gordon ND, McMahon TA, Finlayson BL. 1992. *Stream Hydrology an Introduction for Ecologist*. John Wiley & Sons.
7. Hutabarat S, Evans S.M. 1985. Introduction of Oceanography. Indonesia University Press. Jakarta.

8. Leeder M.R. 1982. *Sedimentology, Process and Product*. Chapman & Hall, Boundaty Row, London.
9. Nemerow, N. L. 1974. *Scientific Stream Pollution Analysis*. Van Nostrand Reinhold L.td. New York. US. 358h.
10. Odum EP. 1971. *The Fundamental of Ecology*. Third Edition. Gadjah Mada University Press, Yokyakarta.
11. Tebbutt, T.H.Y. 1992. *Principles of Water Quality Control*. Fourth edition. Pergamon Press. Oxford.