The Depositional Influence in Regard of Environment Carrying Capacity in Waters at Inner Ambon Bay to Floating Net Cage Propagate

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ABSTRACT

Inner Ambon bay is a shallow and narrow waters that serve as the location of floating net aquaculture systems, but its water quality is threatened by depositional. This research is aimed at knowing depositional rate, its effect to carrying capacity of marine environment that indicated by water quality, and to formulate environmental management strategies.

Depositional rate assessed by calculating the rate of suspension sediment discharge from river, potential erosion estimates with USLE method, satellite imagery analysis of year 2004 and 2012, rate of water flow analysis from outer Ambon bay to inner Ambon bay, as well as bathymetric data analysis of year 2008 and 2012. To determine the water quality, sampling and laboratory test as well as scoring, weighting and matching was did to parameters, that is turbidity, DO, pH, brightness, temperature, TSS, TDS, gross primer productivity and nett primer productivity, while its environmental management strategies studied by causal approach.

The research finding showed that depositional rate from suspension sediment discharge calculation and unit convertion of Wae Heru river and Wae Tonahitu river is 1.7 cm/year, while the class of potential erosion at the Wae Heru and Wae Tonahitu river mouth, both of them is very light (<15 tons/hectare/year). Satellite imagery analysis showed that depositional rate at Wae Heru and Wae Tonahitu mouth river is 2445 square meters/year and 1459.625 square meters/year respectively. Through complementary data, that is the rate of water flow analysis obtained that rate of water flow to inner Ambon bay is 84 cm/s, whereas bathymetric analysis show a reduction in water depth is 13.9 cm/year. Results of water quality analysis indicates that the carrying capacity of waters are in the medium class, as well as refer to depositional rate and water quality, so environmental management strategy is focused on the management of upstream rivers, midstream rivers, downstream rivers, riparian and coastal area.

Keywords: *depositional, carrying capacity of marine environment, floating net cage, inner Ambon bay.*

I. INTRODUCTION

Ambon Bay is located at the geographical coordinates of 128º4'15" West Longitude – $128^0$14'25" West Longitude, and 3º37'5" South Latitude – 3º47'35" South Latitude. It is also known as the catching and the cultivation of various types of fish which are cultured with Floating Net Cages (FNC) system. This area is divided into two water areas with different characteristics, i.e.; the outer Ambon Bay and inner Ambon Bay, separated by a sill which takes the form of the bottle neck with a depth of 12.8 meters and a width of 7.8 meters. Outer Ambon Bay has current patterns which are influenced by Banda Sea, thus the current is heavier, whereas in the inner bay, the current is more still. (Wouthuyzen, 1984; Sumadhiharga and Yulianto, 1987; Miller, 1999; Natan, 2008; Nirahua, 2009; Selanno et al, 2009; Natsir, 2010; Cappenberg, 2011 and Mulyadi, 2011).

Inner Ambon Bay have functions supporting the fisheries, transportation, education and research. However, inner Ambon Bay are currently under threat due to the increasing population. The higher number of the residents, thus the higher needs of the residential locations, therefore it's encourages upper land clearing activities, but land clearing activities done are becoming uncontrollable and even excessive, leading to the disappearance of the most of buffer vegetation in rainfall catchment areas. Therefore, when it rains, many sediments are carried to the bay and they result in turbidity (Miller, 1999; Salili 2007 in Nirahua, 2009; Selanno et al, 2009 and Cappenberg, 2011). Ambon Island has hilly and mountainous landscapes, accompanied with steep slopes ($\geq 45^0$) and only about 20% of them are in the form of lowlands (Wouthuyzen et al, 1996; Miller, 1999), so the depositional process happens quickly.

Romimohtarto and Juwana (2007) suggest that the carrying capacity of the waters environment is affected by waters parameters in the form of water movement, temperature, salinity and light. Additionally, the effort of FNC posses essential requirements of the environmental carrying capacity that must be maintained, i.e.; (1) its location has small possibility to be exposed to strong winds and wave effects; (2) the depth of the water from the bottom of the waters at the lowest tide is 6-9 meters, (3) the movement of the water is 20-40 cm/second, (4) the salinity is 27-33 ppm, (5) the effect of the water temperature ranges from 28ºC to 30ºC; (6) it is pollution/contamination free, and (7) it does not inhibit the cruise line in the surrounding waters (Direktorat Jenderal Perikanan and Departemen Pertanian, 1994). Overdue depositional in water body will result in the increased turbidity level, thus the light penetration into the waters is reduced. It indicates that the level of the dissolved oxygen (DO) is also reduced (Romimohtarto and Juwana, 2007; Shuhua et al, 2009). Such condition is improper for the efforts of FNC, thus an assessment is necessary on the depositional effects towards the carrying capacity of waters environment at inner Ambon Bay for the development of FNC, which aims to: (1) to assess the depositional rate of inner Ambon Bay, (2) to assess the depositional effects on the carrying capacity of the waters environment at inner Ambon Bay, indicated by the quality of its waters for the development of floating net cages, and (3) to formulate depositional control strategies in inner Ambon Bay to stabilize its waters quality condition in order to support the floating net cages propagate.

II. MATERIALS AND METHODS

This research was conducted from May to July 2013 and was located at inner Ambon Bay (Figure 2), and was also located on Wae Heru River and Wae Tonahitu River (Figure 1). For the analysis of depositional rates, it was obtained by finding the suspension of the river discharge cargo to further perform conversion unit. Suspended load discharge (Qs) was sought by connecting the data of the river current discharge (Qw) with level of suspension load (Cs) which was measured on each different water level (h). Furthermore, on quality of the waters analysis, the parameter measured was the pH, the temperature, dissolved oxygen (DO), brightness, turbidity, TSS (Total Suspended Sediment), TDS (Total Dissolved Sediment) and also gross and net primary productivity (GPP and NPP). The parameters of the waters, namely: turbidity, pH, temperature, DO and brightness was each measured by using portable turbidimetry, pH meter, thermometer, DO meter and secci disk, meanwhile TSS and TDS were analyzed in the laboratory by using filter paper, oven, desiccators, analytical balance, petri bowls and butler bowls, meanwhile the primary productivity by using DO meter.

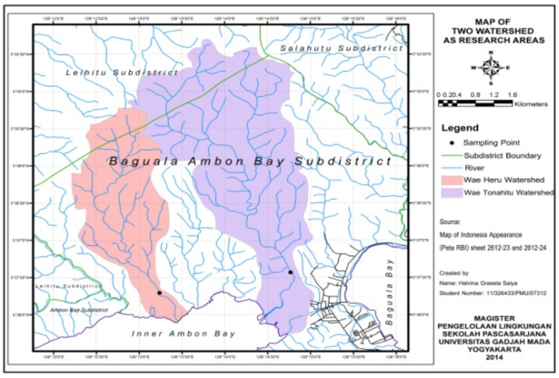

Figure 1. Map of two watershed as research areas

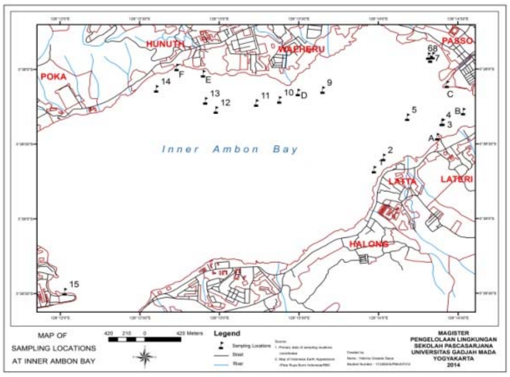

Figure 2. Map of sampling locations at Inner Ambon Bay

Then, the result of the measurement and the analysis were weighted and scored in accordance with the weighting and the scoring on Table.1.

Table 1. Weighting and scoring assessment of suitability waters parameters at inner Ambon Bay which affected by depositional to floating net cages

Parameters	Weight	High Class (S1)		Medium Class (S2)		Low Class (S3)	
		Value Range	Score	Value Range	Score	Value Range	Score
pH	1	7 – 9	3	5 – 6.9	2	<5 & >9	1
Temperature	1	28 – 32ºC	3	20 – 27,9ºC	2	<20ºC & >32ºC	1
DO	3	>6 mg/l	3	3 – 6 mg/l	2	<3 mg/l	1
TSS	3	5 - 25 mg/l	3	>25 - 50 mg/l	2	>50 mg/l	1
TDS	2	< 500 mg/l	3	500-1000 mg/l	2	>1000 mg/l	1
Turbidity	3	< 3 NTU	3	3 - 5 NTU	2	>5 NTU	1
Brightness	3	>3 m	3	1 – 3 m	2	<1 m	1

Source: Kepmen LH No. 51; Swingle Modification in Kangkan (2006); Kordi K. and Tancung (2010); Tucker and Hargreaves in Jumadi (2011); Affan (2012); PP No. 82/2001; KLH (2004 in Hartami, 2008); Pramono et al. (2005), Suryanto et al. (2005) and Cornelia et al. (2005 in Hartami, 2008).

Subsequently, low, medium and high carrying capacity of the class interval was obtained by subtracting the highest value to the lowest value and divided by the desired class number, i.e. 3 (three), therefore, the low class interval was 16-27, the medium class interval was 28-37 and the high class interval was 38-48. Then, subjective matching on the scoring result with the key parameters is DO and primary productivity.

Afterwards, to see the effect of river current discharge and the level of suspension load on suspended load discharge, as well as other parameters of the waters towards the turbidity as a parameter indicating the presence of depositional, thus multiple linear regression analysis was performed.

Potential erosion estimates with USLE formulate. So that, the data were analyzed is rainfall data, soil type data, slope data as well as the land use data and land conservation data. In addition, collecting sediment in coastal at inner Ambon Bay analyzed with reference to the data from Google Earth satellite imagery in 2004 and Geo Eye satellite imagery in 2012. Current data is obtained from Research and development center for Oceanology LIPI Ambon and bathymetric data which its necessary to create a contour map obtained from Research and development center for Oceanology LIPI Ambon and Dishidros Indonesia. All the results of the data analysis was followed by the formulation of environmental management strategies that were analyzed by using a causal approach.

III. RESULTS AND DISCUSSIONS

The results of the analysis of the depositional rate calculation from suspended load discharge of Wae Heru river and Wae Tonahitu river is as follows:

Wae Heru river is 3,50 Kilometers flowing along the stream at Wae Heru village, that is a part of Inner Ambon Bay District, and empties into the inner Ambon bay.

Table 2. Suspended load discharge calculation of Wae Heru River

no	Water level h (m)	Level of suspension load Cs (gr/liter)	River current discharge Qw (m^3/second)	constants	Suspended load discharge Qs (tons/day)
1	0.17	0.42975	0.78939759	86.40	29.31064828
2	0.18	0.455	0.862933955	86.40	33.92365964
3	0.19	0.48025	0.93839759	86.40	38.93749424
4	0.20	0.5055	0.940014141	86.40	41.05530561
5	0.22	0.53125	0.960636364	86.40	44.09320911
6	0.23	0.5815	0.996463611	86.40	50.06392616
7	0.25	0.632	1.186907514	86.40	64.81084742
8	0.27	0.694	1.374772552	86.40	82.43356185
9	0.28	0.71425	1.629973615	86.40	100.5876277
10	0.29	0.73575	1.68	86.40	106.795584
11	0.30	1.58625	1.85485053	86.40	254.2109748
12	0.31	1.68325	1.963132049	86.40	285.5037907
13	0.32	1.692	2.387114094	86.40	348.9693449
14	0.33	1.57	2.269988381	86.40	307.9193839
15	0.35	1.665	2.29824543	86.40	330.6163946
16	0.37	1.76025	2.504860234	86.40	380.9531716
17	0.38	1.80775	2.610117503	86.40	407.6732087
18	0.40	2.529	2.824423941	86.40	617.1524479
19	0.44	2.78425	3.206077741	86.40	771.2514965
20	0.46	2.91075	3.496299619	86.40	879.2801956
21	0.49	2.2925	3.835236059	86.40	759.6528767
22	0.53	3.35375	4.331325698	86.40	1255.06226
SUM		31.394	44.94116821		7190.25741
Average		1.4270	2.0427		326.829

Source: Primary Data, 2013

Wae Tonahitu river is 6,00 Kilometers flowing along the stream at Passo village, that is a part of Inner Ambon Bay District, and empties into the inner Ambon bay.

Tabel 3. Suspended load discharge calculation of Wae Tonahitu River

no	Water level h (m)	Level of suspension load Cs (gr/liter)	River current discharge Qw (m^3/second)	constants	Suspended load discharge Qs (tons/day)
1	0.24	0.13625	0.514413437	86.40	6.05567498
2	0.26	0.2905	0.861569622	86.40	21.62470826
3	0.27	0.30175	1.167529313	86.40	30.43889023
4	0.28	0.2525	2.183340926	86.40	47.63176564
5	0.29	0.324	2.289266512	86.40	64.08481103

6	0.31	0.345	3.15158801	86.40	93.9425354
7	0.32	0.3575	3.648257919	86.40	112.6873906
8	0.33	0.36875	3.47151077	86.40	110.6023331
9	0.35	0.366	4.144498879	86.40	131.0590014
10	0.37	0.38675	5.03953211	86.40	168.3969734
11	0.40	0.41825	6.026482714	86.40	217.7778005
12	0.42	0.439	6.781289803	86.40	257.2116097
13	0.45	0.4705	7.930377954	86.40	322.3793803
14	0.46	0.476	8.541745376	86.40	351.291237
15	0.48	0.48	9.097642341	86.40	377.2974232
16	0.49	0.48175	9.490435138	86.40	395.0222798
17	0.50	0.497	9.884977944	86.40	424.4688609
18	0.53	0.53	10.23213986	86.40	468.5501485
19	0.55	0.54425	11.88213062	86.40	558.7358046
20	0.56	0.55125	12.28612973	86.40	585.1637868
SUM		8.017	118.624859		4744.422415
Average		0.40085	5.9312		237.221

Source: Primary Data, 2013

Figure 3. Distribution of sediment when it rains which is monitored from a height

Depositional rate calculation was followed by the conversion of tons/day unit into cubic meters (m^3) and into meters (m). In Table 2 and Table 3, it can be seen that the average suspended load discharge in Wae Heru River is 326.829 tons/day, meanwhile the average suspended load discharge in Wae Tonahitu River is 237.221 tons/day, thus it is obtained that the average number of suspended load discharge ($\sum \overline{Q_s}$) of the two rivers entering the inner Ambon Bay is 564.05 tons/day. Therefore, the calculation is as the following:

It is found that:

1) Suspension is a material drifting in the water, therefore, the suspension ($\rho_{suspension}$) is equal to the density of water (ρ_{water}), i.e. 1g/m^3 is equal to 1000 kg/m^3
2) $\sum \overline{Q_s}$ = 564.05 tons / day
3) Thus, the mass suspension ($m_{suspension}$) = 564.05 tons = 564050 kg.

With $\rho = \frac{m}{v}$, thus the water volume is obtained by the formulation of $v = \frac{m}{\rho}$.

$$v = \frac{m}{\rho}$$

$$= \frac{564050\ kg}{1000\ kg/m^3}$$

$$= 564.05\ m^3$$

To find out how many meters of the silting resulted by the load suspension from both of the river, the water volume is divided by the width of inner Ambon bay.

It is found that:

1) The width of inner Ambon Bay = 12.1 km^2 = 12100000 m^2 (Berhitu, 2003; Selanno, 2009)
2) volume = 564.05 m^3

Thus,

$$\frac{564.05\ m^3}{12100000\ m^2} = 4.66\ \times\ 10^{-5}\ m$$
$$= 0.0000466\ m$$

Therefore, it is obtained that per day silting as the result from suspension load from Wae Heru River and Wae Tonahitu River is 0.0000466 m, thus within a year, it is obtained from 0.0000466 m × 365 days = 0.017 m/year. Therefore, the depositional rate of the inner Ambon Bay through Wae Heru River and Wae Tonahitu River is 0.017 m /year or 1.7 cm/year.

The following is the result of the measurement and the laboratory testing on the parameters of the waters at 21 observation stations at inner Ambon Bay.

Table 4. The results of measurements and the laboratory testing of water samples in the inner Ambon Bay

Station	Ph	Tempe -rature °C	Bright- ness m	DO mg/l	Turbidity NTU	TSS mg/l	TDS mg/l	NPP mgC/m^3/jam	GPP mgC/m^3/jam
1	6.7	33.2	8.15	4.8	1.04	0.0000936	0.0379	562.5	937.5
2	6.8	33	9.3	5.1	3.39	0.0002236	0.043104	-843.75	656.25
3	6.6	33	9	6	3.52	0.0000114	0.04275	-93.75	-93.75
4	6.19	33.6	8.5	4.6	4.20	0.000231933	0.037648	-1125	0
5	6.5	39	9.3	6.2	0.97	0.0003656	0.049696	-1781.25	937.5
6	5.7	30	6	5.1	2.38	0.0000418	0.047024	-468.75	656.25
7	6.5	31.6	6.25	5.2	2.56	0.000011333	0.040144	-937.5	93.75
8	6.3	32	8.5	5.6	3.61	0.000024266	0.049012	-468.75	468.75
9	6.17	34	7.15	5.1	1.75	0.000029666	0.040326	-562.5	-187.5
10	6	31.6	7	4.5	1.43	0.000029533	0.04107	0	468.75
11	5.4	33	8	5.1	1.55	0.000020133	0.04358	-1500	562.5
12	6.3	31.8	7	4.1	2.23	0.000026266	0.04475	-468.75	-93.75
13	6	32	7	2.4	2.19	0.000012133	0.043552	-2625	0
14	6.4	32.1	7	5.3	1.25	0.000017266	0.05105	-187.5	937.5
15	6.2	31.2	8	7	0.73	0.000023733	0.046744	-93.75	843.75
A	5.4	33.6	1.3	5.3	6.22	0.000076933	0.042228	-375	0
B	6.5	29	1	4	3.62	0.000069066	0.050418	-1500	0
C	5	35	9.3	4.9	3.76	0.000043266	0.03805	-562.5	1125
D	6.2	29.8	1.5	6.1	6.58	0.000146867	0.04312	-1875	-562.5
E	6.2	29.3	1	5.9	8.39	0.000037133	0.038868	-375	468.75
F	6	29.6	1	3.9	5.87	0.000041333	0.039544	-187.5	281.25
Average	6.146	32.25	6.25	5.057	3.20	0.000075088	0.043360857	-736.60714	357.142857

Source: The analysis result of the water samples, dated May 27, 2013

Table 5. Scoring and Assessment

STATIUN	PARAMETERS	PARAMETERS'S VALUE	WEIGHT	SCORE	WEIGHT × SCORE	SUM	GROUP
1	pH	6,7	1	2	2	42	S1 High
	Temperature (ºC)	33,2	1	1	1		
	Brightness (m)	8,15	3	3	9		
	DO (mg/l)	4,8	3	2	6		
	Turbidity (NTU)	1,045	3	3	9		
	TSS (mg/l)	0,0000936	3	3	9		
	TDS(mg/l)	0,0379	2	3	6		
2	pH	6,8	1	2	2	39	S1 High
	Temperature (ºC)	33	1	1	1		
	Brightness (m)	9,3	3	3	9		
	DO (mg/l)	5,1	3	2	6		
	Turbidity (NTU)	3,3933333	3	2	6		
	TSS (mg/l)	0,0002236	3	3	9		
	TDS(mg/l)	0,043104	2	3	6		
3	pH	6,6	1	2	2	39	S1 High
	Temperature (ºC)	33	1	1	1		
	Brightness (m)	9	3	3	9		
	DO (mg/l)	6	3	2	6		
	Turbidity (NTU)	3,52	3	2	6		
	TSS (mg/l)	0,0000114	3	3	9		
	TDS(mg/l)	0,04275	2	3	6		
4	pH	6,19	1	2	2	39	S1 High
	Temperature (ºC)	33,6	1	1	1		
	Brightness (m)	8,5	3	3	9		
	DO (mg/l)	4,6	3	2	6		
	Turbidity (NTU)	4,2066667	3	2	6		
	TSS (mg/l)	0,000231933	3	3	9		
	TDS(mg/l)	0,037648	2	3	6		
5	pH	6,5	1	2	2	45	S1 High
	Temperature (ºC)	39	1	1	1		
	Brightness (m)	9,3	3	3	9		
	DO (mg/l)	6,2	3	3	9		
	Turbidity (NTU)	0,975	3	3	9		
	TSS (mg/l)	0,0003656	3	3	9		
	TDS(mg/l)	0,049696	2	3	6		
6	pH	5,7	1	2	2	44	S1 High
	Temperature (ºC)	30	1	3	3		
	Brightness (m)	6	3	3	9		
	DO (mg/l)	5,1	3	2	6		
	Turbidity (NTU)	2,3883333	3	3	9		
	TSS (mg/l)	0,0000418	3	3	9		
	TDS(mg/l)	0,047024	2	3	6		
7	pH	6,5	1	2	2	44	S1 High
	Temperature (ºC)	31,6	1	3	3		
	Brightness (m)	6,25	3	3	9		
	DO (mg/l)	5,2	3	2	6		
	Turbidity (NTU)	2,5683333	3	3	9		
	TSS (mg/l)	0,000011333	3	3	9		
	TDS(mg/l)	0,040144	2	3	6		
8	pH	6,3	1	2	2	41	S1 High
	Temperature (ºC)	32	1	3	3		
	Brightness (m)	8,5	3	3	9		
	DO (mg/l)	5,6	3	2	6		
	Turbidity (NTU)	3,6166667	3	2	6		
	TSS (mg/l)	0,000024266	3	3	9		
	TDS(mg/l)	0,049012	2	3	6		
9	pH	6,17	1	2	2	42	S1 High
	Temperature (ºC)	34	1	1	1		
	Brightness (m)	7,15	3	3	9		
	DO (mg/l)	5,1	3	2	6		
	Turbidity (NTU)	1,7566667	3	3	9		
	TSS (mg/l)	0,000029666	3	3	9		
	TDS(mg/l)	0,040326	2	3	6		
10	pH	6	1	2	2	44	S1 High
	Temperature (ºC)	31,6	1	3	3		
	Brightness (m)	7	3	3	9		
	DO (mg/l)	4,5	3	2	6		
	Turbidity (NTU)	1,4333333	3	3	9		
	TSS (mg/l)	0,000029533	3	3	9		
	TDS(mg/l)	0,04107	2	3	6		
11	pH	5,4	1	2	2	42	S1 High
	Temperature (ºC)	33	1	1	1		
	Brightness (m)	8	3	3	9		

Table. 5

	DO (mg/l)	5,1	3	2	6		
	Turbidity (NTU)	1,5583333	3	3	9		
	TSS (mg/l)	0,000020133	3	3	9		
	TDS(mg/l)	0,04358	2	3	6		
12	pH	6,3	1	2	2	44	S1 High
	Temperature (°C)	31,8	1	3	3		
	Brightness (m)	7	3	3	9		
	DO (mg/l)	4,1	3	2	6		
	Turbidity (NTU)	2,2316667	3	3	9		
	TSS (mg/l)	0,000026266	3	3	9		
	TDS(mg/l)	0,04475	2	3	6		
13	pH	6	1	2	2	41	S1 High
	Temperature (°C)	32	1	3	3		
	Brightness (m)	7	3	3	9		
	DO (mg/l)	2,4	3	1	3		
	Turbidity (NTU)	2,195	3	3	9		
	TSS (mg/l)	0,000012133	3	3	9		
	TDS(mg/l)	0,043552	2	3	6		
14	pH	6,4	1	2	2	42	S1 High
	Temperature (°C)	32,1	1	1	1		
	Brightness (m)	7	3	3	9		
	DO (mg/l)	5,3	3	2	6		
	Turbidity (NTU)	1,2533333	3	3	9		
	TSS (mg/l)	0,000017266	3	3	9		
	TDS(mg/l)	0,05105	2	3	6		
15	pH	6,2	1	2	2	47	S1 High
	Temperature (°C)	31,2	1	3	3		
	Brightness (m)	8	3	3	9		
	DO (mg/l)	7	3	3	9		
	Turbidity (NTU)	0,73	3	3	9		
	TSS (mg/l)	0,000023733	3	3	9		
	TDS(mg/l)	0,046744	2	3	6		
A	pH	5,4	1	2	2	33	S2 Medium
	Temperature (°C)	33,6	1	1	1		
	Brightness (m)	1,3	3	2	6		
	DO (mg/l)	5,3	3	2	6		
	Turbidity (NTU)	6,2233333	3	1	3		
	TSS (mg/l)	0,000076933	3	3	9		
	TDS(mg/l)	0,042228	2	3	6		
B	pH	6,5	1	2	2	38	S1 High
	Temperature (°C)	29	1	3	3		
	Brightness (m)	1	3	2	6		
	DO (mg/l)	4	3	2	6		
	Turbidity (NTU)	3,625	3	2	6		
	TSS (mg/l)	0,000069066	3	3	9		
	TDS(mg/l)	0,050418	2	3	6		
C	pH	5	1	2	2	39	S1 High
	Temperature (°C)	35	1	1	1		
	Brightness (m)	9,3	3	3	9		
	DO (mg/l)	4,9	3	2	6		
	Turbidity (NTU)	3,76	3	2	6		
	TSS (mg/l)	0,000043266	3	3	9		
	TDS(mg/l)	0,03805	2	3	6		
D	pH	6,2	1	2	2	38	S1 High
	Temperature (°C)	29,8	1	3	3		
	Brightness (m)	1,5	3	2	6		
	DO (mg/l)	6,1	3	3	9		
	Turbidity (NTU)	6,58	3	1	3		
	TSS (mg/l)	0,000146867	3	3	9		
	TDS(mg/l)	0,04312	2	3	6		
E	pH	6,2	1	2	2	35	S2 Medium
	Temperature (°C)	29,3	1	3	3		
	Brightness (m)	1	3	2	6		
	DO (mg/l)	5,9	3	2	6		
	Turbidity (NTU)	8,3916667	3	1	3		
	TSS (mg/l)	0,000037133	3	3	9		
	TDS(mg/l)	0,038868	2	3	6		
F	pH	6	1	2	2	35	S2 Medium
	Temperature (°C)	29,6	1	3	3		
	Brightness (m)	1	3	2	6		
	DO (mg/l)	3,9	3	2	6		
	Turbidity (NTU)	5,8716667	3	1	3		
	TSS (mg/l)	0,000041333	3	3	9		
	TDS(mg/l)	0,039544	2	3	6		

Source: Analysis Result, 2014

Based on the assessment of the parameter conformity in the inner Ambon Bay waters that are affected by the depositional for the floating net cages (Table 1), the average value of the dissolved oxygen is classified in the medium class for FNC condition (Table 4). Thus although on the basis of the weighting and scoring method (Table 5), it is obtained that all sampling stations are classified in high class, however, by judging the parameters of dissolved oxygen condition (as a first key parameters) in the inner Ambon Bay, it can be said to be classified in medium class, because most of the results of the dissolved oxygen measurement at the sampling stations shows that dissolved oxygen condition is classified in the medium class (3-6 mg/l). In addition, by judging the condition of the nett primary productivity (as a second key parameters) that lies in a negative value, then the waters certainly is not classified in high class category for FNC system cultivation. Because net primary productivity values were negative indicating the respiration rate of the autotrophs organisms is higher than the gross primary productivity of the autotrophs organisms (Kicklighter *et al*., 1999 in Roxburgh *et al*., 2005).

The following is the result of multiple linear regressions between the river current discharge (Qw) and the level of suspension load (Cs) towards the suspended load discharge (Qs) in Wae Heru River and Wae Tonahitu River:

ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2257829.379	2	1128914.690	180.529	.000[a]
	Residual	118813.743	19	6253.355		
	Total	2376643.122	21			

a. Predictors: (Constant), Cs, Qw of Wae Heru River

b. Dependent Variable: Qs of Wae Heru River

The result of F_{count} can be seen on the table, which is 180.529, therefore, F_{table} can be determined by viewing the table of F standard value at the critical level by 5%, with the degree of residual free (df), i.e. 19 as df denominator, meanwhile df regression, which is 2 as df numerator, therefore, F_{table} is obtained at 3.52. $F_{count} > F_{table}$ is obtained, then Ho is rejected and Ha is accepted. It means that there is a significant relationship between Cs and Qw of Wae Heru River towards Qs of Wae Heru River.

ANOVA[b]

		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	647370.845	2	323685.423	698.369	.000[a]
	Residual	7879.292	17	463.488		
	Total	655250.137	19			

a. Predictors: (Constant), Cs, Qw of Wae Tonahitu River

b. Dependent Variable: Qs of Wae Tonahitu River

The result of F_{count} can be seen on the table, which is 698.369, therefore, F_{table} can be determined by viewing the table of F standard value at the critical level by 5%, with the degree of residual free (df), i.e. 17 as df denominator, meanwhile df regression, which is 2 as df numerator, therefore, F_{table} is obtained at 3.59. $F_{count} > F_{table}$ is obtained, then Ho is rejected and Ha is accepted. It means that there is a significant relationship between Cs and Qw of Wae Tonahitu River towards Qs of Wae Tonahitu River.

The photosynthesis is highly dependent on the presence of the light, but what becomes the barrier of the presence of high light intensity to the waters is suspended and deposited particles in the waters. The parameters of turbidity, TSS and TDS are highly crucial to the parameter of the brightness that indicates the intensity of the incoming light to the waters. Thus, the turbidity, TSS and TDS are interconnected independent factors to affect the brightness:

ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	113.746	3	37.915	8.657	.001[a]
	Residual	74.459	17	4.380		
	Total	188.205	20			

a. Predictors: (Constant), Turbidity (NTU), TSS (mg/L), TDS (mg/L)

b. Dependent Variable: Brightness (m)

The result of F_{count} can be seen on the table, which is 8.657, therefore, F_{table} can be determined by viewing the table of F standard value at the critical level by 5%, with the degree of residual free (df), i.e. 17 as df denominator, meanwhile df regression, which is 3 as df numerator, therefore, F_{table} is obtained at 3.20. $F_{count} > F_{table}$ is obtained, then Ho is rejected and Ha is accepted. It means that there is a significant relationship between turbidity, TSS and TDS towards brightness.

The brightness and the temperature are interconnected. It is certainly still related to the light intensity in the waters. These two parameters are the ones that will directly affect the level of DO in the waters. Thus, the brightness and the temperature are interconnected independent factors to affect DO:

ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	9.320	2	4.660	4.947	.019[a]
	Residual	16.958	18	.942		
	Total	26.278	20			

a. Predictors: (Constant),brightness (meters), temperature (celcius degree)

b. Dependent Variable: DO (mg/L)

The result of F_{count} can be seen on the table, which is 4.947, therefore, F_{table} can be determined by viewing the table of F standard value at the critical level by 5%, with the degree of residual free (df), i.e. 18 as df denominator, meanwhile df regression, which is 2 as df numerator, therefore, F_{table} is obtained at 3.55. $F_{count} > F_{table}$ is obtained, then Ho is rejected and Ha is accepted. It means that there is a significant relationship between brightness and temperature towards DO.

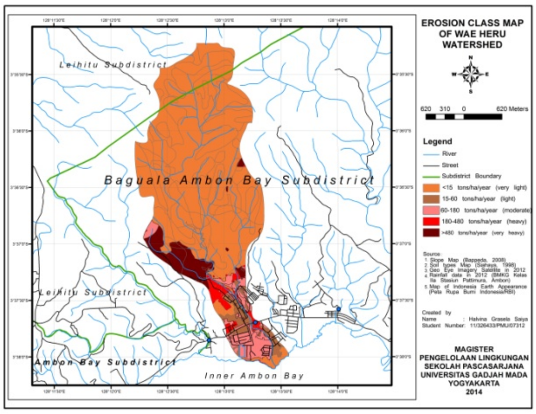

Figure 3. Erosion class map of Wae Heru watershed

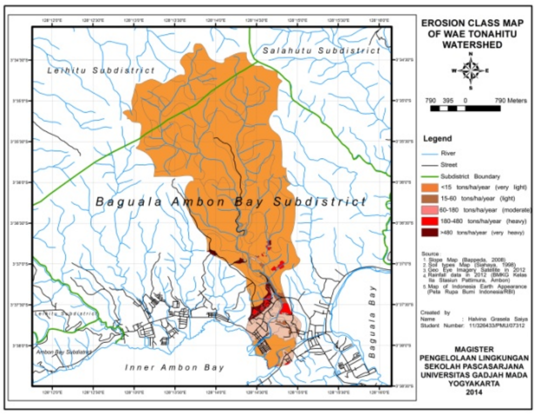

Figure 4. Erosion class map of Wae Tonahitu watershed

USLE analysis begins with calculation of rain erosivity on rainfall data during the year 2012 which uses the Lenvain formula, rain erosivity obtained for 5312.68 tons/year, multiplied by value of soil erodibility (obtained from secondary data belongs to the departement of agriculture about the types of soil in Indonesia), slope index value (with class intervals 0-8%, 8-15%, 15-25%, 25-40% and >40% based on the classification of forest departement) and value of land use and land conservation using the classification of Arsyad. Based on figures 3 and 4, it can be seen that the results of analysis by using USLE formula shows that potential erosion on both rivers are in the range of less than 15 tons/hectare/year, this means that the potential for erosion is very light.

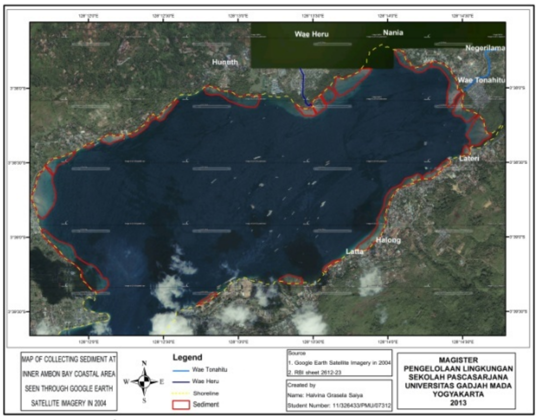

Figure 5. Collecting sediment at Inner Ambon Bay coastal area seen through Google Earth satellite imagery in 2004

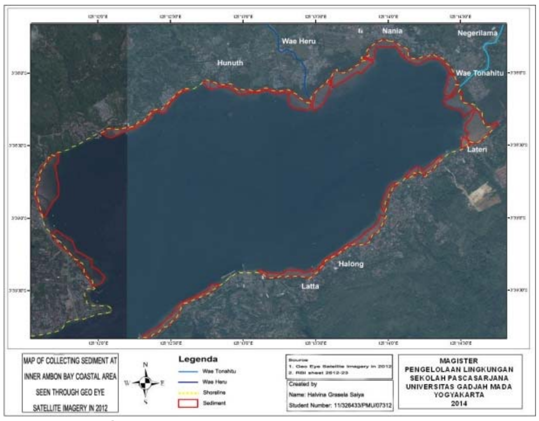

Figure 6. Collecting sediment at Inner Ambon Bay coastal area seen through Geo Eye satellite imagery in 2012

After satellite images digitized on screen and calculated by calculate geometry using ArcGis, then the extent of sediment collection at Wae Heru mouth river in 2004 is 83147 m^2 and in 2012 is 102707 m^2, then obtained a rate of 2445 m^2/year. Beside that, then the extent of sediment collection at Wae Tonahitu mouth river in 2004 is 163918 m^2 and in 2012 is 175595 m^2, then obtained a rate of 1459,625 m^2/year.

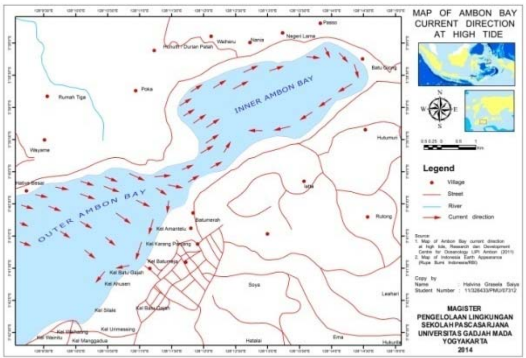

Figure 7. Ambon Bay current direction at high tide

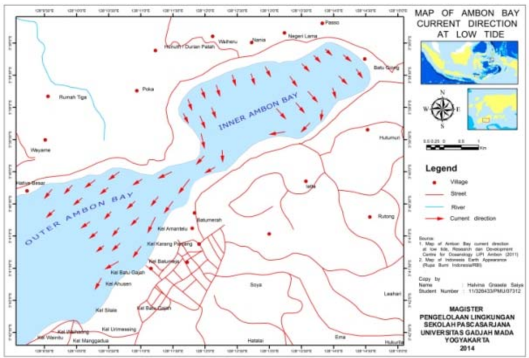

Figure 8. Ambon Bay current direction at low tide

Based on data from Research dan Development Centre for Oceanology LIPI Ambon by using Lagrangian method, the average of flow velocity from inner Ambon Bay to outer Ambon Bay is 34.7 cm/s and the average of flow velocity from outer Ambon bay to inner Ambon bay is 84 cm/s. This suggests that incoming flow velocity to inner Ambon Bay is greater than out flow velocity from inner Ambon Bay. This is a basic characteristic which may indicate that sediment transport is carried along with the flow from outer Ambon Bay to inner Ambon Bay has a greater payload than the sediment transport out of the inner Ambon Bay.

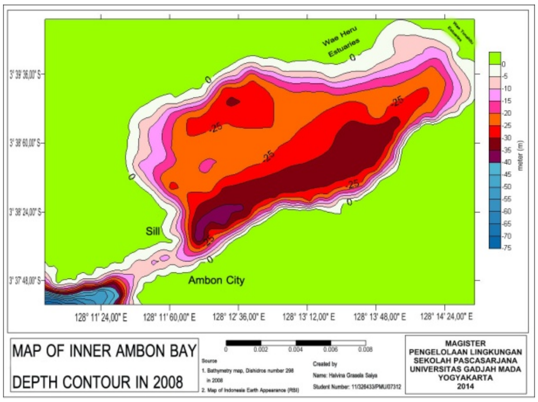

Figure 9. Map of Inner Ambon Bay depth contour in 2008

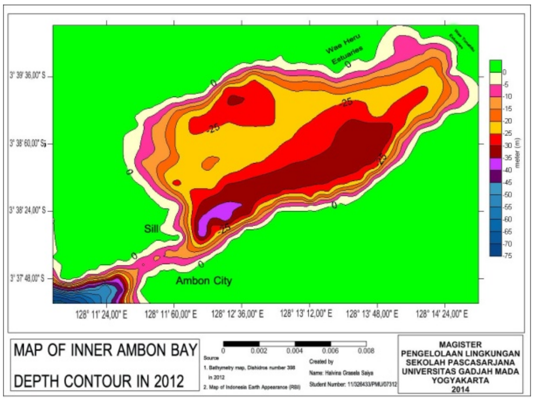

Figure 10. Map of Inner Ambon Bay depth contour in 2012

Through the analysis of inner Ambon Bay depth grid calculation using Surfer, then obtained the average of depth water in 2008 is 18.175 meters, and in 2012 is 17.617 meters. So the difference for four years is 0.558 meters. So that, the water depth reduction is 0.139 meters/year or 13.9 cm/year. In figure 9 and 10, seen that almost no change between the bathymetry of 2008 and the bathymetry of 2012, its shows that silting that occurs each year is small, which are in the range of centimeters.

Furthermore, from the causal approach, the three main causes of the depositional are obtained, i.e. erosion, siltation of the waters and sediment depositional, therefore, the environmental management strategies are being focused on the watershed management (upstream, midstream and downstream), the management of riparian areas and the management of coastal areas.

Table 6. Environmental Management Strategies

LOCATION	PROBLEMS	CAUSES	MANAGEMENT STRATEGIES	PROGRAM/ACTIVITIES	PERSONS IN CHARGE
Upper River on Watersheds	Erosion , landslides as well as large sediment transportation by river	The vegetation is reduced in several locations, sands and rocks on the river which is not well-controlled, and the residents' houses built on cliffs grooves.	1. Appropriate land use on forest areas , especially in areas with a slope of >15-25 %.	Licensing for land clearing as well as for mining activities should be made more stringent, especially in the hamlet or village level, while for the owners of the land, they must be given an understanding on the land clearing governance of forest areas, especially areas with slope condition at >15-25 % from the relevant institutions	1. Village Head or Hamlet Head. 2. Hall of River Basin 3. Natural Resources Conservation Agency 4. Department of Land Affairs 5. Department of Agriculture 6. Department of Forestry
			2. Avoiding housing construction on a steep cliff area as much as possible	home construction licenses should be made more stringent by considering the condition of the land location that will be built	1. Department of Land 2. Regional Development Agency of Ambon 3. Environmental

					Impact Management Agency
			3. Reducing surface flow	Creating infiltration wells	1. The communities, coordinated by the village head 2. Regional Development Agency of Ambon 3. Environmental Impact Management Agency
			4. Reducing potential erosion and landslides mechanically	Creating gully plug	1. The communities, coordinated by the village head 2. Regional Development Agency of Ambon 3. Environmental Impact Management Agency
			5. Reforestation in forest areas which have turned to be moors	Creating routine greening program and distributing free tree seeds to plant.	1. The villagers, coordinated by the village head or also the village youth groups 2. Non-governmental organizations, schools and even universities 3. Natural Resources Conservation
			6. Avoiding homogeneous plantation type	Applying mixed plantation system	1. Farming groups existing in the village and individuals 2. Department of agriculture 3. Agricultural-based vocational school
In Mid-River in the Watersheds	Floods, erosions, landslides and sediment transportations by river	Many river border areas of the river that has been opened and used for the activities and development of public infrastructures, the vegetation decreased.	1. Applying polyculture plantation system	Creating the regulations for the villages or hamlets that require tree canopy shade on the plantation that will be opened or has been opened and maintained alongside the community	1. village head 2. Farming groups existing in the village and in individuals 3. Department of agriculture 4. agricultural-based vocational school
			2. Reforestation	Making routine reforestation programs and distributing free tree seeds to plant.	1. The villagers, coordinated by the village head or also the village youth groups 2. Regional Development

					Agency of Ambon 3. Environmental Impact Management Agency
			3. Making the management manner mechanically on the river basin of which surrounding area is filled with settlements and slope condition at > 15-25 %	Making check dam	1. Regional Development Agency of Ambon 2. Department of Public Works 3. Environmental Impact Management Agency
Downstream River on the Watersheds	The Reduction of mangrove forest area coverage	Sediment covers	Reducing sediment cover so that mangrove growth is not inhibited and to prevent the loss of mangroves slowly	Conducting sediment dredging to the rivers	1. Regional Development Agency of Ambon 2. Department of Public Works 3. Environmental Impact Management Agency
Riparian areas	Floods, garbage, riparian areas which are getting more narrow.	Overflowed water from the river that is accompanied by heaps of garbage, reduced vegetation and residential location is in the area that is still classified as riparian areas	1. Is not allowed to be made into landfills	holding river cleaning program and it can be reinforced by the legislation on the prohibition and sanction for dumping garbage to the river	1. Ambon Municipal Government through the Major 2. Environmental Impact Management Agency 3. Village Head or Hamlet Head, other civic organizations
			2. Reforestation	Tree planting by the community	1. village head hamlet head 2. Youth organizations or other civic organizations in the village
			3. mechanical manners and monitoring	Creating embankment, especially in riparian areas, contained residential housing and legislation establishment that bans house building on river border areas	1. Ambon Municipal Government through the Major 2. Environmental Impact Management Agency 3. Village Head or Hamlet Head
Coastal areas	Siltation of the waters	Sediment transportations that are constantly going through watersheds and through erosion and the threat of massive garbage found	1. Handling in a short term mechanically	Conducting dredging of the sediment	1. Regional Development Agency of Ambon 2. Department of Public Works 3. Environmental Impact Management Agency

		around the coastal areas.	2. Not dumping garbage along the coastal areas	1. Regional Regulation in the form of bylaw which contains prohibitions and sanctions. 2. The existence of coastal areas clearance program to be launched by agencies, schools and even universities and other community organizations	1. Ambon Municipal Government through the Major 2. Environmental Impact Management Agency 3. Non-governmental organizations and other civic organizations

Source: Analysis Result, 2014

IV. CONCLUSION

1) The amount of depositional rate value which is obtained based on the calculation and conversion of river suspended load discharge unit of Wae Heru River and Wae Tonahitu River is 1,7 cm/year;
2) Based on the parameters of the waters that have been measured and analyzed, and subsequently processed by the method of weighting, scoring and correcting by subjective matching method, the environmental carrying capacity condition of internal Ambon Bay waters is classified as medium class (S2) for the floating net cages propagate.
3) Environmental management strategies in order to conduct depositional control efforts at internal Ambon Bay are divided into watershed management strategy, riparian management and coastal areas management:
    a) on watersheds management, it is focused on the governance of the land use that is adjusted to the contour of the slopes, the selection of the housing construction that is not built on the steep slopes location, infiltration wells creation, construction of gully plugs, agroforestry planting system, reforestation and the construction of check dams, and dredging;
    b) on riparian management, it is focused on provision of regional legislation containing prohibitions and sanctions on garbage disposal on riparian as well as prohibitions on building houses on the riparian areas, and then followed by reforestation and embankment construction;
    c) On coastal areas management strategy, it is focused on the dredging of the river mouth and coastal areas that have been suffering from silting in a

long term and regional regulation containing prohibitions and sanctions on garbage disposal on coastal areas.

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