

**PLASTIC DEBRIS ON THE SHORES OF SELAYAR ISLAND COAST, SOUTH SULAWESI**

**Roni Hermawan**

Sekolah Tinggi Perikanan dan Kelautan Palu

\*E-mail: [rooney\\_hermawan@yahoo.com](mailto:rooney_hermawan@yahoo.com)

**Abstract**

*Enormous plastic debris has been stranded on Selayar island shore during the west monsoon due to its position which is directly faced Java sea. Plastic debris had impacted social and economy of Selayar fishermen. The research was aimed to understand the composition, density, and distribution of the plastic debris; it impacts to social and economy. Line transect was used as the research method to quantify the numbers dan width of the plastic debris spread. The size of plastic debris that was researched about >2,5 cm which categorized as macro litters. The research was conducted in February to March 2016. The impacts of plastic debris were reduce income from tourism, fishing industry, disrupting fishing operations, requiring clean-up and, repairing vessel. Direct costs for repair and clean-up fishing vessels was about 192.9 million rupiahs per year and repair fishing gears was about 156.2 million rupiahs per year. The plastic debris consists of plastic bottle, plastic cup, rope and fish net, gas matches, plastic box, bouy, food packaging, toothbrush and syringe. The average of plastic debris about  $9.5 \pm 2.7$  item/m<sup>2</sup> and weight about  $229.2 \pm 109.9$  g/m<sup>2</sup>.*

Keyword : *Plastic debris, management, impact, socio-economy, Selayar Island*

**INTRODUCTION**

Plastic debris was increased as growing of economy and plastic for support human life as consumptions or other activities. Plastic products increase significant and domination of every market products since 1930s to 1940s. World's plastic production reach 288 metric tonnes in 2012 or increase 620% from 1975 (Jambeck *et al.*, 2015). Plastic debris came from industry, domestic litter, shipping vessel, boatship and another land-based source that drive by river or drainasse to the sea (Derraik, 2002 ; UNEP, 2005; Williams and Simmons, 1997)

Plastic debris has been deposit into ecosystem and degradation to be microplastic and become more dangerous. In the environmental, polymer-based spread everywhere and the impacts of polymer are yet fully understood (Lambert, 2013). The impact of plastic debris to fishing industry impact are distrubting fishing vessel, ship propeller, ghost fishing from broken or abandoned fishing gear and repairing fishing vessel that requiring cost (Lee, 2014).

Coastal are a vulnerable area from marine waste, some of the ecosystems depend on coastal and used by many stakeholders (Lindgren, 2011). Plastic debris drive by surface currents, end up on the beach and make many environmental problems. West coast of Selayar island is directly facing open sea, on west monsoon (January to April) marine debris drive by surface current from Makassar strait and Java sea to Selayar island west coast (Balitbang KP, 2016; ECMWF, 2016; Wyrcki, 1961). Few researchers about marine plastic debris on Indonesia (Sherman and Sebille, 2016; Unepetty and Evans, 1997a; Unepetty and Evans, 1997b; Walangi, 2007; Willoughby, 1997).

Plastic litter on Selayar island west coast are unmanaged, when east monsoon (April to September) plastic litters debris mostly drive back by tide and surface current, then make another problem to other islands. The research was aimed to determine the types, quantities, and distribution of the plastic debris and its impacts to local socio-economic.

**MATERIALS AND METHODS**

**Time and Location of Reseach**

The research was conducted on Selayar Island west coast in February to March 2016, it was the peak of west monsoon to east monsoon transition. The plastic litters was collected from 7 coastline sites depend on coastal landforms where plastic debris was stranded (Figure 1).

**Methods and Analysis**

Data of plastic debris were collected by line transect method to determine its numbers and spreads. Transects were 5 m width and length depend on coastline width. Sample sizes were macrodebris (>2,5 cm), samples sorted by type for identification, measured, weighed (g) and measured the location plot site (m<sup>2</sup>). The plot point of observation was sorted to clean and marked, each station consists of three plots (Lippiatt *et al.*, 2013 and UNEP, 2009). Social and economy impact observed by the interview with local community, non-government organization, and local government.

**Loss of fishing vessel (modified from Takehama, 1990)**

Data kerugian diambil dari hasil wawancara terhadap pemilik kapal, bengkel kapal, nakhoda, pemilik alat tangkap dan beberapa pekerja. Kapal yang diwawancara adalah kapal yang

$$A = ((a.b).N_1) + ((a.c).N_2)$$

Where:  $A$  = Loss of fishing vessel

$a$  =  $\Sigma$  vessel on west coast

$b$  = Frequency of entangled of vessel propeller (unit)

$c$  = Frequency of others repairing/cleaning (unit)

$N_1$  = Cost of propeller repairing (Rp)

$N_2$  = Cost of others repairing/cleaning (Rp)

**Loss of fishing gear (modified from Takehama, 1990)**

$$B = ((p.q).R)$$

Where:

$B$  = Loss of fishing gear

$p$  =  $\Sigma$  fixed gear on west coast

$q$  = Frequency of extra cleaning, fixing net, frame, bouy, anchor, etc

$R$  = Cost of gear repairing and cleaning (Rp)

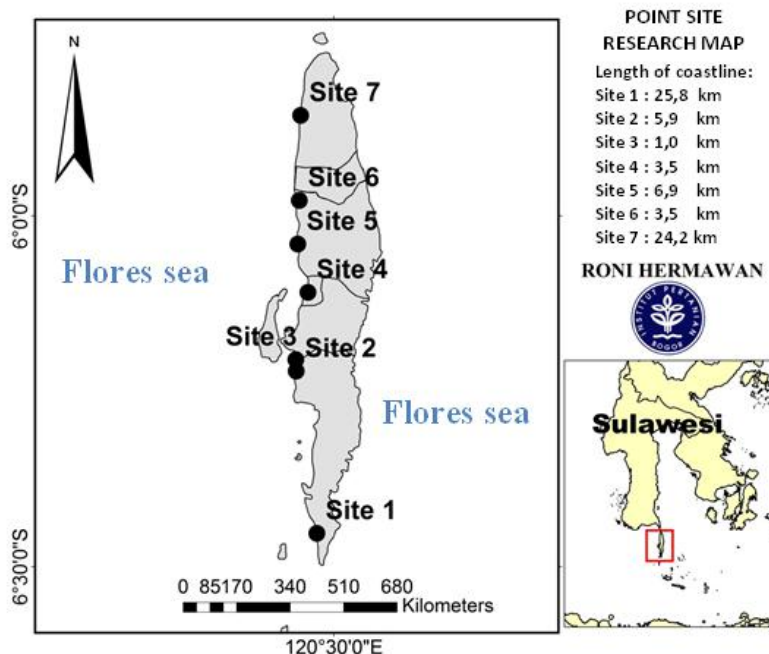


Figure 1. Point Site Research Map

**RESULT****Types, quantities, and distribution of the plastic debris**

Plastic litters consist of plastic bottle, plastic cup, rope and fish net, gas matches, plastic box, bouy, wrapper, toothbrush, and syringe. Most of the plastic litters are plastic for food or daily-need packaging, cups and bottle plastics are dominant. On site 4, total density was about 6 item/m<sup>2</sup> for plastic cup, site 7 plastic bottle was about 5 item/m<sup>2</sup>, describe on Table 2.

On Table 3 shown weight ( $\text{g/m}^2$ ) of plastic litters, site 1 is highest with weight about  $129 \text{ g/m}^2$  for rope and fish-net and  $128,9 \text{ g/m}^2$  for plastic bottle. Rope and fish-net were from abandoned or parts of fishing gears. Based on the calculation results and total length of coastline per site (Figure 1), the total amount was about 7,310,173 item with average  $9.5 \pm 2.7 \text{ item/m}^2$  and total weight was about 241,759 kg with average  $229.2 \pm 109.9 \text{ g/m}^2$ .

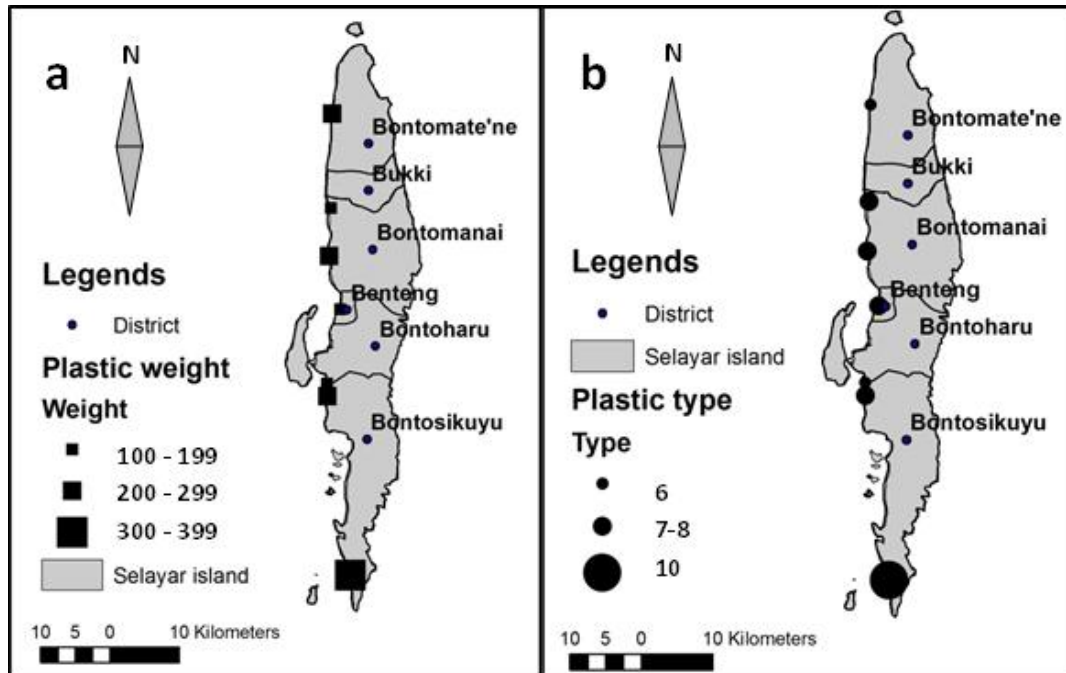
Table 2. Total of plastic debris per site ( $\text{item/m}^2$ )

Type	Site						
	1	2	3	4	5	6	7
Plastic drink bottle	4.9	3.0	2.4	2.8	4.0	3.9	5.0
Plastic cup	3.7	4.7	5.5	3.6	6.0	4.3	3.2
Rope & fish-net	0.3	0.3	0.4	0.2	0.6	0.3	0.7
Gas matches	0.9	0.2	0.4	0.3	0.7	0.3	0.4
Basket	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Bouy	0.04	0.02	0.00	0.03	0.05	0.03	0.03
Plastic packaging	0.7	0.3	0.4	0.4	0.4	0.2	0.3
Toothbrush	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Plastic spoon	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Syringe	0.1	0.0	0.0	0.0	0.0	0.0	0.0

Table 3. Weight of Plastic Debris per site ( $\text{gr/m}^2$ )

Type	Site						
	1	2	3	4	5	6	7
Plastic drink bottle	128.9	71.6	70.5	52.1	114.3	83.0	100.2
Plastic cup	36.6	52.3	32.7	32.7	62.8	44.3	51.6
Rope & fish-net	129.0	101.9	18.6	18.6	24.9	36.2	72.7
Gas matches	13.4	2.2	3.5	3.5	4.0	2.4	4.0
Basket	25.8	30.4	26.3	26.3	8.8	3.5	11.5
Bouy	18.0	6.4	0	0	16.0	6.2	14.3
Plastic packaging	11.7	2.0	2.7	2.7	3.1	7.8	8.1
Toothbrush	1.2	0	0	0	0.0	0	0
Plastic spoon	0.3	0.2	0	0	0.0	1.4	0
Syringe	0.4	0	0	0	0.0	0	0

The spread of plastic debris along the west coast of Selayar island and deposited on the beach, west coast has a length of 108,59 km, plastic litter covered 70,78 km or 65,18% of coastline. Based on observations and calculations at site 1 of 10 type of plastic debris, which was dominated plastic bottle (Figure 2b) and a highest average weight of plastic debris at site 1 was about 300-400  $\text{gr/m}^2$  (Figure 2a).



a Weight of Plastic debris (gr/m<sup>2</sup>).; b Types of Plastic debris (type).

Figure 2. Map of Plastic debris spreads

**Plastic debris impact on social**

Social appraisals for plastic debris quite varied, it is because some locals found that the deposited debris is a natural phenomenon that commonly occurs annually. To know the community assessment conducted by interviewing randomly at each site point of observation and analyzed by Likert. Based on 7 observation site points with 110 respondents were mostly local who settled and lived on the west coast of Selayar island, presented in Table 4. Based on the community impact assessment of plastic litter were 5 categorized by very undisturb, undisturb, moderate, disturb and very disturb. The result of assessment showed a moderated, disturb and very disturb category. Local activities were interrupted by plastic debris as beach covered by plastic and marine debris, which is access to the shore and fishing activities. Aesthetics beach interrupted by marine debris were piled up, the plastic debris is also disturbing tourism activities such as swimming or enjoy the beach view. Fishing gears often disrupted and damaged by plastic debris, thus reducing catches. Marine litter provides the aesthetic impact on the coastal environment and the economic impact of various industries that depend on coastal environmental and sea (Bergmann,2015).

Table 4. Community Assessment for Social Impact of Plastic Debris

Number	Variable	%	Category
1	Disturbing activities	66.5	Disturb
2	Decrease aesthetic value	79.2	Disturb
3	Reduce catch	71.8	Disturb
4	Reduce tourism	80.6	Very disturb
5	Damaged ecosystem	77.6	Disturb
6	Reuse plastic debris	51.1	Moderate
7	Economic value of plastic debris	54.5	Moderate

Some type of plastic are collected, utilized and sold by locals. Thick and heavy plastics are valuable, while plastics lightweight plastics such as mineral water bottle or plastic cups no economic value while there were in large number. Plastic waste collectors only receive a thick plastic, the cost of transport from Makassar to Selayar island constraint. The collectors in Selayar island also brought commodity crops to Makassar for efficient transport costs and improve benefits. The collector bought plastic debris only as a side benefit.

**Plastic debris to economy**

The Majority of fishermen on Selayar island is a side job, most of the population relying on the farming as the main livelihood (BPS, 2015). Many fishermen come from small island around the Selayar island such as Tinabo, Pasimasunggu, Taka Bonerate and other islands. On the Selayar island boats and ships activities are very high because Selayar is the capital district of Selayar islands, thus becoming berths, fishing spot, transporting, docking and transaction from Makassar or other islands.

Floating plastic debris disturbing even damaging part of ship as propeller of ship, engine cooling system and other damage that requires repair and maintenance cost higher. Fishing gear also affected and require high costs. Based on calculation of loss cost of boat and fishing gear by plastic debris, presented on Table 5 and Table 6.

Table 5. Table of Loss of Fishing Vessel by Plastic Debris

<b>Lose of Fishing-vessel by Plastic Debris (unit)</b>			
<b>District</b>	<b>Small (&lt;10 GT)</b>	<b>Moderate (30-10 GT)</b>	<b>Large (&gt;30 GT)</b>
Bontosikuyu	44	49	5
Bontoharu	59	77	9
Benteng	39	62	9
Bontomanai	15	45	10
Bontomatene	30	55	10
Total	187	288	43
Cost of propeller repairing (Rp)	1,168,750	25,920,000	46,762,500
Cost of boat-body repairing (Rp)	14,025,000	58,320,000	46,762,500
Total (Rp)	15,193,750	84,240,000	93,525,000
<b>Total Lose (Rp)</b>	<b>192,958,750</b>		

Table 6. Table of loss Fishing Gear by Plastic Debris

<b>Lose of Fishing-gear by Plastic Debris (unit)</b>				
<b>District</b>	<b>Fix lift-net (Bagan)</b>	<b>Boat lift-net (Bagan apung)</b>	<b>Set-net</b>	<b>Hand lift-net</b>
Bontosikuyu	5	5	3	12
Bontoharu	10	45	15	35
Benteng	3	5	0	0
Bontomanai	3	5	6	0
Bontomatene	0	0	25	0
Total	21	60	49	47
Cost of Fishing-gear repairing (Rp)	17,010,000	32,400,000	94,080,000	12,690,000
<b>Total Lose (Rp)</b>	<b>156,180,000</b>			

Losses of cost by boats and fishing gears (Table 5 and Table 6) derived from the number of vessels and fishing gears were operating on the west coast of Selayar island and information from local fishermen, shipowners, and ship docking worker. The total loss of the boat was about 193 million IDR and fishing gears were about 156 million IDR each year. Nets of fishing gear often damaged by plastic debris such as stuck on the set-net that fixed installed in tidal areas, so its very easy affected by sharp or large number of plastic debris. Set-net also easy to uprooted because its used wood-stick frame and require high cost for repairing.

Several studies of loss due to plastic debris from fishing vessels or fishing gears, such as the British ship losses 1,245 to 3,283 million US dollars in 2008 (Lee, 2014), Japan's loss 18,4 million US dollars for the ship in 1985 (Takehama, 1990). British losses in the fishing gear 12,000 to 67,500 US dollars in 2012 (Lee, 2014).

### CONCLUSION AND SUGGESTION

#### Conclusion

Plastic debris on Selayar island spread along 70.78 km or 65.14% of west coast, dominated by plastic wrapper from daily consumption from floating debris driven by surface current and stranded on the coastline. Socio-economic impact to local activities and economic loss especially for fishermen about 349 million IDR each year.

#### Suggestion

Plastic debris can be an alternative livelihood and reduce the effect of plastic debris. Waste Bank need to establish as a platform for community-based waste management and for attracting locals to process plastic debris. Reduce plastic uses, prohibit people throw waste into rivers or the sea.

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