Pollution control in coastal area through Indonesian coastal education concept

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Abstract. Litter becomes one serious threat for the coastal area in Indonesia. Those litters are derived from various anthropogenic activities and various land uses. Indonesia is declared as the biggest second country after China in contributing marine debris in 2015. But marine debris in Indonesia, not all derived from the domestic product. In the coastal area of Aceh province, there are marine debris which derived from foreign countries. One right way to overcome the pollution in the coastal area is by incorporating Marine education into the educational curriculum. In anticipating the effect of destruction in the marine environment, Indonesian Ministry of Marine Affairs and Fishery has launched a coastal education model namely Indonesian Coastal Education. The aim of this study is (1) to identify the types of pollution in the coastal area, (2) to arrange the steps of observation, and (3) to arrange the action plan of Indonesian Coastal Education (ICE) in overcoming pollution in the coastal area. This study uses literature study by searching the reference of theories which are relevant to the case or problem of litter/waste pollution in the coastal area. By applying 4A learning method in ICE, students can directly understand the problem occurs in their area, particularly related to litter pollution in the beach. The concept of the study is, students of ICE are expected to be able to arrange an action plan based on the result of observation and analysis.

1 Introduction

According to BIG data [1], Indonesia has 16.056 islands which had been enlisted to the United Nations. Realizing that two third of Indonesia geographical area is marine, it is undeniable that Indonesia is a maritime country. In the colonial era, maritime orientation is diverted to become agricultural orientation. Entering the independence era, various efforts had been done by our nation predecessors to whip up again the maritime spirit of the Indonesian nation, particularly in the era of Old Order government. On 13th December 1957, a declaration named Djuanda Declaration is announced which say to the world that Indonesia holds Archipelagic State principles as archipelago conception.

Djuanda Declaration then is announced officially to become Act No.4/PRP/1960 about Indonesia Water Territorial. As a result, the width of the Republic of Indonesia area is double 2.5 times from 2.027.087 km² become 5.193.250 km² [2-4].

Historically, the Indonesian nation is maritime nation shown by the various civilization of Archipelago kingdom in interacting with the world community through an analogy from seven elements of culture universal. Those seven elements are directed to empowerment and marine resource to the growth and dynamics of the community who live in a coastal area [5], [6].

According to Centre of Study on Coastal Area and Marine Resource, IPB in IGI [7], the potency of Indonesian maritime is just utilized 20% whereas the rest had not been touched. It is a very big detriment, with sea area which is very large and

its very big potency, Indonesia just utilizes 20% of its sea potential, aided by sea ecosystem destructions occur in each region.

More than a half of century since Indonesian independence, coastal area, and national marine are physically destructed, in severe scale. That destruction including abrasion and beach sedimentation, decrease in fish production as result of overfishing in some water locations, destruction in coral reef and mangrove ecosystem, and destruction in seawater quality as a result of beach and sea pollution.

Even in his study, Jambeck [8] say that Indonesia is in the biggest second rank as a country which contributes marine debris after China. Each year Indonesia capable to contribute 187,2 million ton marine debris. While China achieves 262.8 million ton. The neighbor country such as the Philippines is in the 3rd rank with marine debris production is 83.4 ton.

Fig. 1. The map of countries as marine debris contributor, Jambeck (2015, page 769)

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Litter becomes one serious threat for the coastal area in Indonesia. Those litters are derived from various anthropogenic activity and various land usage. Tons of litters can be picked in one event called 'Coastal Cleanup'. Cigarette butt, various kinds of plastic, glass, rubber, various kinds of the bottle, food package, wood, textile, and metal can be easily found. Those litters can float on the sea (*floating litter*), trapped in the bottom of the sea (*benthic litter*) or on left on the beach (*beach litter*). The litters in coastal areas and marine ecosystem not only become a direct threat for biota in that ecosystem but also decline the quality of water which in the end can decline the environmental quality and community welfare.

One right way to overcome the pollution in the coastal area is by incorporating marine education into the formal education curriculum in Indonesia. By incorporating marine education into national education curriculum in all levels of the educational unit is the right step to building maritime spirit and soul of the Indonesian nation in overcoming the pollution in the coastal area. Unfortunately, marine education had not become a priority in the national education curriculum in Indonesia. But in anticipating the effect of destruction in the marine environment occur today, The Indonesian Ministry of Marine Affairs and Fishery had launched a model of coastal region education namely Indonesian Coastal Education.

Indonesian Coastal Education (ICE) is a program which aims to introduce the potency of marine and fishery in the coastal area of Indonesia to the young generation. It aims to more awake the spirit of love maritime among people in the coastal region particularly students in a coastal area school.

The aim of this study is (1) to identify the types of pollution in the coastal area, (2) to arrange the steps of observation, and (3) to arrange the action plan in ICE in overcoming the pollution in the coastal area.

2 The material and method

This study uses literature study by searching the theory reference which is relevant to a case or problem of waste and litter pollution in the coastal area. The theory reference obtained by a literature study is made to become the basic foundation and main tool for research practice in the field.

2.1 Method of location selection

Environment sampling plays important role in giving the right information about the environmental condition, similarly in the litter –picking. Therefore, litter-picking is needed in represented location. In long beach, it needs a location which meets several criteria, so information is not ambiguous. Based on guidance from the Directorate General of Pollution Control and Environmental Destruction KLHK [14]. The criteria of each segment for litter sampling is as follow:

- Can be accessed for all year long or season (for continuous monitoring).
- Sandy or stony.
- There is no wave breaker, jetties, harbor or another building.
- Minimally 100 m long, and can be lengthened until 1000 m parallel with water bank.
- The slope of low- moderate 15 ° - 45°

- There is no cleanup activity in the time near sampling time.
- There is no litter management in that location
- Not sensitive habitat or there are no threaten species which probably disturbed caused by this sampling; this information can be asked to competent people in the conservation field.

2.2 Method of transect determination

According to Cordova [15], the study on waste sampling in the beach should be done by line transect. It needs to be noticed that sampling position each time should be in the same place, in the condition when the water is receding so it makes easier litter sampling. The position of line transect should be in the area between high tide location with receding water. Line transect can be spanned 50 meters 2 times or 100 meters directly. Observers must walk along the line transect. Observation toward litter is done along that transect line, by picking up the litter in each 1 meter around in the right and left on the transect line. All litters found in that sampling area are classified, the amount is counted and weighed (wet weight). The litters should be cleaned from sand/mud, From water contained in the litter by draining the water inside and place it on a clean surface in 5 minutes at least. The classification of litters is divided into 6 categories adapted from NOAA (2013) classification, namely (1) plastic and rubber; (2) metal; (3) glass; (4) wood, not natural wood-like branch fallen naturally, etc; (5) clothes and such a kind ; (6) another litters.

2.3 Equipment and material

The equipment used in this activity among others are:

- BS (Beach slope) meter/ klinometer/ parameter to measure the slope of the beach;
- Scale/weight
- Camera
- Calculator
- GPS
- Loop
- Rolled tape measure
- Wheel tape measure
- Drain
- Litter filter (0.5 cm and 2.5 cm)
- Litter pinned stick
- Scissor
- Cutter

The material used among others are:

- Glove
- Masker
- Sack sized 50-100 kg
- Tarpaulins
- Flag/ stick
- Utensils (pencil, clipboard, permanent marker, marker)
- String (rope, raffia)
- Transparency plastic bag sized 3-5 kg

3 Results and discussion

3.1 The concept of Indonesian coastal education

Indonesian Coastal Education (ICE) is part of Gerakan Cinta Laut (Gita Laut) campaign launched by Indonesian Ministry of Marine Affairs and Fishery. ICE is initiated to raise awareness of coastal region people, particularly students in the coastal area about the management of their beach and to grow the feeling of care and love to the environment by equipping students with knowledge about the effect of climate change on coastal area ecosystem. The ICE program is one program which is in accord with Unesco direction in supporting the preservation of the coastal area in the world [9].

ICE also encourage students to have an ability to design and do various activities in overcoming various identified problems in the coastal area. Besides, students also are expected to be able to enhance the quality of the coastal environment and the toughness of the coastal ecosystem toward the effect of climate change. ICE is designed to use a set of simple management so it can be used by everyone from various ages and educational background. By using the component of observation in the field, ICE tries to make science to become enjoyable and interactive by integrating some sciences such as environment, marine, geography, biology, mathematics until social and culture.

In the ICE program, students are expected to capable to design and implement various activities to overcome problems in the coastal region. Besides, students also expected to capable to enhance the quality of the coastal environment and the toughness of coastal ecosystem against the effect of climate change. The following are some learning materials in ICE:

2. The observation of Mangrove Ecosystem and Its Management
3. The observation of Coral Reef Ecosystem and Its Management
4. The observation of Coastal Area Pollution and Its Control
5. The observation of Beach Dynamics and Its Management
6. The observation and Distribution of Climate and Weather Information

These five materials are taught to students by doing scientific practice, in which students not only learn the theory but also doing observation in the field. As for the method used in learning is 4A method with the detail as follow:

1. Observe: students observe the beach in accord with the material chosen
2. Analysis: analyze the result of observation into table, graphics, and diagram in accord with the material chosen
3. Teach: teach to participant or coastal region people about the result of observation and its analysis
4. Action: make action by planning and implementing activity related to the material chosen

One material taught in ICE is about Observation of Coastal Area Pollution and Its Control. As for acts done by ICE students in reducing pollution in the sea is coastal cleanup. This coastal cleanup is part of world citizen effort to care about the cleanness of coastal environment. This is international activity and involves the volunteers to do a coastal cleanup activity by survey method, usually done in the concurrent period. So it is known as International Coastal

Cleanup (ICC) which is done concurrently in the various coastal region in the whole world. This activity also gives an opportunity for the community and volunteers from Indonesia to be able to participate in this coastal cleanup campaign. ICC is an effective activity concept to increase public awareness of coastal pollution through direct observation or survey and to pick the waste directly [10].

3.2 The litter pollution in coastal area

According to NOAA [11], marine debris is a persistent solid object, produced and processed by humans, directly or indirectly, intentionally or unintentionally, thrown or left in the marine environment. The types of marine debris among others are plastic, cloth, foam, Styrofoam, glass, ceramic, metal, paper, rubber, and wood. Mega debris and macro debris result in health risk directly for marine animals (fish, turtle, bird, sea turtle) such as wrong consumption and trap, can cause internal bleeding and boils, obstruction of the gastrointestinal tract even the death for marine biota. Marine debris, particularly plastic is a big problem, not only in Indonesia but in the whole world. The types of litter on the beach according to NOAA [11] can be seen in table 1.

As an archipelagic country, marine pollution will give big effect to Indonesian people, particularly for those whose occupation rely on the sea, such as fishermen, tourism activist, or people who live in the coastal area. According to Thompson [12], most litter which pollute the sea is plastic. Plastic increase the practicality of a product packaging which makes a product easier to be stored, distributed, and brought everywhere. However, human inability in recycling plastic than producing it and lack of discipline in human behavior in throwing the litter will exacerbate plastic litter pollution, which finally pollutes the sea also.

However, the litters existed in Indonesia not all derived from domestic products. In the coastal area of Aceh Province, there are found many litters derived from foreign countries. Those litters are derived from Malaysia, Thailand, Singapore, Bangladesh, North Africa, China, India, Sri Lanka, even French. According to the report the result of Sahabat Laut Aceh community who conduct coastal cleanup in Pulau Aceh Regency, Aceh Besar Regency, they found more than 60% of litters derived from foreign. The types of litter found also varied, from a mineral water bottle, pieces of Styrofoam, food packing, glass bottle, plastic, rope, straw, and another kind of plastic bottles [13].

3.3 Pollution control in coastal area with 4A method

3.3.1. Observation

Observation of pollution is done by conducting a direct survey. The selection of location is determined based on the Guidance of Beach Litter Monitoring KLHK [14] as mentioned in this study method. The observation initially determines first the beach coordinate which will be chosen, then students install the transect along 100 meters. The width of the beach is determined based on the condition of the field. For 100 m area there are 5 sections, with each has 20-meter distance.

Table 1. Marine debris based on NOAA criteria

No	Category	Amount	Weight (gram/kg)	Product (Domestic/ Foreign)
PLASTIC AND RUBBER				
1	Ball, Tire, Balloon, Pieces			
2	Plastic bottle			
3	Plastic glass			
4	Plastic covering			
5	Plastic match			
6	Plastic wrapping			
7	Thick plastic wrapping			
8	Pieces of rubber			
9	Tape			
10	Drug wrapping			
11	Straw			
12	Food box, spoon, glass, plastic, etc			
13	Shoes and sandal trash, glove, pieces of it.			
14	Styrofoam			
15	Rope, fishing rope, fishing gears			
16	Raffia			
17	Pipe			
18	Pieces of another plastic			
19	Cosmetic wrapping, bathing tool, etc.			
METAL				
20	Can			
21	Nail iron			
22	Another iron material			
GLASS				
23	Glass bottle			
24	Pieces of glasses			
25	Lamp			
26	Another glass material			
WOOD AND ITS DERIVATIVE				
27	Box			
28	Cigarette wrapping			
29	Wood			
30	Wooden match			
31	Cigarette butt			
32	Paper, newspaper, pieces of paper			

CLOTHES AND ITS DERIVATIVE				
33	Cloth, dress			
34	Diapers and sanitary napkin			
35	Clothes material/cloth			
THE OTHERS				
36	Food remnant			
37	Animal carcass			
38	The others			
Another information is given at the time of the survey				

Source: NOAA, 2013

Next, for a minimal box of 5x5 meter in each row of 20 meters. Place the area such as this so that point represents the transect area. Observation should be done continuously in the same location for 1 time for one week until 1 month.

The most important part in sampling implementation is littered collection and classification. After transect had been determined, then the following activities are done:

1. The recording of location coordinate of sampling in each transect by using GPS or by plotting it in Google Earth application;
2. Search sampling area which is not blocked by vegetation or a building along 100 meters.
3. Collect the litters in transect area in accord with Figure 2.
4. Started from point 0 and tracking sampling area line parallel with coastal line and pick the litters in beach surface sized more than 2.5 cm.
5. Make sure that there are no litters unpicked along 100 m
6. If the litters too big to be picked, then note that object into the mega waste column.
7. Do not pick a living creature.
8. Dry and clean up the litters from water and sand
9. Sort the litters based on litter classification, in each transect
10. Count and weight the litter per type- per transect
11. Do it for each size group of litter (macro and meso)
12. Do not forget to document the activity
13. Invite the surrounding community or volunteers if possible as educative form.

3.3.2. Analysis

After the litters collected then the analysis is done in accord with its types based on classification of NOAA, namely: (1) plastic and rubber; (2) metal; (3) glass; (4) wood but not natural wood such as the branch fallen naturally, etc; (5) clothes and the like; (6) another litters.

In doing data analysis, count the number of litters per type, then count the weight of litter per type and count the number of litters from domestic products or abroad. The result of the analysis is tailored to the classification of litter types according to NOAA in table 1 and after that arrange analysis of the whole result as in table 2.

Table 2. Analysis of litters result in the coastal area

Date and Time	:	
Name of Location	:	
Latitude Coordinate (Origin Point)	:	
Latitude Coordinate (final point)	:	
Longitude Coordinate (origin point)	:	
Longitude Coordinate (final point)	:	
Length of transect	:	
Width of transect	:	
Water condition (tide-recede-transition)	:	
Weather condition	:	

Type of Litter	Average	
	Amount	Weight
Plastic and Rubber	0.00	0.00
Metal	0.00	0.00
Glass	0.00	0.00
Wood and Its Derivative	0.00	0.00
Clothes and Its Derivative	0.00	0.00
The others	0.00	0.00
Poisonous and dangerous material	0.00	0.00

Data analysis should consider the following:

1. Make sure that all the information in the worksheet is filled before leaving the sampling area.
2. All information is entered into a file which had been prepared.
3. The number of litters is counted in a whole to determine the litter density (unit/m²)
4. Heavy trash is calculated to get a percentage of each type of waste
5. Data of amount and weight of litters will be analyzed by information of beach characteristic and land utility
6. After data is entered into the file, then search the distribution percentage of distribution of litter type with a diagram.

Fig. 2. The example percentage of litter type distribution

3.3.3. Teach

In preventing more pollution in the beach, communication is done to various people who are related directly to pollution in the area of observation. They are Local Governments, customary institution, and the community who do an activity around the location of observation.

The delivery of analysis result can use various media and methods. Choose media which is suited with people who will be reached in order that information delivered can be easily accepted and understood. Media of delivery can be print media (poster and brochure), no print media (radio broadcasting), even social media (facebook, twitter, etc).

3.3.4 Action

After knowing the condition of pollution in each location, students are required to make activity in order to anticipate pollution in the beach not reoccur. The initial step in determining action is making a table of condition identification (table 3) until the description of the activity done.

Table 3. Identification of condition and action

The condition of Observation Location	Causing Factor	Type of Activity	Description of Activity
There are many plastic bag litters found on the beach.	The waste management system which has not been optimal.	Plastic bag diet campaign	Reduce the activity which uses plastic bag by substituting it with a cloth bag.

Source: The Guidance of Indonesian Coastal Education, 2017

Based on the mapping of the condition in Table 3, students can determine the type of activity in accord with the aim which will be achieved in the certain period.

Table 4. The formulation of action activity

Problem Formulation	There are many plastic litters found on the beach
Aim	Reduce pollution in the beach from a plastic bag
Initial Condition	It is found 10 kg plastic litters each week
Supporting and Hinder Factor	Supporting factor: The tourists are willing to care about plastic litters they bring Hinder factor: There is no litter bin.
Design of Activity	The supply of 100 litter bins along the beach
Planning	1. The Making of Proposal 2. Selection of Donator 3. Execution of Activity
Control of Activity	Make sure that activity run in accord with the timeline made
Evaluation of Activity	Compare the aim of activity with the problem formulation. Whether there are still plastic litters found on the beach.

Source: The Guidance of Indonesian Coastal Education, 2017

4 Conclusion

The problem of marine debris pollution including marine debris in the beach area had attracted an attention from the world society and it is one main issue which is related to the problem of the coastal area and sea environment in Indonesia. However, the activity of control or monitoring relates to marine debris has not done in Indonesia. Therefore, learning in school particularly in the coastal area is very expected to be able to give knowledge to students and community to collectively maintain the preservation of coastal area from the threat of pollution caused by litter.

Indonesian Coastal Education is one model of school which involve students directly in the process of learning in the field, so students can directly understand easily related to pollution occur in their area.

In the concept of pollution control in the coastal area, students of Indonesian Coastal Education are invited to do litter data making in accord with criteria of NOAA. The type of litter will be weighted and entered in data continuously with the time span of observation one time in 1 week until 1 month. After that, the data is analyzed based on the amount, product (domestic/foreign), weight (gram), and type of plastic polymer (if it is possible using equipment from the laboratory).

The result of the analysis will be taught to another student or people surrounding the beach. In the stage of teaching, students are also demanded to campaign zero waste culture, in order that the beach existed in that area can be avoided from pollution which endangers those people themselves. After the stage of observing, analysis and teach are finished, students are demanded to design an action to reduce litter pollution in the beach. The action can be litter management, campaign to reduce using the disposable material, or supplying litter bins around the beach.

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