MANAGING AMBON FOR A SUSTAINABLE COASTAL CITY

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Abstract
As a coastal city, Ambon gets environmental pressures that threaten its sustainability. Various needs of the community come from the utilization of natural resources, mainly marine and land. However, with the increasing number of population and lifestyle changes that tends to be consumptive, this causes the limited of the natural resources so it becomes increasingly difficult to obtain. The most environmental stress derived from the upper area of the city. The environmental pressures include land clearing for settlement purpose and the presence of domestic waste both solid and liquid those are not properly managed. In managing Ambon for a sustainable coastal city, it is necessary to improve the water quality in coastal areas and its water through four elements of strategy, they are: (1) pollution prevention strategy, (2) pollution minimization strategy, (3) improvement of water resources strategy, and (4) pollution handling strategy. The research used a descriptive method by utilizing primary and secondary data. Benefits gained from this study are the identification of pollutant sources based on both primary and secondary data so there methods and problem solving of obtaining the pollution prevention can be clearly identified and solved. Another benefit is used as reference material for the improvement of domestic solid waste and wastewater management system in inland areas of Ambon as well as effort the improvement of active community participation in that of waste management.

Keywords: Managing, sustainable, coastal city, environmental, strategy

INTRODUCTION
Ambon as the capital city of Maluku province has a land area of 359.45 km² dan sea area of 17.55 km², consisting of five districts namely Nusaniwe, Sirimau, Teluk Ambon (TA) Baguala, Laitimur Selatan and Teluk Ambon. Geographically, the position of the city of Ambon is located between 3° - 4° south latitude and 128° – 129° east longitude. Distribution of the population in Maluku province remains uneven.

Ambon is located on the island of Ambon which is part of the Maluku islands and is surrounded by the sea. Several rivers empty into Ambon bay, they are such as Batu Merah, Waitomu, Galala, Lateri and Pokka rivers. In general, Ambon has an area consisting mostly of hilly region and slope. The topography of Ambon about 73% of the land area can be classified as hilly to steep slope, with the slope in above 20%. While 17% of the rest can be classified as flat or gently sloping with a slope of less than 20%.

Activities of the residents in the Gulf region Ambon contribute significantly to the pollution of the bay. Population activities that generate wastewater and solid waste if it is not managed
properly will carry over into the bay through the river or waterways. Residents who live along the river generally utilize the river as a place to dispose of domestic waste water and garbage as well. Population growth resulted in an increased need for housing that is procured by opening new land originally forest and groundwater recharge areas. Land clearing activities lead to soil erosion, especially in the rainy season and resulting sedimentation in Ambon bay. In addition the increasing of sea transportation has potential to pollute the bay.

With that in mind, there are several important issues related to the environmental management of coastal areas and water in Ambon, namely:

a. The development of settlements in watershed and coastal area
The development of human settlements on the banks of the river carries consequences of which increase pollution, such as domestic waste water that enter the waste stream and also carried away by the flow of the river to the coast.

b. Uncontrolled of development and distribution of population
The development of the population carries consequences of increasing water demand and consumption. The amount of waste water produced is also increased, as well as the waste generated. Spreading distribution of population complicate the handling of waste water and garbage, therefore the intervention of appropriate technology is needed.

c. Increasing of sea transportation
Marine pollution may occur due to lack of awareness of ship owners, operators and passengers. Ship owners should provide adequate sanitation facility in the ship, so there is no disposal of liquid and solid waste into the ocean. Operators should implement good management practices to all existing facilities. Other problems related to the shipping are discharging of ballast water and spilling of fuel oil when refueling, or when washing the vessel.

d. Large number of piers
Large number of piers has risk of increasing pollution, in terms of becoming a multi-point pollution source, and if not controlled it will be difficult to handle. Spatial arrangement needs to be done.

e. Not feasible of the treatment system of industrial wastewater
The quality of wastewater treatment discharged by the industries should meet the quality standards and required to obtain a wastewater disposal permit from the Environment Agency (Dinas Lingkungan Hidup /DLH), and periodically must be reported to the DLH and DLH on their own initiative are required monitoring without being asked by the proponent. If the result of industrial waste treatment is not able to meet the quality standards, then carried the admonition, ranging from administrative level to legal process.

f. Wastes from households and markets
Garbage from households and markets, especially those located at the coastal area, should received priority in the provision of facilities and handling of its garbage. Trash if not managed properly will worsen the aesthetics. Disposal of waste on beaches should be discontinued and waste management in coastal needs to be improved.
g. Waste oil from the ferry, fishing vessels and others
Oil pollution is easily observed, both visually and from satellite image. This condition can be avoided if there is high awareness of ship owners and operators. However, inspection of the ship should also be executed.

h. Sedimentation from upland clearing
Land clearing increased the rate of run-off, increasing the run-off led to increase soil erosion, so that the water turbidity increased, and sediment will be deposited on the beach.

i. Low public awareness of solid waste management
Public participation in solid waste management in general is very low. It can be said that only 1% of 100 people who think about how waste should be managed. To increase public awareness, it is necessary to conduct socialization, education and training to increase understanding of the dangers of litter and to change public attitudes, so that government programs can be supported.

j. Lack of law enforcement (related to sanctions)
Law enforcement is often constrained by the lack of evidence and the lack of environmental monitoring which is conducted regularly by competent parties. Completion of regulation is still done, especially concerning the control of wastewater and solid waste problems.

k. Lack of cross-sector coordination
Any activities that emit wastes to exceeding quality standards in an area of activity, must be followed up within 24 hours, if within 3 days could not be overcome, the activities must be stopped. In fact, the time required is often longer. Therefore, cross-sector coordination within the governmental body should be strengthened.

l. Lack of facilities and infrastructures provided by local government
The facilities and infrastructures mean of transporter to transfer the solid waste, garbage collection facilities, and centralized waste treatment facilities.

m. Optimization Kewang Society at the city level
Kewang society is traditional institutions that play an important role in the control of marine pollution, the socialization and training on Kewang leaders can effectively accelerate the delivery of information regarding the management of waste water as well as domestic waste.

n. Potential development opportunities on tourism and nautical sports.
Development of tourism and nautical sports requires a clean and comfortable marine environment. Tourists visiting the beach are usually very sensitive to the cleanliness of the beach.

**IMPROVING THE WATER QUALITY**
The activities in improving water quality in coastal area and its waters are very crucial in managing Ambon for a sustainable coastal city. The activities can be done through four elements of strategy, namely: pollution prevention, pollution minimization, improvement of water resources, and pollution handling strategies.
Pollution Prevention Strategy

Pollution prevention strategies can be done through public education programs on environmental management, waste water management, solid waste management, sanitation management of ports and shipyards, and watershed management.

The public education is an introductory program aimed at increasing public understanding and participation on environmental management in Ambon that will be done by the stakeholders, the goal is to understand and support community environmental management program that will be conducted in Ambon by the stakeholders. Counseling is done through various media (local TV, radio, local newspaper and dissemination of brochures as well as leaflets), to perform this socialization, it is necessary to increase the quality of human resources who is competent to issue public communications. To succeed this program, it requires commitment from decision makers to increased the socialization budget.

The target of these program is the achievement of a good understanding in the community regarding the importance of environmental sustainability in Ambon, which is characterized by increased public support for the running program. Socialization programs include the management subject of wastewater, municipal solid waste, ports and shipyards sanitation, traditional market, residential, tourist area, hotel, office, and watershed.

Pollution Minimization Strategy

Pollution minimization strategies can be implemented through regulatory improvement program. Strengthening and improvement of regulation needs to be done to support the implementation in the field as a legal basis. The purpose of this program is to improve the control and supervision of pollutant discharge into public waters, with the goal of requiring polluters to manage its waste before entering into public waters. The strategy will be carried out starting from the evaluation of the existing problem that need regulation improvement. Further step is doing improvements and coordinate with stakeholders, focusing on problems that may arise in the implementation phase. Policy directives aimed at improvement of quality standards, with the involvement of stakeholders, experts, and using references from the regulation of other big cities, such as Jakarta, Surabaya, and others.

Improvement of Water Resources Strategy

Water is a natural resource that there should be and need to be maintained and preserved so that its presence can be sustained until the next generation. This water source improvement program involves many sectors and should be carried out simultaneously and continuously.

The goal is to get the information of potential raw water, preserving water quality in water sources, repairing damaged forest in the upstream region with a reforestation using local plants which are have rapid growth characteristic and good effects on aquatic systems.

The main target of this program is to obtain quantitative and qualitative data of potential water sources that guarantee the availability for drinking water and agriculture. Reforestation is more focused on the area of potential water sources and has a strategic role for the community and development.
Pollution Handling Strategy
This program aims to determine the suitable individual and communal WWTP with the result that the treated water has already meet the quality standard. It is necessary to give examples of the application of wastewater and solid waste treatment technology for domestic or the small scale one, office, health center, hospital, hotel, restaurant and market.

MATERIALS AND METHODS
The research used a descriptive method by utilizing primary and secondary data. Data collected is the basis for determining the appropriate method or technology, so that existing problems are expected to be solved.

Primary Data Collection
Primary data collection was conducted by a survey in Ambon landfill and water sampling in 5 estuaries and analyzed at the laboratory of Engineering Center for Environmental Health and Communicable Disease Class II Ambon with the parameters of pH, temperature, TSS, BOD5, COD Ammonia, nitrates, phosphates, surfactants, oil and grease, sulfide, Cd, Cu, Pb, Zn, Cr, and Coliform.

Secondary Data Collection
The secondary data was obtained from Dinas Lingkungan Hidup Ambon to get the information on population and the activities on municipal solid waste handling.

Calculation of Pollution Load
Pollution load is calculated based on population, the waste produced per capita and the concentration of waste generated. The pollution load calculation is applied for domestic wastewater and domestic solid waste.

RESULT AND DISCUSSION
Table 1 shows the results of water quality analysis of some estuaries in Ambon. TSS is suspended solids derived from organic and unorganic materials that can be separated using a filter paper having pores um 0.45 µm. This suspended material has adverse impact on water because it prevents the penetration of sunlight into the water body. The presence of the TSS will increase water turbidity. In general, TSS form colloidal surface for the attachment of potentially pathogenic bacteria.
Table 1. Results of Water Quality Analysis in Some Estuaries of The River

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Unit</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Sample 5</th>
<th>Seawater Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Physical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>TSS</td>
<td>mg/l</td>
<td>38</td>
<td>34</td>
<td>34</td>
<td>25</td>
<td>33</td>
<td>20</td>
</tr>
<tr>
<td>II.</td>
<td>Chemical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>pH</td>
<td>mg/l</td>
<td>7.2</td>
<td>7.5</td>
<td>7.74</td>
<td>6.71</td>
<td>6.71</td>
<td>7 - 8.5</td>
</tr>
<tr>
<td>2</td>
<td>COD</td>
<td>mg/l</td>
<td>28</td>
<td>15</td>
<td>16.8</td>
<td>9.4</td>
<td>8.6</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>BOD</td>
<td>mg/l</td>
<td>8.2</td>
<td>5.3</td>
<td>7.4</td>
<td>3.2</td>
<td>4.2</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>NH₃-N</td>
<td>mg/l</td>
<td>1.4846</td>
<td>0.0123</td>
<td>0.0143</td>
<td>0.0181</td>
<td>0.571</td>
<td>0.3</td>
</tr>
<tr>
<td>5</td>
<td>PO₄³⁻</td>
<td>mg/l</td>
<td>0.3431</td>
<td>0.0608</td>
<td>0.0608</td>
<td>0.0262</td>
<td>0.0501</td>
<td>0.015</td>
</tr>
<tr>
<td>6</td>
<td>NO₃⁻</td>
<td>mg/l</td>
<td>2.8208</td>
<td>0.001</td>
<td>0.9326</td>
<td>3.9818</td>
<td>0.7564</td>
<td>0.008</td>
</tr>
<tr>
<td>7</td>
<td>H₂S</td>
<td>mg/l</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.002</td>
<td>0.05</td>
</tr>
<tr>
<td>8</td>
<td>Oil and Grease</td>
<td>mg/l</td>
<td>0.036</td>
<td>0.029</td>
<td>0.092</td>
<td>0.014</td>
<td>0.1864</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>SO₄²⁻</td>
<td>mg/l</td>
<td>0.05</td>
<td>0.02</td>
<td>0.04</td>
<td>0.02</td>
<td>0.02</td>
<td>0.005</td>
</tr>
<tr>
<td>10</td>
<td>Cr³⁺</td>
<td>mg/l</td>
<td>0.01</td>
<td>0.008</td>
<td>0.008</td>
<td>0.007</td>
<td>0.007</td>
<td>0.001</td>
</tr>
<tr>
<td>11</td>
<td>Cd</td>
<td>mg/l</td>
<td>0.007</td>
<td>0.007</td>
<td>0.006</td>
<td>0.012</td>
<td>0.012</td>
<td>0.008</td>
</tr>
<tr>
<td>12</td>
<td>Cu</td>
<td>mg/l</td>
<td>0.165</td>
<td>0.114</td>
<td>0.088</td>
<td>0.11</td>
<td>0.133</td>
<td>0.008</td>
</tr>
<tr>
<td>13</td>
<td>Pb</td>
<td>mg/l</td>
<td>0.03</td>
<td>0.03</td>
<td>0.013</td>
<td>0.02</td>
<td>0.011</td>
<td></td>
</tr>
</tbody>
</table>

III. Microbiological

|    | Coliform          | MPN/ |          |          |          |          |          |                  |
|----|-------------------|------|----------|----------|----------|----------|----------|                  |

Remarks:
Sample 1 was taken from the estuary of the Batu Metah river.
Sample 2 was taken from the estuary of the Waitomu river.
Sample 3 was taken from the estuary of the Galala river.
Sample 4 was taken from the estuary of the Lateri river.
Sample 5 was taken from the estuary of the Pokka river.

Ammonia in the river comes from urine, feces, and the results of the microbiological decomposition of organic matter derived from natural water, waste water, industrial waste water and domestic sewage. The presence of ammonia can cause toxic conditions for aquatic life. Level of free ammonia in water will increases with increasing of pH and temperature. Aquatic life affected by ammonia at a concentration of 1 mg/l and can cause suffocation because it can reduce the concentration of oxygen in the water (Barnes and Blisse, 1980). Ammonia in water can be microbiologically processed by heterotrophic and autotrophic bacteria through the nitrification process to form nitrite and nitrate. The nitrification process takes place under aerobic conditions, necessitating the addition of oxygen through aeration (Bitton, 1994).

The concentration of phosphate compounds also exceeded the sea water quality standard. Phosphate indicates nutrient status of the water. High phosphorus content indicates that the water is fertile. As a result of what happens is the potential for uncontrolled growth of algae (algal bloom). Phosphate in estuaries is generally derived from the use of detergents by residents who directly discharging it into the river.

The main sources of heavy metals contained in the water derived from agricultural and industrial activities (Mallick and Rai, 1993). The use of pesticides and fertilizers that contain heavy metals excessively, sludge from the wastewater treatment industry (especially the physico-
chemically treated) could potentially increase the concentrations of heavy metals in the waters. Heavy metals have properties that are difficult to degrade, so when entering into the food chain, the heavy metals will accumulate (Hart and Scaife, 1977).

Secondary data collection includes the population, the amount of solid waste generated per capita (2.75 l/capita/day, SNI S-04-1993-03) and waste management activities in Amnon (Dinas Kebersihan dan Pertamanan Kota Ambon, 2012). The water usage in residential amounting to 120 l/capita/day (SNI 03-7065-2005) and 80% of water usage has potential to be wastewater with the average BOD concentration amounting to 400 mg/l. For weight calculation of solid waste, the bulk density data used is 0.229 kg/l (Mulyanto and Titiresmi, 2009). Composition of plastic waste in the city of Ambon is very high, ie 15.05% of the total solid waste generated. While big cities such as Bandung, Semarang and Jakarta generate the plastic waste with composition of 8.58%; 14.15% and 13.25% respectively (Damanhuri and Padmi, 2010).

If the domestic wastewater is not treated, then Ambon will be burdened pollution by organic matter amounting to 15,006.64 kgBOD/day (Table 2).

<table>
<thead>
<tr>
<th>District</th>
<th>Population</th>
<th>Water Consumption (l/cap/day)</th>
<th>Total Water Consumption (l/day)</th>
<th>Potential of Wastewater (l/day)</th>
<th>BOD Concentration (mg/l)</th>
<th>Wastewater Load (kgBOD/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nusaniwe</td>
<td>113,142</td>
<td>120</td>
<td>13,577,040</td>
<td>10,861,632</td>
<td>400</td>
<td>4,344.65</td>
</tr>
<tr>
<td>Sirimau</td>
<td>160,808</td>
<td>120</td>
<td>19,296,960</td>
<td>15,437,568</td>
<td>400</td>
<td>6,175.03</td>
</tr>
<tr>
<td>T.A.</td>
<td>56,921</td>
<td>120</td>
<td>6,830,520</td>
<td>5,464,416</td>
<td>400</td>
<td>2,185.77</td>
</tr>
<tr>
<td>Baguala</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teluk</td>
<td>49,647</td>
<td>120</td>
<td>5,957,640</td>
<td>4,766,112</td>
<td>400</td>
<td>1,906.44</td>
</tr>
<tr>
<td>Ambon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leitimur</td>
<td>10,280</td>
<td>120</td>
<td>1,233,600</td>
<td>986,880</td>
<td>400</td>
<td>394.75</td>
</tr>
<tr>
<td>Selatan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>390,798</td>
<td>120</td>
<td>46,895,760</td>
<td>37,516,608</td>
<td>400</td>
<td>15,006.64</td>
</tr>
</tbody>
</table>

Indonesian Government Regulation number 81 year 2012 on the management of household waste and similar household garbage set the community-based waste management (communal scale) based on the principles of reduce, reuse and recycle. Communal scale waste management is very suitable to be done in Indonesia, because it can extend the service life of the landfill (Mulyanto, 2008). Communal scale facilitates the sorting process which is alleged as the principle of waste management (Tchobanoglous, et al, 1993).

Waste management activities undertaken by the public and the government of Ambon city can be described as follows:

- Performed by the individual directly

This activity is carried out by people to bring their solid waste directly into the garbage truck that comes to the area of service daily, and then the garbage truck transported the waste directly to the landfill.
• Performed by individual indirectly. This activity has involved the temporary shelters in the form of a container or bin. People bring their trash directly into the temporary shelters, and then the garbage truck pick up and transport it to the landfill.

• Carried out by communal directly. Garbage is collected by officer using a garbage cart and then carries the waste directly into the garbage truck. The garbage truck then throws it into the landfill.

• Carried out by communal indirectly. Community served by the garbage collectors use a garbage cart and took it to a temporary shelter in the form of a container or bin. From temporary shelter then the garbage is transported by truck to landfill.

Table 3. Potential Domestic Solid Waste Load Per District Based on Population Data in 2012

<table>
<thead>
<tr>
<th>District</th>
<th>Population</th>
<th>Solid waste Generated (l/cap/day)</th>
<th>Bulk Density (kg/l)</th>
<th>Potential Solid waste Generated (ton/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nusaniwe</td>
<td>113,142</td>
<td>2.75</td>
<td>0.229</td>
<td>71.25</td>
</tr>
<tr>
<td>Sirimau</td>
<td>160,808</td>
<td>2.75</td>
<td>0.229</td>
<td>101.72</td>
</tr>
<tr>
<td>T.A. Baguala</td>
<td>56,921</td>
<td>2.75</td>
<td>0.229</td>
<td>35.85</td>
</tr>
<tr>
<td>Teluk Ambon</td>
<td>49,647</td>
<td>2.75</td>
<td>0.229</td>
<td>31.27</td>
</tr>
<tr>
<td>Leitimur Selatan</td>
<td>10,280</td>
<td>2.75</td>
<td>0.229</td>
<td>6.47</td>
</tr>
<tr>
<td>Total</td>
<td>390,798</td>
<td>2.75</td>
<td>0.229</td>
<td>246.11</td>
</tr>
</tbody>
</table>

In term of solid waste, Ambonese produce garbage for 246.11 ton/day which is a burden for the existing landfill.

CONCLUSIONS

Community and the government of Ambon have not fully perform the processing of domestic waste water and garbage. This is indicated by the high chemical and physical parameters of the sample analysis results from several river estuaries in Ambon. Parameter that exceeds the quality standard for seawater is TSS, total ammonia, phosphate, nitrate, chromium, cadmium, lead, and coliform bacteria.

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