The behavior of coastal communities on management of domestic wastewater in Ternate City, Indonesia

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Abstract. Coastal area is a region that highly vulnerable to environmental degradation. One of the problems occurred in the coastal area in Ternate city is the number of solid and liquid household waste throws to the watershed or sea water. The different of geographical characteristics in Ternate is the focus of this study. The study took place in Kampung Makassar Timur Village that has people who have the house on the sea water and Sangadji village who live in the coastal area. This research aims to determine the behaviour of the population in residential areas who live in different geographical characteristics by calculating a total load of domestic wastewater and measuring the quality of domestic wastewater. Data collection and information collected by using questionnaires to the respondents in the study areas and following up by determining the quality of wastewater in some representative stations by laboratory analyses performed. The result shows that the behaviour of most respondents indicate the same behaviour in disposing the domestic wastewater directly to the sea because of it is an easy way to throw the wastewater, while other mentioned there is no wastewater drainage available at their place.

1. Introduction
Coastal areas, especially small islands, face challenging sanitation issues due to terrestrial waste generation as well as waste from the ocean. There are various social and economic activities; residential, industrial, transportation, and production area of aquaculture [1]. The threat to the Ternate coastal area had been increasing due to the increase in population and also the exploitation of coastal land. This threat was exacerbated by bad habits of people in disposing of waste. Based on data from Sanitation Working Group of Ternate City in 2014[2] that sanitary conditions in Ternate City which include waste management, domestic wastewater management, and urban drainage are still very poor. The poor sanitation condition was not only caused by the limited access of the population to the available sanitation facilities but also due to the low awareness and understanding of the public on sanitary and environmental health issues.

The coastal areas develop into a region with a fairly rapid growth in order to land-use changes[3]. Actually, the coastal region can provide space with high stability and relatively cheap compared with
the land space [4]. Therefore, this area becomes the center of population movement. Almost 60% of the urban population in Indonesia, like Jakarta, Surabaya, Semarang, Medan, and Makassar were located in the coastal areas. Thus, ineffectively on development of coastal areas as urban settlement leads to increase of environmental problems in coastal areas such as organic wastewater pollution [5].

The pattern of community behavior is really closed to environmental condition. In this system, people and nature are creating a unique behavior or performance of the resource system and consist of a bio-physical unit and associated with social actors and institutions [6]. As in coastal areas where the access to resources such as clean water, drainage system, and land was limited, can lead to the community use every resources that they get including in wastewater disposal. They throw the waste directly to the location where they are settled.

In Ternate City, there have two characters of community settlements that are the settlement on the water and settlement in the land area. This study aims to compare the behavior pattern of coastal communities, who built their home on the seawater in Kampung Makassar Timur Village and who live in the land area in Sangadji Utara Village in domestic wastewater disposal. Then continue with laboratory analysis to calculate a total load of domestic wastewater disposed of and the physical-chemical characters of wastewater.

2. Materials and methods
2.1 Sampling sites
Site 1, Kampung Makassar Timur Village was located in the western coastal area of Ternate Island. Topographically, this village is classified as sloping due to located at the foot of Gamalama Mountain. Meanwhile, the administrative area is 0.42 km$^2$ with a population in 2016 was 5265 people and 1069 household.

![Figure 1. Sampling sites](image)

Site 2, Sangadji Utara Village was located in the north of Ternate Island. Administratively its area is 0.9 km$^2$ with a population of 4969 people and 1015 households. All of the houses of the community in this site were built on land area (Figure 1).

2.2 Data collection and analysis
Data collecting use the basic information related to assessing domestic wastewater pollutants, and community participation approach used to understand the community behaviour in terms of disposing of domestic wastewater. The data was collected by using various techniques such as desk study, field research (observation), an in-depth interview and also Focus Group Discussion (FGD). In desk study, as a preliminary investigation, the secondary data relevant to human behaviour to manage their
domestic wastewater was obtained from the internet, journals, books and also officially documents from the statistical bureau, and Environmental Government Agency.

Field research (observation) focuses on the application of the questionnaire. To assess the real condition of the sampling sites, the questionnaire was developed to find out their habits and attitude. The questionnaire consisted of twenty questions which are used in the survey to addressed and discussed with 50 household head on each sampling sites. The main topics of this survey include socio-demographic characteristics of Households; domestic wastewater sources; their practices towards wastewater management, and the education level. Meanwhile, depth interview was conducted with key informants, head of the village, head of sub district, and leader of the religion. And FGD was done to complete the information and data that have not been obtained. This activity engages stakeholders on each study site.

In addition, the water sample was collected from several sites in order to analyze the characteristic of physical-chemical properties of wastewater, and the samples were analyzed at the Environmental Laboratory.

To calculate the pollutants load in study sites following steps:

The average number of a family member

\[ R = \frac{\text{Total Family Member of All Respondents}}{\text{Number of Respondents}} \]  

(1)

The total load can be measured using the following formula:

\[ \text{Total Load} = K \times D \]  

(2)

Where; \(K\) = concentration of contaminant (mg/L), \(D\) = debit of waste water use, this value is assumed from 85% water consumption (L/sec).

Calculation of the total wastewater load disposed per capita on those sites use the formula;

\[ C = \frac{T}{R} \]  

(3)

Where; \(C\) = waste load per capita, \(T\) = total waste removed, and \(R\) = average number of family members.

3. Result and discussion

3.1 Sociodemographic characteristic of respondent

Sociodemographic, the study of people in society, refers to the classification of society into different classes as social stratification and due to which there are inequalities that exist in society[7]. These factors such as gender, age, number of family members, education level, and occupation[8]. The result of sociodemographic characteristic of respondent illustrated on figure 2.

The age of respondents in Kampung Makassar Timur Village dominated by 25-30 years old around 32% and between 36-40 years old approximately 35%. While, in Sangadji Utara village, the age of participants was dominated by 31-35 years old and above 50 years old around 20% (fig 2a). Furthermore, the rates of family members from both study sites can be seen in fig 2(b). On both sites, the number of family members average on 4-6 people/family. However, the high percentages found at Kampung Makassar Timur around 63% than Sangadji Utara village about 50%.
The education level (fig 2.c), the participants who completed their study in senior high school are dominant found in Kampung Makassar Timur village around 55% and followed by junior high school level about 30%. Compare to Sangadji Utara village, the education level of respondents was dominant by undergraduate about 40% and senior high school around 35%. While, from occupations aspect, most of respondent from both study sites work as entrepreneur such as businessman or traders, particularly at Kampung Makassar Timur village around 50%. This job was very famous in this area because the village closed to trading center and traditional market. But in another side, Sangadji Utara village, civil servant was also dominant.

3.2 Sources of domestic wastewater pollution

The quality of seawater in the study sites is generally decreasing[2]. Due to the presence of domestic wastewater streams from human activity in the coastal area. In this study, information from respondents was extracted about the consumption of materials that have the potential to produce wastewater by people. Those materials include bath soap, shampoo, laundry soap, fragrance clothing liquid, floor cleaner liquid and bleaching liquid. The consumption level of those materials by respondent each month is shown in table 1.

3.3 Community behavior in disposing of domestic wastewater

Attitude is an individual consciousness of society that determines real actions in everyday life. The habits related to domestic wastewater management are evident from how respondents manage and dispose of their wastewater into the environment. The investigation result shows that in Kampung Makassar Timur, most respondents (78%) agreed to dispose of their domestic wastewater into the sea, while 22% disagreed. In contrast, in the Sangadji Utara village, most respondents (85%) did not agree to dispose of their domestic wastewater into the sea and only 15% agreed with this attitude.

The reason of respondents on both of study sites to dispose of their wastewater into the sea are;(1) There is no of drainage channel used to dispose of household wastewater except to sea; (2) fast and easy, (3) has become a community habit, and (4) there is no available land for managing household wastewater. While the respondents who do not agree to give reasons; (1) can pollute the environment, (2) can cause disease and odour, and (3) waste disposal often contain hazardous materials.

In the other side, it could be said that the level of education correlates with the attitude of respondents in disposing of domestic wastewater. The fact indicates that the number of respondents
who agree to dispose of domestic wastewater into the sea are generally educated at the end of junior high and high school. Although others also feel compelled to dispose of their domestic waste into the sea due to circumstances that require them to do it.

**Table 1.** The consumption of wastewater disposal materials by respondent every month in sampling sites

| Materials                  | Percentage of Respondent (%) | Average consumption in a month |
|----------------------------|------------------------------|--------------------------------|
|                            | Makassar Timur | Sangadji Utara | Makassar Timur | Sangadji Utara |
| Bath Soap                  |                |                |                |                |
| a. Solid Soap (pack)       | 82             | 49.09          | 7.19           | 4.6            |
| b. Liquid Soap (ml)        | 24             | 50.91          | 270.92         | 270            |
| Liquid Shampoo (ml)        | 100            | 100.00         | 122.04         | 105            |
| Laundry Soap               |                |                |                |                |
| a. Solid (pack)            | 60             | 32.73          | 7.9            | 8              |
| b. Liquid (ml)             | 10             | 36.36          | 346            | 355            |
| c. Powder (gr)             | 50             | 50.91          | 644.8          | 900            |
| d. Cream (gr)              | 10             | 9.09           | 400            | 300            |
| Fragrance clothing (ml)    | 70             | 76.36          | 289            | 280.9          |
| floor cleaner liquid (ml)  | 16             | 50.91          | 359            | 446.43         |
| Bleaching liquid (ml)      | 32             | 63.64          | 210            | 184.43         |

Overall, this analysis indicates that the level of education gives a good influence on the attitude of the respondents but still less influence on the actions of respondents in disposing of domestic wastewater into the environment. The facts in the field stated that the respondent's actions in disposing of domestic wastewater have influenced by knowledge and attitude and also the availability of the drainage system in his neighbourhood.

In addition, from FGD, this study found that the condition of domestic wastewater management in Ternate City currently generally still utilizes the nearest water bodies as domestic waste disposal sites, if there is management, the community only use septic tank without the absorption field (with manual drain system removed/disposed through wastewater disposal services). Domestic wastewater disposes of with channelled through existing sewer/conduit. This condition causes the pollution of groundwater, watershed, and an unhealthy environment. This habit is not only practised in the inland areas of settlements but also occurs in urban areas/centres of community activities. The most significant impact is the aesthetic disturbance that occurs in water bodies and coastal area, aside from being smelly and filled with household waste also become a source of the disease that can at any times effected the local community.

### 3.4 Total load of domestic wastewater

Wastewater is a liquid waste in which the composition consists of 99.9% water and the remaining solids [9]. Furthermore, it is stated that the domestic liquid waste consists of bathroom waste, kitchen, laundry, elements contained therein is a very complex element. Meanwhile, the complex mixtures present in the impurities consist of mineral and organic rocks in the form of large and small particles, residual solids of solution materials in a floating state, colloidal and semi-colloidal forms [9].

Completely, that the wastewater comprises 99.9% of the liquid form comprising organic[10], inorganic[11], suspended, colloidal, dissolved solids and microorganisms[12]. Organic materials include paper, faces, urine, soap, fat, detergent and food scraps[13][14]. While inorganic materials, such as ammonia and ammonium salts are derivatives of the decomposition of faces, urine, and nitrate
Furthermore, nitrates can also form nitrosamines and nitrosamides; potentially carcinogenic compounds.[17][18][19]. The total usage of water by people could be converted related to the amount of wastewater disposal. In developing countries including Indonesia, domestic wastewater is the largest amount of pollutants where 85% of water consumption entering water bodies will become a pollutant. While in developed countries, domestic wastewater constitutes 15% of all contaminants entering water bodies. Based on the standard of water consumptions for the middle city, 125 L/person/day, so in Kampung Makassar Timur village, with population 5625 people and 1069 household, total water consumption reach 658.125 L/day or 19.743.750 L/month. Whereas, Sangadji Utara village with population 4369 people and 1015 household, the total water consumption get 546.125 L/day or 16.383.750 L/month. Consequently, refers to the assumption above, the number of domestic wastewater discharge that enters the watershed reach 559.406, 25 L/day in Kampung Makassar Timur Village and 464.206,25 L/day in Sangadji Utara Village. In comparison, the rate of water consumption in a small city was 138.5 L/person/day and in rural areas is 60 L/person/day. The water will partly return to the environment as wastewater usually between 70 - 100 m³ per person per year[20].

3.5 Concentration of physical-chemical parameters on domestic wastewater
The physical-chemical parameters show that most of the parameter has concentration above the quality standard from the Ministry of Environmental Affair Decree No. 68/2016 (Table 2). According to the respondents saying that the water condition is not feasible (dirty), where 83.3% said the water was dirty, 6.6% said clean and 10% said polluted.

| Parameters                  | Concentration | Quality Standard | Measuring Method          |
|-----------------------------|---------------|------------------|---------------------------|
|                             | Makasar Timur | Sangadji Utara   |                           |
| TSS (mg/L)                  | 10            | 40.00            | 30                        |
| BOD (mg/L)                  | 224.10        | 73.50            | 30                        |
| COD (mg/L)                  | 560.07        | 69.25            | 100                       |
| Phosphate (PO₄)³⁻ (mg/L)    | 0.53          | 0.25             | Method 8048 Phosphor      |
| Nitrate (NO₃⁻) (mg/L)       | 0.53          | 1.58             | Colorimetric              |
| Oil & Grease (mg/L)         | <0.1          | 1.65             | 5                         |
| pH                          | 7.14          | 7.18             | 6-8                       |

4. Conclusions
The behavior of coastal communities in both two sites with the different characteristics’ settlement shows similarity behavior in the household waste disposal. Due to lack of knowledge of domestic wastewater management by community lead the increase of pollution in the coastal area. This is shown by a large number of people who dump their waste into the sea (Kampung Makassar Timur) or to the watershed (Sangadji Utara). A total load of wastewater disposed of by community was dominated by organic waste. Consequently, it showed on the high value of BOD and COD.

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