Utilization of BSF To Reduce Organic Waste In Order to Restoration of the Citarum River Ecosystem

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Abstract. Citarum River is named as the dirtiest river in the world along with nine other rivers located in various countries. The predicate was awarded in 2013 by the Blacksmith Institute, a nonprofit organization based in New York and Green Cross in Switzerland. The Citarum River is polluted by organic and inorganic waste. This paper focuses on how to process organic waste in Dayeuhkolot sub district which is one of the densely populated areas on the banks of the Citarum River. The method in this paper uses descriptive method, which explains the role of Black Soldier Fly (BSF) in reducing the volume of organic waste in the area. The purpose of this study is to analyze the effectiveness of BSF in reducing organic waste. Based on the analysis, BSF is able to reduce organic waste up to 56% of total organic waste. Therefore, in an effort to reduce organic waste in Dayeuhkolot sub district not only using BSF, but also must be combined with other ways.

1. Introduction
Garbage is a serious problem for the central government and regional governments. Waste production that continues to increase along with population growth, changes in consumption patterns, and people's lifestyles that have increased the amount of waste generation, type, and diversity of waste characteristics. The increasing volume of solid waste generation is one of the problems in Bandung Regency, especially along the banks of the Citarum River. In 2013 the Citarum River was given the title by the Blacksmith Institute, a non-profit organization based in New York and Green Cross in Switzerland as the dirtiest river in the world with nine other rivers in various countries.

The predicate is given because of the high pollution from the area around the Citarum river. One of the areas on the banks of the Citarum River is Kecataman Dayeuhkolot. Dayeuhkolot is one of the major industrial activities centers, trade, settlements and is the gateway to the South Bandung region. Industrial, trade and settlement activities produce large volumes of waste. In addition to the waste produced by industry, most of the waste produced is organic waste from market and household activities that have been polluting the Citarum River. To overcome the garbage problem, serious efforts are needed from various stakeholders.

The most garbage from household activities and market activities is the type of organic waste. This type of waste if it is not directly processed will cause a bad smell, unpleasant scenery and a source of disease. Therefore, effective and sustainable organic waste management is needed. The type and
composition of waste in urban areas consists of 65-75% organic waste, 10% paper and plastic waste, glass and metal 2% of the total waste produced every day. The source of such waste generally comes from housing and markets.

Organic waste processing that has been done so far is by composting. However, the conventional composting method requires a relatively wide and relatively long time. Additional methods are needed to process organic waste, in addition to those already implemented. One method that can be done to process organic waste is by using insect larvae, for example Black Soldier Fly (BSF). The use of larvae from these insects as organic waste processors has a promising economic value, because the harvested BSF larvae can be useful as a source of protein for animal feed, so that it can be an alternative feed substitute for conventional feed.

Based on this, the aim of this paper is to explain the condition of garbage problems in Dayeuhkolot sub-district, to analyze how the BSF’s mechanism of action is to control organic waste and analyze the effectiveness of BSF in tackling organic waste in the District of Dayeuhkolot, Bandung Regency.

2. Method
This research uses a descriptive method. According to Sukmadinata (2006) descriptive research is a form of research aimed at describing existing phenomena, both natural phenomena and man-made phenomena. This phenomenon can be in the form of activities, characteristics, changes, relationships, similarities, and differences between one phenomenon and another. The phenomenon referred to in this study is the problem of waste which affects the Citarum river ecosystem. This study attempts to describe the effectiveness of using Black Soldier Fly to reduce organic waste in the area around the banks of the Citarum river. The location of the study was carried out in Dayeuhkolot sub-district which is one of the areas on the banks of the Citarum river. Data collection is done by observation or observation, interview and literature study.

3. Result and Discussion
3.1 General Conditions of Dayeuhkolot District
Dayeuhkolot Subdistrict is one of the sub-districts in Bandung Regency which is located in the south and borders the City of Bandung. Geographically, District of Dayeuhkolot is located at coordinates 107°30'7" - 107°40'7"E and 6°55'30 "-7°0'24" S.

Dayeuhkolot District, Bandung Regency borders the following areas:
- a) North: Padaleunyi Toll Road, Bandung City
- b) East: Lengkong Village, Bojongsoang District, Bandung Regency
- c) Southern: Citarum River, Baleendah District, Bandung Regency
- d) West: Sukamenak Village, Margahayu District, Bandung Regency

Based on data from Dayeuhkolot Subdistrict in Figures 2017, the area of Dayeuhkolot sub-district is 1,078.60 Ha which includes five (5) villages namely Cangkuang Kulon, Cangkuang Wetan, Pasawahan, Sukapura, Citeureup and one (1) kelurahan namely Dayeuhkolo. The following is table 1 which shows data on the area of each villages. A high population with increasingly diverse activities will produce a number of waste.

| No | Villages/Kelurahan | Area (acres) | Amount Population | density person/acs |
|----|-------------------|--------------|-------------------|-------------------|
| 1  | Dayeuhkolot       | 97,00        | 16.624            | 171               |
| 2  | Cangkuang Wetan   | 209,90       | 19.503            | 93                |
| 3  | Cangkuang Kulon   | 214,5        | 39.970            | 186               |
| 4  | Pasawahan         | 192,20       | 12.992            | 68                |
| 5  | Sukapura          | 115,00       | 10.301            | 90                |
| 6  | Citeureup         | 250,00       | 22.177            | 89                |
|    | Jumlah            | 1,078,60     | 121.567           | 113               |

Source: Dayeuhkolot District in Figures, 2017
3.2 Dayeuhkolot District Waste Potential

To calculate the amount of potential waste generated by the population, the standard according to SNI 19-3964-1995 is used as follows:

a) Large municipal solid waste generation units = 2 - 2.5 L/person/day, equivalent to 0.4 - 0.5 kg/person/day

b) Medium/small municipal solid waste generation units = 1.5 - 2 L/person/day, or equivalent to 0.3 - 0.4 kg/person/day

Because waste generation from a city mostly comes from households, the assumption is that the waste generation unit can be considered to include waste generated by each person in various activities and various locations, both at home, street, market, hotel, park, office and so on. For Dayeuhkolot sub-district, use the medium city category, the waste collection unit used is 0.3 - 0.4 kg/person/day. Furthermore, by using the assumptions from the Bandung Regency Sanitation Department in 2005 the amount of wet waste (organic) reached 65% of the total waste generated so that the potential for solid waste in Dayeuhkolot sub-district can be calculated as follows. Based on Table 2 the potential for organic waste generated by residents in Dayeuhkolot District is 31,607.42 kg / day or 31.6 tons / day.

Table 2. Potential of Organic Waste / Volume Dayeuhkolot District, Bandung Regency

| Villages/Kelurahan   | Amount Population | Medium / small city waste unit | Total waste generation (kg/day) | Organic Waste (65% of total waste) (kg / day) |
|----------------------|-------------------|-------------------------------|--------------------------------|-----------------------------------------------|
| Dayeuhkolot          | 16.624            |                               | 6.649,6                        | 4.322,24                                      |
| Cangkuang Wetan      | 19.503            |                               | 7.801,2                        | 5.070,78                                      |
| Cangkuang Kulon      | 39.970            |                               | 15.988                         | 10.392,2                                      |
| Pasawahan            | 12.992            | 0.4 kg/ person/day            | 5.196,8                        | 3.377,92                                      |
| Sukapura             | 10.301            |                               | 4.120,4                        | 2.678,26                                      |
| Citeureup            | 22.177            |                               | 8.870,8                        | 5.766,02                                      |
| Jumlah               | 121.567           |                               | 48.626,8                       | 31.607,42                                     |

Source: Researcher, 2017

3.3 Waste Management in Dayeuhkolot District

The waste management system in the planning area is currently managed by the community itself and the Bandung District Sanitation Department. Community management is carried out by burning, hoarding or dumping around the yard of his house. While the management by the Bandung Regency Environmental Service is limited to certain areas such as trade, shops, industry, roads, markets and settlements. Referring to the 2014 Regional Performance Indicator data (Renja DLH Bandung Regency, 2018), only around 19.06% of the waste in Bandung Regency was handled. In general, the waste problems that occur are as follows:

a) Inefficient waste collection system, transportation of garbage by trucks is still carried out from house to house and not from TPST (Integrated Waste Disposal Site).

b) The absence of a waste treatment process at the TPS (temporary disposal site) so that all waste is taken to the TPA (Final disposal site) which currently still applies an open dumping system.

c) Lack of community independence in waste management, where transportation of garbage from houses to TPST (Integrated Waste Disposal Site) should be carried out independently using a cart (which has been prepared by the government).

d) There are no villages that are independent of waste management.

e) The low level of public knowledge in managing household scale waste.
3.4 Use of BSF to process organic waste

The use of maggot caterpillars or BSF larvae to reduce organic waste is carried out in Dayeuhkolot Market. The waste produced from this traditional market reaches 10 m$^3$ per day. The volume consists of organic and inorganic waste. The capacity for organic waste for this experiment is 4 m$^3$. The initial stage that must be done is to sort out organic and inorganic waste. Although BSF larvae are generally very tolerant of various organic wastes as food. However, it is still important to ascertain whether organic waste received at the facility is suitable for eating by larvae. Most organic materials with a water content of 60% to 90% and with specific particle sizes will definitely be digested. In Table 3 can be seen a list of organic waste that can be eaten by the BSF larvae.

| Urban Waste                  | Agro-industrial waste            | Feces                      |
|------------------------------|----------------------------------|----------------------------|
| Organic household/residential waste | Food processing waste            | Animal waste (poultry, pigs, cattle) |
| Food and restaurant rubbish  | Used grains                      | Human waste                |
| Market organic waste         | Waste slaughterhouse             | Feces                      |

Source: eawag aquatic research, 2017

Based on observations of organic waste testing sites in Dayeuhkolot market, from the volume of 4 m$^3$ of waste (equivalent to 800 kg of organic waste) after being distributed by BSF larvae / maggots as much as 10 kg (± 80000 larvae) in a day experienced a reduction of 0.16 m$^3$ in a day (24 hours). Maggot / larva phase occurs within 14 days, so the total shrinkage of garbage reaches 2.24 m$^3$. Overall, the reduction of organic waste by using BSF maggot / larvae reaches 56% of the total organic waste or around 448 kg. The rest of the decomposition process by maggot or former maggot (kasgot) reaches 90 kg. Kasgot can be directly used as organic fertilizer. The rest of the waste in the form of compost material that has not been decomposed completely.

The use of BSF larvae for processing organic waste in Dayeuhkolot District is expected to be part of the solution to reduce pollution to the Citarum River ecosystem.

4. Conclusion

Waste management in Dayeuhkolot District, Bandung Regency in general still uses the principle of Gathering and Waste, and the community has not done waste sorting. Analysis of the potential for organic waste generation in Dayeuhkolot District is produced around 31.6 tons/day of organic waste. Organic waste is waste that is rapidly degraded (rapidly decomposes), especially those coming from households and waste from the rest of market activities. To overcome these problems one of them is by using the BSF maggot / larva with the aim to reduce the generation of organic waste. Based on the waste processing tests using BSF maggot/larvae carried out in Dayeuhkolot market, the reduction of organic waste reached 56% of the total organic waste. This condition is due to the lack of optimal management and environmental conditions that have not been supported. We recommend that environmental conditions and organic waste optimal for larvae are as follows:

a) Warm climate: the ideal temperature is between 24 °C to 30 °C. If it’s too hot, the larvae will come out of the food source to find a cooler place. If it’s too cold, the metabolism of the larvae will slow down. As a result, larvae eat less so that their growth becomes slow.

b) Shady environment: larvae avoid light and always look for a shady environment and away from sunlight. If the food source (organic waste) is exposed to light, the larvae will move to a deeper layer of food sources to avoid the light.

c) Water content in food: food sources must be sufficiently moist with water content between 60% to 90% to be digested by larvae.
d) Nutritional needs for food: ingredients rich in protein and carbohydrates will produce good ingredients for larvae. Ongoing research shows that waste that has gone through the process of decomposing bacteria or fungi is likely to be more easily consumed by larvae.

e) Food particle size: because the larvae do not have the mouth to chew, nutrients will be easily absorbed if the substrate is small parts or even in liquid or slurry form. So that it requires an organic garbage counting tool.

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