KnE Social Sciences

ISTEcS 2019
Equity, Equality, And Justice In Urban Housing Development
Volume 2019

Knowledge E
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Conference Paper

Environmental Management Planning in Residential Area of RT 05 RW 05 Jemur Wonosari Sub-District, Surabaya City As Climate Change Adaptation

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Abstract

The residential area of Jemur Wonosari is one of the densely populated regions in Surabaya City. This condition is not always in line with adequate environmental management, resulting in several ecological problems. This research was conducted to plan environmental management in this area. The research method collected primary data through planning area observation, survey and interview, and secondary data about the description of region and literature. The initial survey result shows that fifty percent of residents used groundwater as the water source. Its area has, in fact, a communal wastewater treatment plant (WWTP), but is no longer in operation, which led the majority of residents (eighty-nine percent) to drain wastewater directly into the river. A total of ninety-four percent of residents disposed of solid waste without processing. The green area in this region has been less than ten percent. The result for clean water, are rainwater harvesting and bio pore. The communal WWTP is considered to be built under the existing road. The solid waste management in this area was processed through composting using takakura, bio pore, and reoperating waste bank. The concept of outdoor space optimization as the green area is divided into public and private space. Mitigation planning in the form of sanitation and green areas needs to be supported by all stakeholders to create a better and adapted environment against climate change.

Keywords: environmental management, residential area, climate change, green area

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Received: 24 May 2019
Accepted: 25 July 2019
Published: 4 August 2019

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ISTEcS 2019 Conference Committee.

1. Introduction

Environmental issues have become a global issue besides the energy crisis, such as environmental pollution and climate change [1]. The issue of climate change in national development should be one of particular concern, including in an environmental management plan. The idea of linking climate change agenda and sustainable development goals (SDG's) is highly relevant and has been adopted by most countries in the world [2].

The 2030 Sustainable Development Goals (SDG's) has five main foundations: human, planet, welfare, peace, and partnership with the target to end poverty, reach equality and resolve climate change [3].

Some efforts to deal with climate change are with mitigation and adaptation. Adaptation is very important to reduce the risks and impacts of climate change that threats humans. One way for adapting climate change is by environmental management which involving all elements of society.

Environmental management planning is closely related to aspects of environmental sanitation including clean water supply, wastewater distribution, and solid waste management [4]. Solid waste management is one of the crucial parts to reduce the greenhouse effect. It is proven that composting of 1-ton solid waste can reduce 5 to 7 ton CO_2 [5]. Inappropriate solid waste and wastewater management can release CH4 directly to the atmosphere. Global warming potentials (GWP) for CO_2 value for 100-year time horizon is 1. Meanwhile CH_4 is 28. It means that while releasing 1 kg CH_4 to the atmosphere has the same amount with releasing 28 kg CO_2 to the atmosphere [6]. The availability of green area is also one of the aspects to be studied in environmental management planning. Green area is essential to examine carbon dioxide (CO_2) and as an effort to reduce harmful pollutants, as urban oxygen reserves provider, creating a comfortable microclimate within the built environment as well as an efforts to conserve groundwater through vegetation and outdoor space arrangements based on area requirement.

Jemur Wonosari District has been considered as one of the densely populated regions in Surabaya City, especially at RT 05 RW 05 area with population density reached 230 peoples per hectare. The high population density was indicated by the limited green space, high-frequent floods, as well as ground and surface water pollution. This condition was not followed by adequate environmental management, resulting in several ecological problems. This research was conducted to plan environmental management in this area on the aspect of clean water supply, wastewater distribution, solid waste management, and green area. This research also considers adaptation to climate change in residential areas. The well-maintained environmental conditions will provide better ecosystem service assurance and capability in reducing climate variations [7].

2. Materials and Methods

Primary and secondary data were used in this study, with primary data sources derived from the survey, observations of research sites and interviews. These primary data include the existing condition of clean water supply management, wastewater distribution, waste management and green areas in the planned area. While the secondary data collected consists of a general description of the research area and various related literature. The result of data collections was analyzed for environmental management planning in RT 05 RW 05 Jemur Wonosari. Environmental management planning was carried out by considering it as a form of climate change adaptation effort. The number of respondents was determined by using the equation (1).

$$n = \frac{N}{1 + N \ (e) \wedge 2} \tag{1}$$

Given that the number of head of the family amounted to about 70 with e value = 0.2 so that 18 residents were obtained as respondents. The first step in data processing was inputting the questionnaire results into SPSS software to determine the questioner validity with Cronbach-Alpha value greater than 0,5. From data processing result, environmental management planning was carried out in the area of RT 05 RW 05 Jemur Wonosari on the aspect of clean water supply, wastewater distribution, solid waste management, and green area.

3. Results and Discussion

Geographically, RT 05 RW 05 Jemur Wonosari is located at $7^0$19‘03.34“ S and $112^0$44‘ 17.67“ T. This area has an area of 9.789 m^2 with the northern part bordering Margorejo highway, the east side with RT 06 RW 05, the south side with RT 03 RW 05 and on the west side with RT 06 RW 04. The majority of the land in the neighborhood is a densely populated residential area with a fixed population in 2017 of 225 people. The existing condition of RT 05 RW 05 Jemur Wonosari is shown in Figure 1.

3.1. Clean water

Related to the provision of clean water, the water source that has been widely used by the residents was groundwater. A total of fifty percent of respondents still use groundwater sources, seventeen respondents use water from drinking water provider (PDAM), and thirty-three percent of respondents use combined water sources (wells and PDAM). The use of water was generally for personal hygiene activities only and

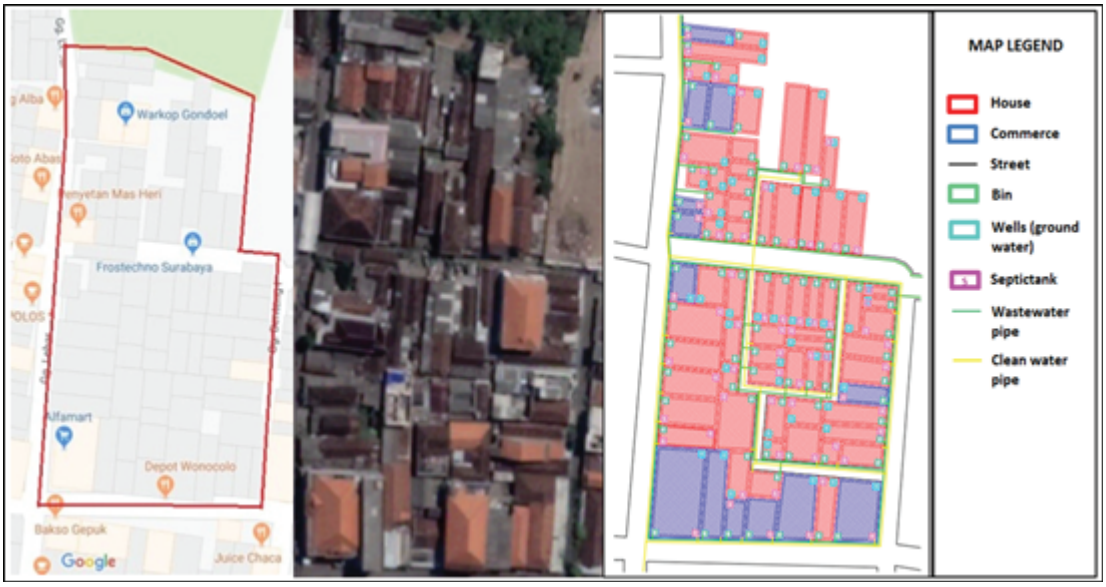

Figure 1: The existing condition map in the research area. (source: author's own work and google maps, 2018.)

other needs than cooking. As for the needs of the kitchen, the majority of residents use water refills. The low number of citizens used drinking water supply (PDAM) services because the cost of installation was considered expensive by most of the residents.

One of the things to consider is how to maintain the quality and quantity of groundwater by doing groundwater conservation [8]. Also, some of these planning options are also for the floods prevention that always occurs every rainy season. Some solutions that can be done include utilizing rainwater for filling groundwater aquifers as compensation for the amount of consumed groundwater [8].

Continuous groundwater exploitation can result in lower groundwater, saltwater intrusion, groundwater contamination, and buildings or roads slopes[8]. Therefore, as much as possible the use of groundwater in this area must be reduced by using rainwater as a clean water source. One of the things that can be done was rainwater harvesting, an attempt to collect, use, and absorb rainwater into the soil [9]. This activity can be done with rainwater pools; infiltration wells/trench and bio pore absorption holes. However, with limited land available, rainwater pools or rainwater infiltration wells were not possible to be implemented, so bio pore or biofiltration and infiltration trench became an appropriate planning alternative. Infiltration trenches are generally not considered practical for sites larger than 5 acres and used in small areas [10]. The planned bio pore will have 20 cm diameters per 5 capita. Another advantage of this method was the ability of its bio pore to process biodegradable organic waste at the same time.

3.2. Wastewater

Around eighty-three percent of respondents stated there was no wastewater treatment in this area. Wastewater management can also be categorized as poor since eighty-nine percent of respondents noted that the wastewater produced was directly discharged into the river, five percent released directly into the artificial soil (perforated ground), and six percent responded instantly to the yard. Based on field observations, the area already had a Communal Waste Water Treatment Plant (WWTP) to treat domestic wastewater, reused for watering plants in the neighborhood (Figure 2). Due to the high operational cost for wastewater treatment operations, the community decided not to operate the installation any more. There are two current wastewater distributions, trough drainage and directly flowed into the nearest river.

Wastewater distribution planning was intended to treat wastewater before discharge into the river and to protect the environment against wastewater pollution. Technically, existing WWTP was not feasible and insufficient to accommodate domestic wastewater generated at a maximum of 21.6 m^3/day. It is needed to plan a communal WWTP that can treat wastewater from this residential area. Given the limited land, communal WWTP can be designed under the existing residential road or public facilities. The planned communal WWTP can use a combination of Anaerobic Baffled Reactor (ABR) and Anaerobic Filter (AF). ABR can remove ninety percent of Chemical Oxygen Demand (COD), generating a seventy percent methane gas potential from the elaborated COD [11]. The ABR also has a simple design, low construction costs, is easy to operate, and low sludge production. On the other hand, AF has the advantage of requiring a small area so that it is suitable to be applied in the densely populated settlement [12].

3.3. Solid waste

Generally, solid waste containers availability in RT 05 has been adequate. From 60 households in the area, there are 50 permanent and semi-permanent waste containers. A total of ninety-four percent of respondents dispose of their garbage into waste containers or bin without being processed first at their houses, while six percent of respondents were still practicing open burning. The transporting waste activities were carried out every two days using the garbage carts by local cleaning officers. In a small alley that cannot be reached by carts, the people who will carry the trash came out to the alley to be handed over to the officers. Waste that has been collected will be sorted by officers, where the organic garbage partly goes to the communal composter

Figure 2: The Communal WWTP, Jemur Wonosari. (source: field analysis, 2018)

in the form of a composter bin. Meanwhile, recyclable inorganic waste was collected at a waste bank that was once made by the residents (Figure 3). The residue will be transported to the landfill facility of Jemur Wonosari District. Unfortunately, the condition of the composter is currently not used correctly and waste bank operations have stalled due to operational management issues.

The planned solid waste management was by reduction of waste at source (household scale) by sorting and composting. It takes at least three garbage containers in each house to separate biodegradable organic waste, recyclable waste (paper, plastic, metal, etc.), and residues (used diapers, styrofoam, pads, etc.). Biodegradable organic waste was processed by composting using takakura baskets and bio pore [13]. One ton of solid waste that disposed of in landfill can produce 0,20 to 0,27 m^3 CH_4 with solid waste density 0,5547 g/L. If it is processed by composting, means that methane gas that can be composed is about 0,21 to 0,29 ton CH_4 or equivalent with 5 to 7 ton CO_2[5]. Recyclable non organic waste will be collected in a waste bank. So it needs to reactivate or to reoperate the existing waste bank. The waste residue that can not be composted or sold to the waste bank will be disposed of in the landfill facility of Jemur Wonosari District.

3.4. Green area

The green area in this area is insufficient, less than ten percent of the total area and severely limited pole-level trees were found. The land was quite dense with settlements

Figure 3: The Existing Waste Bank. (source: field analysis, 2018.)

and some commercial spot (Figure 4). Greening efforts currently being undertaken by residents, in front of the house and create a shelf in some empty places in the area to fill with potted-plants species, generally ornamental plants and some herbal plants. The absence of green space also has an impact on the lack of rainfall absorption area in this region. Most respondents stated that flooding often occurs when the rainy season comes. While in the dry season, with the limited pole-level trees existed, the air is quite hot in this area.

Increased land prices in urban areas have an impact on changes in land function from open space to residential and residential purposes into commercial. These changes, in turn, also have an effect on the availability of green open space or green area in an urban area. A city must provide and manage at least thirty percent of its land area as green open space, with details of twenty percent charged to municipal government, and ten percent on private and public sectors [14]. Considering the condition of the existing of dense settlements with the percentage of outdoor space in the form of green open space and non-green open space which was only ten percent of the land area, the concept of outdoor space optimization as green area should be done as an effort to increase ecological carrying capacity environment in residential area.

The green area in this area was planned to be divided into two regions. In the public space, the placement of the garden is in the form of potted plants, pendants, or tendrils along the pedestrian pathway while maintaining the level of safety and comfort of road users. The area around the river banks will be planned as placement of plants that can root as a binder of water to conserve groundwater. While in the private space in the

Figure 4: The existing public spaces vegetation in the research area. (source: field analysis and google maps, 2018.)

form of arrangement of vegetation in the yard of the house with the area of infiltration or potted plants.

Essentially, green area planning in this area should pay attention to the type, function, and location of existing vegetation placement, so that green regions can optimally support climate change adaptation efforts (see table 1). The green fields of the area are planned with vegetation arrangement that is divided into three primary functions such as CO_2 and pollutant reducer as well as a provider of urban oxygen reserves, comfortable microclimate controller, as well as improvement of groundwater quality and conservation.

Planning green areas with vegetation placement within this area should be supported by the following:

1. The composition of vegetation arrangement should consider the aesthetic factor by processing the color, shape, and size in laying to promote comfort.

2. The type of vegetation to be used should consider the growth factor, root system, growth location, maintenance pattern, and the leaves characteristics and the safety of fruit produced.

Table 1: The Analysis on vegetation needs in RT 05 RW 05 Jemur Wonosari.

No	Function	Type	Placement Locations
1	Reducing CO2 and harmful pollutants as well as providing urban oxygen reserves	Palm Trees, Longan, Sansevieria, *Pterocarpus indicus*, *aloe vera), Chlorophytum comosum, Sansevieria trifasciata, epipremnum aureum, dracaena marginata, Chrysanthemum morifolium*, etc.	Vertical garden in the space of building walls, pots along pedestrian ways, terrace/yard/space outside the building
2	Microclimate controller	Productive plants, spiral/pergola plants, shade plants/plants with wide canopy:Trees, *Terminalia mantaly*, *Polyalthia longifolia*, *Pterocarpus indicus*, etc.	Pedestrian ways in the form of shelters using spiraling plants, terrace/yard/space outside the building using the type of productive plants and vegetation types of shade trees.
3	Water conservation	Bamboo, grass,*Filicium decipiens*, *Syzygium oleana*, etc.	House yard, river border area and empty land on the north side of the area
(Source: field analysis, 2018)			

3. Efforts to provide ten percent of the area in each land area as green area and infiltration

4. The synergy between vegetation arrangement and sanitation, so that attempts to support climate change adaptation in this environment can be optimized.

4. Conclusions

Based on the results of environmental management planning in the field of climate change adaptation research, it can be concluded as follows:

1. The clean water supply in the planning area can be done by rainwater harvesting and bio pore placement with diameter 20 cm per 5 capita

2. Wastewater distribution planning in the area can be done by planning communal WWTP, and it should be considered to be built under the existing road or public facilities so that it can accommodate all of the wastewater. The communal WWTP planned for a combination of Anaerobic Baffled Reactor (ABR) and Anaerobic Filters (AF)

3. Planning of solid waste management in the area is done by reducing waste at source (household scale) with sorting. Biodegradable organic waste is processed by composting using takakura baskets and bio pore. Recyclable non organic waste

was collected for deposits to waste bank. The waste residues that cannot be composted or sold to waste banks will be disposed to the landfill facility of Jemur Wonosari District

4. Green area planning in the area is conducted to support CO_2 and pollutants reduction's efforts, urban oxygen supply providers, microclimate controllers and water conservation efforts by optimizing appropriate vegetation selection based on type, function, and location as required. The concept of outdoor space optimization as green area divided into public and private space.

5. Mitigation planning in the form of sanitation and green areas in this neighborhood needs to be supported in good faith from all stakeholders to achieve the ideal goals to create a better and adapted environment against climate change.

This climate change adaptation study is still focused on ecological handling. So that in the future can be done further research on ecological and social aspects. Quantitative measurements and modeling simulations need to be done to test the success of this plan so that it can be more effective in engaging communities and stakeholders in real action.

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