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The "Green Palisade" Concept: a scenario of waste and wastewater as resources city

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1 ABSTRACT

"Liveable city for everyone means a high environmental quality performance whenever we are breathing." From this interpretation, this paper should focused on two main 'refuses' from our daily life - waste and wastewater – and options for their use as resources. In this sense a scenario for one area in Jakarta's (the capital city of Indonesia) satellite cities, Bogor, where most population concentrated will be delivered.

Bogor City has been 100% transferred into urban area in the last few decades and expected to have more significant urban rising in the future. The inhabitants in Pulo Geulis, one area in Bogor City, potentially throw their refuses into the rivers which surround the area. A scenario is designed to implement waste and wastewater as resources and make them as benefits among themselves and others. At the same time it improves the community livelihood of life and contributes in lowering global GHG emissions from waste and wastewater sector. This paper calls it as the „green palisade" concept.

Keywords: green, community livelihood, waste and wastewater, river, polution avoidance, GHG reduction

2 BACKGROUND

Environment is a combination of aesthetical, social and physical concepts with an interrelated synthesis among resources, man and the species (Jain 2009). Liveable cities must be supported by suitable environment quality and public health. Taking waste-and-wastewater-from-household-activities as resources into considerations, humans routines will be greatly determine the quality of environment and public health. This will be a great challenge for Indonesia where the society's participation in community livelihood improvement is still weak (BPS 2008).

This paper will focus in one 'isolated' area in Bogor City. Bogor is a name of one of Regencies in West Java, Indonesia, and it is also a name for the capital city of Bogor Regency. In this paper Bogor is used to represent the city only.

It is Pulo Geulis, located at the center of Bogor. Pulo/pulau means Island in english and geulis means pretty, so Pulo Geulis means pretty island. Pulo Geulis is a delta that formed by Ciliwung River long time ago. The reason of selecting Pulo Geulis as case study is because the river surrounded area, where river littering potentially become environmental problem.

By developing the 'green palisade' concept in the area, the paper tries to contribute to the green urban community development particularly using the resource potential from waste and wastewater sector. The specific aims of this paper are to reveal the economic value from waste and wastewater resources and to look at some ways in decreasing the natural resources exploitation in the area. This paper also looks at the potential as renewable energy sources from this sector.

With the "green palisade" concept it is expected the society awareness for community participation in their livelihood improvement will increase. Also, 'the green palisade concept' is expected to improve the soil quality in the outskirts of the area and therefore give chances for trees to grow. At the same time it decreases the potential GHG emission released uncontrolled into the atmosphere.

2.1 The Green Community Development and waste and wastewater sector

The 'greens' are generalized as the principle of community self-reliance, improving quality of life, harmony with nature, decentralization and diversity (Roseland 2001, p. 90). In fact the waste and wastewater production increase moves along with the open space decrease. Therefore problems often hit high-populated

cities where waste minimizations, such as home composting, are limited due to the free space availability (den Boer 2007).

Developing countries familiar with low-level quality of waste and wastewater management. Often this sector stimulates diseases, cause environmental degradation and triggers food insecurity. In the relation with climate change, waste and wastewater sector contribute 2-3% of the total green house gas emission generation between 1997-2003 and 4.5% only for Developing countries (Bogner et al 2007, p 596). In this sense, since cities in developing countries are commonly most populated, waste and wastewater sector has important role in influencing the green urban community development.

2.2 Indonesia, Bogor, and Pulo Geulis

Indonesia is a tropical country in the South-East Asia. It has rainy and dry season, from October-April and from April to October, respectively. Jakarta, the capital city, has amazingly developed in to a metropolitan city with population of 8.8 million populations (BPS 2008). Since decades Jakarta expands its influences and shapes the Greater Jakarta; the five cities chain abbreviated as JABODETABEK (Figure 1). Nevertheless these cities become dependent one another. Currently these satellites cities are experiencing significant urban rising where almost 100% of the area has turned into urban structures (Table 1).

The Center Bogor is the densest sub-district in Bogor City, with 13,445 person/km2 (BPS Kota Bogor 2008). Located about 10-15 minutes walk to the south part of Kebun Raya Bogor (80 hectare Bogor Botanical Garden), this area looks very contrast. Trees are very rare here. Dense settlement with one-family/single houses, small alleys, bridges and massive fences are the main urban infrastructures on the site.

2.2.1 Bogor and the selection of Pulo Geulis

In January and February Bogor normally has highest rainfall, 500 mm/month. This rainfall is 200-250 mm/month higher than the high-classification given by Indonesian National Institute of Aeronautic and Space (LAPAN). Bogor is located in a high land, 150-330 m above the sea level, at the southern part of Jakarta. Geographically, this city has four Mountains with many fresh water sources, relative hilly land (0-15% angle of inclination). Bogor is passed by six rivers and has the highest rainfall rate compare to other cities in Indonesia (BPS Kota Bogor, 2008).

Fig. 1: the Greater Jakarta, including Bogor (Source: Jakarta City Map)

City	Total Area (km^2)	Urban Population (%)	Rural Population (%)	Total Population (Million)	Density (Person/km^2)
Jakarta	656	100	0	8.8	13,400
Bogor	118	100	0	0.8	6,700
Depok	200	97.5	2.5	1.3	6,500
Tangerang	164	70	30	3.2	19,500
Bekasi	210	97.5	2.5	1.9	9,000

Tab. 1: Rural-Urban Transform by Population in JABODETABEK (Source: BPS, 2008)

One of Bogor's rivers, Ciliwung River, also pass Jakarta. At the peak of rainy season the river size could not compete with the flow due to the solid waste along the river. Then it blasts over the surface and cause flood almost all over Jakarta. Mainly it is because the limitation of soil ground and its absorption capacity. This condition turned Bogor into a "flood transmitter" for Jakarta on the peak of rainy season.

By utilizing waste and waster from household activities at the field study, not only the soil quality is improved but also decreasing the amount of water that entering Jakarta. There will be significant amount of water reduction if many places in Bogor implement the concept, thus decreasing the flood potential in Jakarta.

2.2.2 Current Waste and Wastewater Treatment in Bogor

Like many other municipalities in Indonesia, municipal waste and wastewater management is administered under Environment and Cleansing Board. In Bogor Public Authority Act (PERDA) no.4/2007, it is stated that every inhabitant is not allowed to throw any kind of refuses in to environment except under the mayor's permission. Based on this Act, the inhabitants should do waste separation into organic and inorganic; set up their own standard waste bin for temporary collection; and throw their refuses at the certain selected places with the presence of monthly retribution. The municipality will transfer the waste in to the Bogor dumpsite near Galuga Mountain, named TPA Galuga.

The Act also stated that the Municipality and private sector operate all wastewater treatment where the inhabitants should pay retribution. Contrary to the strict regulation there is no wastewater network in Bogor but one sludge treatment plant (IPAL). Bogor Environmental Report (2003) states that only 22.35 % inhabitants have their own septic tank. Almost 80 % of households in Bogor dispose domestic wastewater directly into the rivers or canals. Some people built their own septic tank under their house, at the back or front side. When the tank is full, normally the municipality/private sector's truck collects/picks and transfer them up to the IPAL. Currently Bogor Municipality is building an integrated sludge treatment plant (IPLT). From these two current situations we conclude that to achieve better environmental and public health, there has to be another approach to solve domestic waste and wastewater problem.

2.3 Methodology

All information in this paper is collected through several methods such as direct investigation in October 2009, shared stories in environmental issues from different medias (newspaper, Blog, etc.) and literature reviews. Investigation has been made with the help from several local inhabitants but they are not representing any group of ages, individual interest, etc. All scenarios are developed based on these findings. Some data, such as waste and wastewater generation, are taken from municipality level.

3 DEVELOPMENT OF THE CONCEPTUAL MODEL

Pulo Geulis is inhabited by around 2,000 persons on a-1.8-hectare area, formed and surrounded by the Ciliwung River. From organizational perspective, Pulo Geulis is divided in to five neighborhood associations (RT). The area is very dense, with around 400 relatively small single houses and most of them have their back façade to the river. Located between two river flows, this area gets smaller and smaller due to abrasion (Figure 2). Therefore people in this area protect their property by building solid/massive grounds and constructions.

Land limitation is also one of important issues in here. It increases the sense of protecting the property construction like fences and walls. Moreover this is done to avoid the rainwater coming in-to the houses. Thus the fences create 1-2 m wide alleys, which restrict the water absorption and direction of the flows.

Bogor’s yearly humidity and temperature in the year 2007 is between 72-95% and around 21.8-26 0C, respectively (BPS Kota Bogor 2008). The yearly rainfall in 2007 is between 31-555 mm/month where the highest rate came in January and February with 555 and 527 mm/month, respectively. The lowest rate came in July and August with 37 and 49 mm/month, respectively. Still in 2007, during the highest rainfall month, the rain occurred in 20 and 22 days while it only occurred in 4 and 4 days during the lowest rainfall, respectively (BPS Kota Bogor 2008).

The inhabitants do washing, fishing, bathing (children), and some even defecating in the river. From the observation, during the working day we found many inhabitants on the site and most of them are woman and children.

These women are mainly housewife. They stay at the house and do the household chores while adult men are working outside the area. Some women make traditional crackers from vegetables as the way to earn money from home. Therefore the women and children are likely to be the most paying attention and critics inhabitant to any changes in the area.

Fig. 2: Pulo Geulis – Between two river streams

Because many houses are backing the river, many inhabitants do not include the river as aesthetic aspect in their property. By contrast they are directing their wastewater network, used water from bathroom, kitchen, rainwater and other refuses, in to river. Amounts of abandoned waste spots can be seen in some points in the site.

Some house have private toilet. Due to the absence of wastewater network, some inhabitants built decentralized septic tank. But because of the small spaces of the dense settlement, the capacity of the septic tank is also very limited. This brings problem of collection and transfer whenever it is full, as the transfer truck could not reach the collection point.

Based on Bogor Data from Dinas Lingkungan Hidup and Kebersihan or Environmental and Cleansing Board in 2008, Bogor as municipality generates 2,205 m3/day of waste, where 73% of them came from the household sector. This brings waste generation 0,0024 m3/day per person in Bogor. If we assume more than 50% is organic waste, it means around 0.85-1.4 m3 organic fresh waste can be collected each day (collection rate between 50-80%) in Pulo Geulis only. Moreover, with 70-80% of water consumption in Indonesia reach 80-100 l/person/day; this will be significant amount in reducing amount of water that enters Jakarta.

3.1 The Limitation and Potential Factors

The ‘green palisade’ concept development begins with the limitation and potential factor in the area. The main consideration for waste and wastewater management in the area takes in to account the economic benefit for the society and factors that could strengthen the social equity.

The limitation of the area is mainly the limited accessibility since 2 river streams surround it. This condition may give bigger chances for the inhabitants to throw their refuses to the river. Physically the area is very dense and almost no open space is available. The existing social and public facilities and also the inhabitants activities, where many women stay 24 hours in the area, are taken as the potential factor of Pulo Geulis

Based on the limitation and potential factors on Pulo Geulis, combination of centralized in-situ waste and wastewater management with low maintenance is preferred. Centralized in-situ is chosen because the condition of the accessibility (limitation) and the strong social community (potential) existence. This will narrow down the list of waste and wastewater treatment in to the small-scale organic treatment plants and lead to the woman and children as a key group as important factors to be considered.

3.2 Waste and Wastewater Scenario Development

Considering the accessibility and function as social and public facilities, six spots are observed as potential places to be taking place for the waste and wastewater scenario. Those are social community office, a social facilities where the community usually held discussions and administrative things; two mosques, public facilities where the Muslim community usually pray together; security post, a social facility where the inhabitant takes turn as security observer at the area; river basin, where the inhabitants can get closer to the river; and one of abandoned spots at the riverside, which currently used as illegal 'dump site' by the inhabitants.

1	Limitation Factor
	Land Morphology: • surrounded by 2 river streams (land abrasion) • limited accessibility Urban Infrastructure: • dense settlement • very limited open and green space • small alleys with massive boundaries • tight bridges • houses backing the river • abandoned spots as 'dumpsite' Social Community: • throwing refuses in to the river • middle to low economic income
2	Potential Factor
	Social Community: • woman and children as key group • different religion beliefs live in harmony • existing public and social facilities

Tab. 2: Pulo Geulis Limitation and The Potential Factors

The centralized in-situ activities are expected to strengthen the sense of belonging of their inhabitant and the social equity, since they play the role as user and controller. The impacts, either negative or positive will directly refer to the area in Pulo Geulis. The local women will mainly motorize these daily activities.

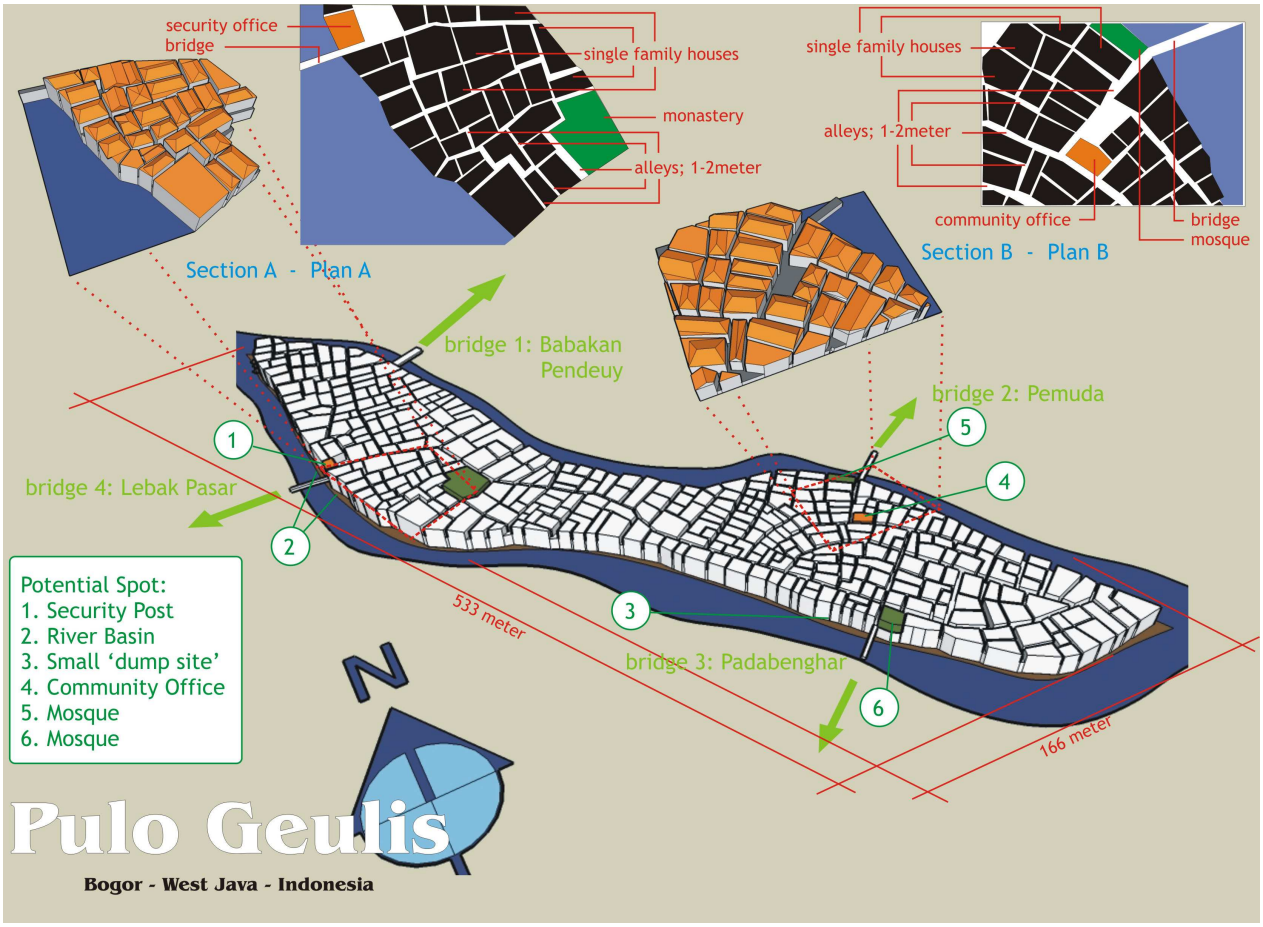

Fig. 3: Pulo Geulis –Eksisting Condition and Potential Spots Discovery

3.2.1 Waste Scenario

The paper suggests two main types of waste treatment for this area: 1) centralized recycling and 2) combine centralized and decentralized composting.

The key factor for these two activities is waste separation at source into two main fractions: non-organic (dry waste) and organic (wet waste) fraction. These organic and non-organic wastes are collected everyday with handcarts and then brought to the recycling center. The recycling center located at previous community office (spot no.4). The reason in selecting this spot is in order to improve the value for the society. Besides the current function, this facility will also play role as composting center, recycling center, recyclable bank and socialization center for these new values.

The collector(s) is the woman from each neighborhood association (RT), community groups or anyone who has interest in utilizing the waste resources, which regularly takes turn based on the schedule. The schedule can be discussed among the society.

Organic waste

The organic waste is suitable for composting. Composting is the aerobic breakdown of organic material such as straw, sawdust, wood, manure or leftover food and liquid sewage by various types of microorganisms and produce valuable material for the compost (Wahyuningsih 2007).

At the recycling center, the organic fresh waste resources will be composted in a compost container. There are varieties of small scale composting containers applied in Indonesia. One of them is Takakura, Japan technology composting container that enables well-aerated composting but prevent flies entering and without bad odors (Wahyuningsih 2007). With its 60-liter box (30×42×60Hcm ~ 0.08 m3) capacity, it is easy to carry and arrange them at the recycling center or at the inhabitants’ house.

The compost product will be useful as fertilizer, to make the settlement greener by pots planting. Beside its function for centralized composting activity, the recycling center also plays role as a ‘class’ where the

inhabitants can exercise the composting and then self-practice in their house. This self-practice is voluntary to those who have interest in home plantation.

The compost product can be uses to build greywater towers as well, as private or public. The definition and the integrated application with greywater tower will be discussed further in greywater scenario part.

Non - organic waste

The recycling center connects to the role as a recyclable bank. Here, the non-organic waste resources will be divided in to the one with and without economic value. The one with economic value will be stored in the recyclable bank and wait until it reaches enough amounts to be sold. The recyclable material segregation and utilization is potential as one of employment options for the inhabitants. The woman can work from home to make economic products such as bags, artificial flowers, etc. from selected material at the recyclable bank.

The one without economic value will be transferred in to nearest temporary collection point (TPS). With active involvement from the inhabitants, this will significantly reduce the waste brought to the landfill.

In the case of Surabaya City, another big city in Indonesia, the implementation of composting and recycling has successfully implemented. Many stakeholders are involved in 3R (reuse, reduce and recycle) project. The municipality has intensely promoted the program by distributing free compost containers while the local Non-Government Organization (NGO) organized a community clean up campaign. This campaign actively involves the inhabitants and the community group in waste reduction on their area. At the city level this activity reduced 20% of Surabaya municipal solid Waste (Maeda 2009).

The motor of this activity is the existing local community group. This group promotes waste segregation at source and goods manufacture from recyclable materials, such as plastics, for income generation (Maeda 2009). Therefore at the same time the project also promotes community empowerment. It is recommended to take the Surabaya successful case as further study.

3.2.2 Wastewater Scenario

The paper suggests Anaerobic Digestion (AD). AD is the controlled process of anaerobic digestion (Waite 1995 p.ix). It allows biogas generation that can be used for cooking. Located on 533 m long and 166 m wide area, Pulo Geulis has potential to be surrounded by wastewater network along the outskirts. The network will collect most of household sanitation networks that mainly end up at the river. Therefore exiting septic tanks will be closed and replaces by the black water network.

Black water network

Black water is wastewater that is produced from toilet activity. It mainly contains of faeces, urine and used water. This network will collect the black water pipe from households sanitation network at the outskirts. To be more effective, the network will be divided in three parts, where each sanitation network will reach the closest storage. There will be three AD plants for this area and one storage tank at the basement level per each.

AD plant I in existing security post (spot no.1), AD plant II and III in mosque (spot no.5 and 6). The locations for AD plants are selected because the function as public/social facility and the accessibility that allows the trucks' trunk reach the storage tank whenever they are full. The faeces, urine and used water are then brought to the municipality sludge treatment plant (IPLT).

Still on the black water network, three public toilets will be made, following the construction of AD I, II and III (spot no. 1, 5 and 6). The free-of-charge use of this public toilet will accommodate the community needs. One story on each mosque will be added and the public toilet will take place at the lower level (on the ground).

In order to avoid another expenditure to build door-to-door gas network, the gas will be accommodated and saleable in a 3kg-gas-tube, as that is the familiar/existing tube in the market. With the help of pump/pressure technology and water principle that flowing to the lower place, the storage tank will be made in the level minus one (-1 or basement) from the ground. The income from the gas trading can be used for AD and public toilet maintenance.

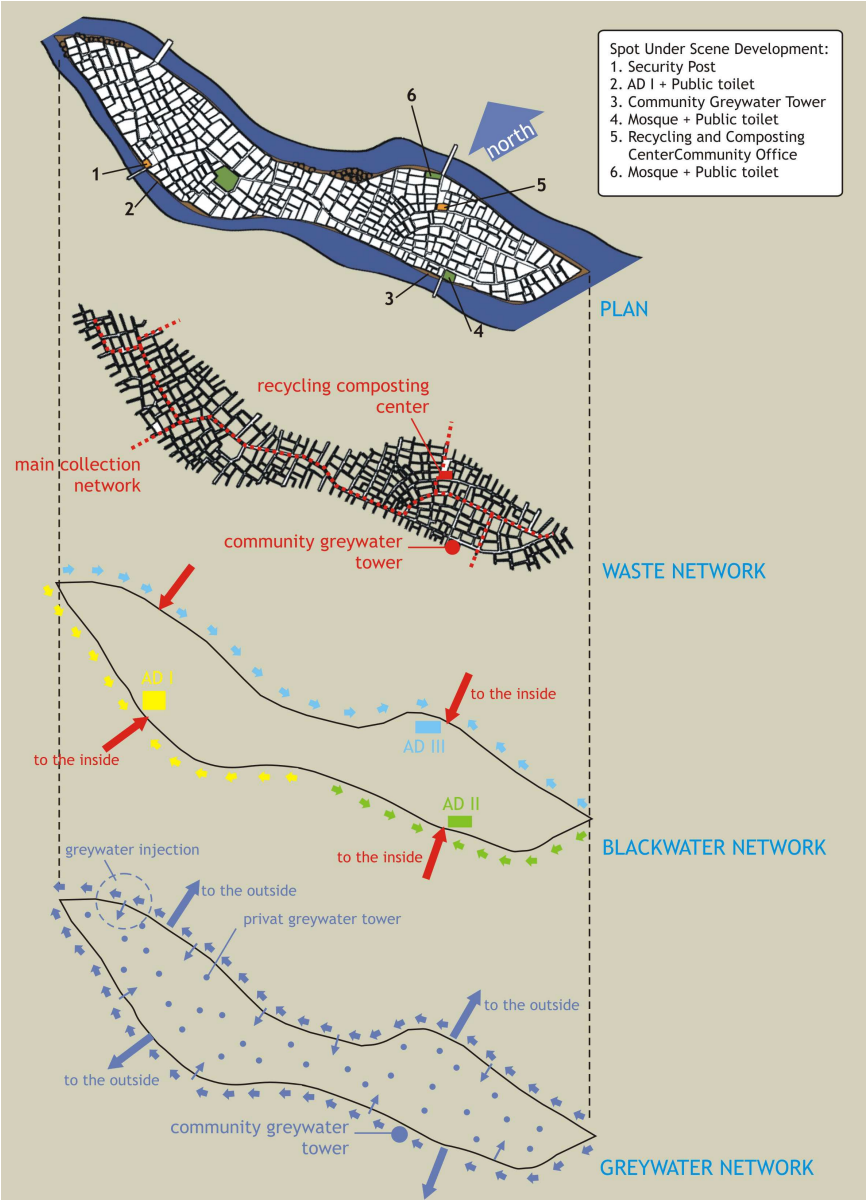

Fig. 4: Waste and Wastewater Scenario Development

Greywater network

Greywater is wastewater that is produced from other household activity such as washing, bathing, etc. Integrated with the composting activity, the greywater network will support the communal greywater tower application at the existing ‘dumpsite’ (spot no. 3).

Greywater tower is one technology to utilize greywater, with flexible diameter (30-50cm). The external structure consists of poles (iron bars or fence post) and shading material surrounding soil and central stone packed drain. The purposes of the stone are to spread the water flow throughout the column (Morel and Diener 2006). Greywater is poured daily with buckets on top of the central stone core. The water trickles through the central stone core and is more or less evenly distributed within the soil column. Due to soil limitation, the soil will be replaced with compost. This will give better result as compost contains nutrition (soil amendment).

The selection of this existing ‘dumpsite’ is in order to avoid the continuation of illegal dumping before it deteriorates the environment further. Moreover the soil cover on the land fits the agriculture activity. The societies can voluntarily implement it in their house for individual greywater tower.

Leafy vegetables, such as spinach and kangkung, are planted into slits of the shading material surrounding the soil column. The slits are offset to one another thus giving more space for root development. Tomatoes, chili or onions are suitable to be planted on top of the column.

The used water from rice, vegetable, and dishes washing can be use to watering the individual greywater tower. It is even possible to chance the tower media into hanging pots whenever there is no free space available. Other greater amount from used water generation such as from bathing, cloth washing, etc. will be directed to the greywater network.

The same as black waster network, the greywater network will collect the greywater pipe from households surround the areas together with the rainwater. The grey water network will be divided in to two parts, left- and ride-side network. To avoid the bacteria contamination from the greywater this network is built 20-30 cm sub-surface. The scenario avoids the centralized greywater collection on the land surface as it potential spots for diseases vector to grow.

In the case of rainwater, since there is no existing drainage at the area, all rainwater will join the greywater network. The greywater and the rainwater are then used to watering the greywater tower and partly circulated through the outskirts that still have soil land. The network will reach any soil land in the area, whenever it is possible, thus triggers soil fertilization and threes growing. In some period the trees at the outskirts will create a real green palisade. In case of over capacity greywater, they will be released in to the river.

The last, to exchange the old post, the two bamboos bungalows at the left and right side of the AD I plant, attached to the slope, will be the new security posts. Located near the river basin (spot no. 2), these bungalow will have access to the river, thus gives opportunity to create 'good looking' by experiencing planting in greywater tower/pots. This is the point that people can see from the nearest main street in Bogor.

4 CONCLUSION

By giving the in-situ scenario, it is expected the inhabitants' motivation and responsibility to participate in the community livelihood will rise as the inhabitant will receive the good or bad impact directly. The community control is the key factor for successful implementation. Therefore all result will be based on community efforts. In this case the community has to be responsible for what they did individually and communally.

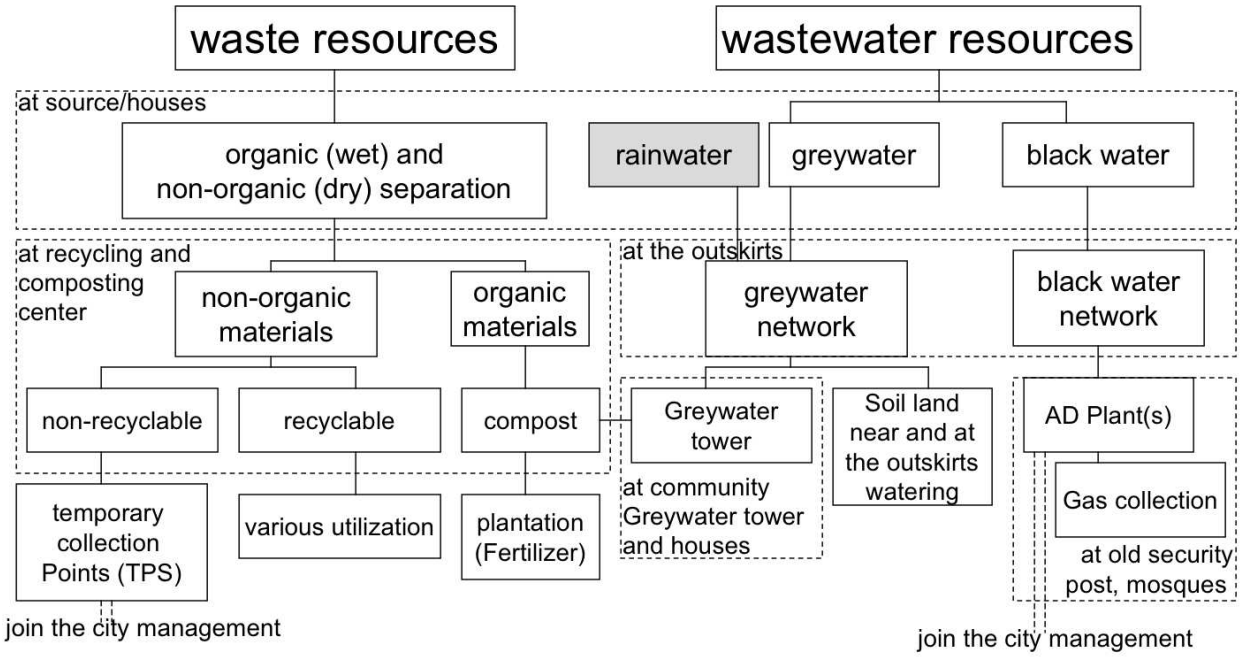

Fig. 5: Scenario Development - Summary

At the optimum implementation, the wastewater scenario improves the soil quality in Pulo Geulis and thus turns the outskirts into the green palisade. Moreover these activities stimulate income generation, and employment. The integration of waste and wastewater scenario contributes to the benefit from vegetables and fruits cultivation, thus it manages the food insecurity. With successful implementation, the network can be developed as a role model and expanded or scale up to the neighborhood societies.

However the concept should begin with public campaign from public authority, influenced or public figure, university/research institute or NGO to the community, and the inhabitants’ commitment in order to deliver the idea and the excellent achievement. It is also necessary to give some training in doing waste separation and built communal/individual greywater tower as a pilot. The municipality also has to commit in finding the funding for construction. The case of initial funding is very sensitive, since it could be the bottle neck and the main question about the sustainability of the implementation. From Surabaya Case, it is found that the local authority and local NGOs play significant role in motoring such activities. Therefore the first role of local government and NGO in Bogor has to convince the society, to built such mutual relationship among them.

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