CARBON ABSORBING VEGETATION AND ENHANCEMENT OF ECOSYSTEM BENEFITS ON RESIDENTIAL ENVIRONMENT

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Abstract

With the increase in population, mainly in urban sprawls, the available vegetation decreases due to land conversion into the residential area. At the same time, the rise in population is proportional to the increase in air pollution, which is characterized by the Greenhouse Gases (GHG) problems. However, naturally, vegetation can absorb greenhouse gas emissions as a component in the photosynthesis process. Increasing space for housing is balanced with spatial regulations for the use of built-up land so that some of the carbon emissions from daily activities are reduced. Based on the research, there is still a difference between carbon absorption and carbon emissions; therefore, increasing the amount of vegetation as a Green Open Space (GOS) needs to be maximized based on the number and type of plants. The air pollution problem is attempted to be done naturally so that the ecosystem will naturally reduce the existing pollutants. The Community Service (CS) stages starting from land preparation, seed preparation, pathway construction, monitoring plantation, can be a solution to answer the problems of city dwellers on a housing scale. The overall implementation of the community services has gone well, such as constructing access pathways, planting trees and flower plants, and using land for public housing facilities into parks. The environment will be safer from wild and dangerous animals to create a better environment.

Keywords: *carbon emission, greenhouse gases, green open space, urban vegetation*

Introduction

Global warming occurs when carbon dioxide (CO_2) and other air pollutants accumulate in the atmosphere and absorb sunlight and solar radiation reflected from the Earth's surface. Typically, this radiation escapes into space, but these pollutants can stay in the atmosphere for years, even centuries, trapping heat and warming the planet (Velayatzadeh & Davazdah Emami, 2019). These heat-storing pollutants come from both natural sources and human activity, specifically carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_x), sulfur oxides (SO_x), water vapor (H_2O), and synthetic fluorinated gases. Those are greenhouse gases (GHG) and cause a greenhouse effect that increases the global temperature (Qiu et al., 2020). This condition is responsible for environmental problems such as increasing seawater temperatures, changing climate patterns, changes in the frequency and intensity of storms, and rising sea levels due to melting polar ice (Mimura, 2013).

Among those heat-storing pollutant gases, the most dominant contributors are CO_2 and CH_4, 83.4% and 8.8% of total GHG emissions. Based

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on GHG emissions inventory data from the Ministry of Energy and Natural Resources energy sector, the total GHG emissions generated in Indonesia in 2015 were 261.89 million tons of CO_2, an increase of 2.43% on average annually. The energy sector is the most significant contributor to greenhouse gas emissions, with 175.62 million tonnes of CO_2 (Sunarti et al., 2020).

Naturally, vegetation can absorb GHG emissions as a component in the photosynthesis process. However, as the population of a region grows, especially in urban areas, land conversion reduces the amount of vegetation available day by day. One of the fastest-growing developments due to population growth is housing estates (Jo & McPherson, 2001). Based on *Undang-Undang Nomor 1 Tahun 2011* concerning Housing and Residential Areas, defines that housing is a collection of houses as part of settlements, both urban and rural, which are equipped with infrastructure, facilities, and public utilities as a result of efforts to fulfill livable houses (Kementerian Lingkungan Hidup, 2012). Based on SNI-03-1733-2004 concerning Procedures for Planning for Urban Housing Environments, the housing density level is divided into 4, i.e., low density (<150 people/ha), medium density (151-200 people/ha), high density (201-400 people/ha) and (very high density>400 people/ha) (Badan Standarisasi Nasional, 2004).

East Pontianak District is one of the sub-districts in Pontianak City, with the highest density of 10,937 inhabitants/km^2 (Badan Pusat Statistik, 2020). It was designed as a residential area, especially Saigon and Parit Mayor Villages, with large-scale and non-large-scale housing designations that increased housing development. The increase in housing development results in increased GHG emissions due to human activities (Ahmad et al., 2012).

Concerns about the greenhouse effect have aroused interest in the potential for urban vegetation to reduce atmospheric CO_2 levels. Urban vegetation reduces cooling energy consumption and carbon emissions by blocking solar radiation, reaching the structure of the building, and creating a cool microclimate near the building by evaporation (Jo & McPherson, 2001). Green Open Space (GOS) is an elongated or grouped area where plants grow naturally and artificially. Based on the *Peraturan Menteri Dalam Negeri No. 1 Tahun 2007* concerning the Arrangement of Green Open Space in Urban Areas, urban GOS is part of the available space of a metropolitan area filled with plants and plants to support ecological, social, cultural, economic, aesthetical, and environmental benefits (Penataan Ruang Terbuka Hijau Kawasan Perkotaan, 2007).

Ecologically, GOS can provide a comfortable area through its canopy, which states that plant leaves absorb sunlight during the day in the assimilation process and converts CO_2 and water into carbohydrates and O_2 (Purwatik et al., 2014). Thus, the determination of the area and the selection of tree species in the creation of green open spaces are very influential in reducing the temperature of the surrounding air.

Based on the *Peraturan Menteri Dalam Negeri No. 1 Tahun 2007* concerning the Arrangement of Green Open Space for Urban Areas, the benefits of green open space are: (1) reflect regional identity; (2) research, education, and counseling facilities; (3) active and passive recreational facilities as well as social interaction; (4) increase the economic value of urban land; (5) foster a sense of pride and increase regional prestige; (6) social activity facilities for children, youth, adults, and seniors; (7) evacuation room facilities for emergencies; and (8) improving the microclimate and increasing oxygen reserves in urban areas.

Through this Community Service (CS) program, we are trying to restore the vegetation on the swampland because it is vital in maintaining a sustainable environmental quality. Planting various woody trees whose trees can reach more than 20 years of age is necessary to increase the amount of vegetation to mitigate climate change. Suitable housing has a private space designated as greenery, while in groups, housing usually facilitates a GOS, which is also used to get together, chat, and play with children. This CS program aims to change the land use from shrub into a green open space park by planting woody trees that can be used as shade and even food sources. The implementation of CS activities will directly benefit environmental sustainability. It will also creates a suitable microclimate, improve the hydrological cycle, and improve soil quality. It will provide more value to aesthetics and safety on a residential scale because wild animals will not nest on manicured land.

Research Methodology

Diverse vegetations are considered on fineness, usefulness, and safety. The 20 trees of fruits are planted in the open area with a height of 1-2 meters. The pathway was made from 50 cm width and stacking type concrete. The planting method is done by raising the soil to form a mound to make the plants not submerged in water. After implementation, these CS activities will be monitored for up to one month to ensure that the trees are successfully adapted to new environmental conditions.

Community Services Location

This CS was conducted in the Star Borneo 7 Residents, SSV 03/RW 23, Saigon Village, East Pontianak District, Pontianak City, West Borneo, 78242.

Figure 1. Star Borneo 7 Residence in Saigon District Map

Land Preparation

The land is overgrown with wild taro (*Colocasia esculenta* L. Schott.), grass, and water spinach (*Ipomoea aquatica* Forssk.). This type of plant is rather difficult to clean up to the roots, so it is necessary to apply herbicides and cut off the remains of the plants. Since the process requires expertise, a gardener carried out this step. After the land has been cleared, the ground is leveled to lay concrete in the pathway construction area, while some part of the land is made into mounds for tree planting areas.

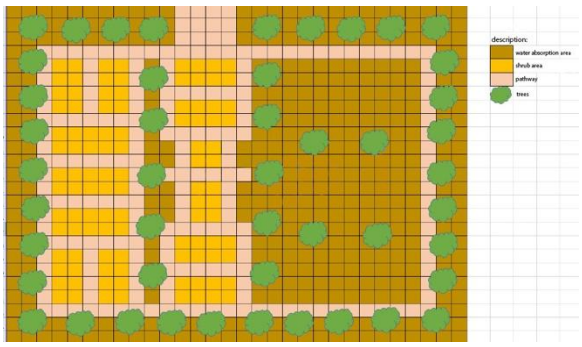

Figure 2. Design of reforestation activities in Star Borneo 7 Residence in Saigon District.

Seed Preparation

Plant seeds were obtained from several sources, either from independent purchases from plant shops, the community, or the Forestry Service. Tree seeds that are old enough are used to increase the success of the planting. This process will be carried out by students who participate in this activity.

Pathway and Planting Area Making

Pedestrian pathways and planting areas were made from medium width and thickness paving. Planting areas were created by arranging bricks into a square with a planting area of 1.5 x 3.5 m**.** Since the process requires expertise, a builder carried out this step.

Seed Planting

After the previous stage was completed, the local community and students carried out tree planting jointly. The tree planting is carried out following the Covid-19 health protocol.

Monitoring

Monitoring is carried out by the housing community and the CS team by monitoring weed growth rates and plant growth rates. If there are weeds, then cleaning is done directly or with the help of herbicides. If there are dead seeds, they will be replaced.

Results and Discussion

The development of the urban environment causes rapid population growth in line with increased consumption. This condition causes an increase in the amount of waste and air pollution, such as carbon, sulfur, and nitrogen compounds. Naturally, air pollutants can be absorbed through biogeochemical processes and cellular respiration of organisms in the ecosystem. This environmental problem can be done by increasing the existing vegetation around the environment.

Amid the Covid-19 pandemic, the implementation of CS at various universities was a bit constrained because of the tendency for CS to interact with the community in associations continually. Therefore, tree planting activities in this residential area are one way so that CS activities can still be carried out with a small group of people. Symptoms of climate change and increasing use of vacant land into housing in residential areas are reasons for carrying out this activity so that university academics can play an active role in creating a conducive micro-climate on a housing scale.

Before the activity was carried out, the land for public facilities had been left alone and filled with taro plants. This circumstance can create a sense of insecurity for the residential environment because it can become a nesting place for snakes to endanger children who often play around.

Therefore, land clearing needs to be done by cutting the taro plant by a small community and assisted by gardeners. It takes about 2-3 days, followed by implementing other work. The condition of the land is as follows.

Figure 2. Condition of the land before cleaning.

Figure 3. Condition of the land after cleaning.

This CS activity focuses on gardening, tree planting, and ornamental planting. Since the planting area is a wetland, the condition is quite

challenging to access. Therefore, the first thing to do is make easy access to the planting area for the long term by creating pathways. The materials used in constructing the pathway are cement and sand, without stones, because the pathway is intended for pedestrians.

Before the pathway construction is built, the muddy and submerged land is filled with sand or sawdust waste. Soil compaction is carried out to minimize soil pores to withstand the load of the concrete. Backfilling with sand is only carried out on the pathway so that the absorption of the soil is maintained. The community does not carry out this activity because it takes about 2-3 days to implement. The high rainfall intensity of Pontianak caused this CS activity to take a long time to process, until more than three weeks. The description of soil compaction conditions can be seen in the following figure.

Figure 4. The sawdust dust that the residents had prepared one month in advance.

Figure 5. Soil compaction as pathway foundation with sawdust and sand.

Longitudinal pathway construction is carried out according to the plan. Still, due to a lack of funds, the construction of these pathways is not perfect, so that pathway improvements will be carried out independently by the residential community next year. By considering cost efficiency and effectiveness, the pathway made is slightly different from the planning picture, as long as the access pathways are connected. The design is made by limiting the movement of water flow to maintain water storage in the swamp. The pathway can facilitate the reach of planting points and inhibit the growth of wild taro. Open land can accelerate the process of soil maturation to improve soil fertility.

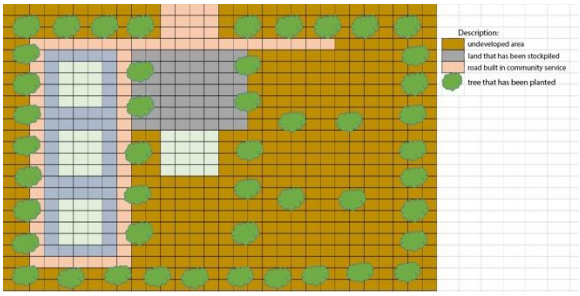

Figure 6. Implementation of reforestation activities in Star Borneo 7 Residence in Saigon district.

In the planning design that has been made, the pathway is designed to be quite long. Still, besides reducing the water absorption area, it takes more sand and soil to compact the land since the site is a swampland that tends to be wet, so extra costs and energy will be required. So, the road design is made shorter than the initial plan design.

(a)

(b)

(c)

(d)

Figure 6. The results of the pathway construction work. (a) results in the first and second days. (b) developments in the third and fourth days. (c) developments in the fifth and sixth days. (d) products on the seventh and eighth days.

Then around the pathway, planting areas are made of bricks arranged in a rectangle with a size of 1.5×3.5 m as a place to plant ornamental and consumption plants, such as kale and mustard greens. In addition to beautifying, tidying, and adjusting the spacing, this planting area is needed to overcome crop failure in swampland. The planting area is made with a height of 15-20 cm to prevent the planting area from puddling so that the plants will continue to grow well.

Figure 7. Long-arranged planting area.

After completing the pathway and planting area, the next activity is planting trees and ornamental plants. Trees planting is carried out by the local community independently assisted by students. Planting begins with cleaning the remains of old plants that have withered and replacing them with new plant seeds.

After planting, monitoring is carried out regularly for the next 30 days to see the development of plant growth and ensure the pathways and planting areas that have been built are functioning properly.

Figure 8. Various trees and flowers were planted in the residence area.

Conclusions

Based on tree planting and reforestation activities carried out in Star Borneo 7 Residents, SSV 03/RW 23, Saigon Village, East Pontianak District, Pontianak City, West Borneo, the conclusions of the activities that have been carried out are as follows:

1. Land preparation and clearing by slashing various wild plants to plant trees so that the land is ready to be produced.
2. Seed preparation by sorting the seeds that are ready for planting.
3. Arrange concrete stones so that they can be pathways for pedestrians.
4. Students and the local housing community carried out seed planting.
5. Monitoring was carried out for 30 days after planting to evaluate the results of planting and pathway construction.

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