

Enhancing the open space of Jabodetabek area, Indonesia

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Abstract. Jabodetabek area is planned to be developed as a sustainable development region. The Government of Indonesia (GoI) committed in Paris Conference that the target of GHG emissions would be reduced by 29% up to 2030 with her own efforts and by 41% with supported by international assistance. This research attempts to apply specific methods such as stratified planting method to improve the quality of green open space by increasing the absorbed carbon level. The study showed that with the planting vegetation of stratified model, the total capacity of the mainland to absorb CO₂ gas is quite significant increase with approximately 20% compared to that of homogeneous vegetation. The stratified planting model is worthwhile to achieve the commitment of the GoI mentioned above.

Keywords: CO₂, land absorption, open space

1. Introduction

Indonesia is designated National Spatial Plan (RTRWN) through Government Regulation No. 26 year 2008. One of them is the Jakarta Metropolitan Area (JMA), known as Jabodetabek as a National Strategic Area or Kawasan Strategik Nasional (KSN). The development of KSN Jabodetabek influences widespread of the built-up areas as a place of economic activity. The expansion of the built-up areas may impact on decreasing the carrying capacity of the environment, as for limited ability the land area to absorb CO₂. Such a condition would result in the increase of emissions of greenhouse gasses (GHG). GHG emissions have been related closely to climate change. Carbon dioxide (CO₂) emissions from land-use change and deforestation account for about 13% of total anthropogenic CO₂ emissions [1]. Such issue would lead to the disaster in all aspects of life, ranging from the physical, social to economic aspects. To mitigate the impact of climate change, one would argue that emissions reduction is one of the priorities for the world's target. One approach to achieving the national GHG emissions reduction targets needs a specific policy related to land-based fields, i.e. a direct regulation of land use restrictions, known as a Spatial Planning Policy. *Conference of the Parties (COP) 21/Conferences of the Parties serving as meeting of parties to the Kyoto Protocol (CMP) 11 United Nations Framework Convention on Climate Change (UNFCCC)* in Paris, the Government of Indonesian (GoI) committed to reduce GHG emissions by 29% up to 2030 with her own efforts and by 41% with support of international assistance [2]. In the last few decades, Indonesia was a frontrunner in deforestation [3]. Based on such a commitment, this study attempts to apply specific methods to improve the quality of green open space to reach the sustainable development of the Jakarta Metropolitan Area. Some researchers have examined the relationship between different types of land cover and CO₂ gas absorption, among others land-use change and CO₂ emissions in Indonesia by 2020 [4], the potential of agroforestry to reduce atmospheric CO₂ concentrations [5]. Previous research similarly focused on land use absorption emission. But, they did not utilize stratified vegetation planting method in calculating total gas absorption. Considering



variety of various vegetation in terms of CO₂ capacity absorption, this paper argues to apply such methodology. Jabodetabek area is located on the island of Java, Indonesia, covering three provinces, Banten, Jakarta and West Java. Located between 106°19'BT-107°30' BT and 5°18'LS-6°48' LS. The range of height for JMA is 0-700 meters above sea level. The region chosen is based on the consideration that the JMA is the largest metropolitan area in Indonesia, Southeast Asia, and the second-largest in the world after Keihin metropolitan areas in Japan consisting of Tokyo, Kawasaki, and Yokohama. The total population of Jabodetabek is 26,746 million people in the year 2013, compared to that of Tokyo-Yokohama which is estimated to 37,239 million people [6].

2. Research Method

According to [7], one of the best approaches to mitigate the land-based National Action Plan for GHG RAN-GRK field is using the prospective method. This method combines the information of trends land's changes in the past and the anticipation of future behavior regarding the land use changes to predict the rate of change and location. In addition, one of the efforts to reduce GHG emissions is induced by the management of land resources, namely the maintenance of carbon stocks (carbon stock) and GHG. The level of CO₂ gas absorption is inversely proportional to the level of GHG emission reduction. In other words, if the rate of absorption of CO₂ gas decreases, the level of GHG emissions will be increased. By using the above approach, previous studies carried out of [8]. This research attempts to discover methods of improving the quality of open spaces in order to increase the stock of carbon in an effort to realize the sustainable development of the Greater Jakarta area. Analysis using Regulation of the Minister of Public Works on guidelines for the provision and utilization of open space in urban areas [9]. The data used in this study are mostly secondary data and cross-section (Table 1).

Table 1. Data needs.

Aspects	Type of Data	Data Forms
Physical	Size of Green Open Space Land Use Prediction in 2020	Secondary
	Topographic	Secondary
Other	Related Policies	Secondary
Supporting Aspects	GHG reduction target	Secondary
	The relationship between vegetated land cover and the ability to absorb CO ₂	Secondary

Source of data is obtained from various institutions. Additionally, direct field observation was conducted to see the justification for the existing secondary data. Furthermore, based on the above approach, the method of data analysis includes:

1. Identification of the area of open space based on the slope in each region in the JMA. Slope classification based on criteria and procedure for determination the forest protection, forest conservation, and forest production. Identification conducted by using Geographic Information System (GIS) (overlay between land use map open space and slope).
2. Prediction distribution of open space in 2020. Prediction is conducted by using a linear projection formula approach and the assumption that there is land's conversion of open space into a built area on a slope of 0-15%. The basic consideration of using linear projection method is due to the pattern of development of land use 5 years previously in the form of a straight line
3. Identify the composition of the plants will be planted with planting vegetation method in open space. Type of plant vegetation on an open space consists of trees, shrubs, and agricultures
4. Estimation of the mainland's ability to absorb CO₂ Gas, calculations are made by applying the model relationship between the type of vegetation and land to cover CO₂ absorption [10] (see Table 2).

Table 2. The relationship between different types of Land Cover and CO₂ Gas Absorption [6].

Types of Land Cover	CO ₂ Gas Absorption (kg/ha/hour)	CO ₂ Gas Absorption (ton/ha/year)
Tree	129,92	569,07
Bush	12,56	55,00
Prairie/grass	2,74	12,00
Agricultural land	2,74	12,00

2.1. Descriptive Analysis

The objective of this part is to formulate and interpret the existing phenomena. Components of analysis are processed to cover a theoretical study, empirical results, the standard technical criteria and related policies. One of the relevant policies is the Regulation of the Minister of Public Works on guidelines for the provision and utilization of green open space in urban areas [9].

3. Results and Discussion

This discussion consisted of (i) the prediction of area of green open space land use in 2020 according to class slope, and (ii) the calculation of predictive capability of mainland land Jabodetabek absorb CO₂ in 2020.

3.1. Prediction of the Size of Open Space Areas in 2020 according to the Class Slope

Prediction of open space areas will be focused on the land use for forests, agricultural areas, and parks.

3.2. Prediction Forest Areas in Jabodetabek in 2020.

Expansion of the built-up areas has consequences on the decrease of open space areas. In general, lands that are in the slope of 0-15% are lands that are vulnerable to land conversion. Based on these assumptions, the estimation of the size of forest green space areas is as follows:

Table 3. Prediction of size of forest areas in 2020 (Ha).

Region	Area based on Slope (Ha)					Total
	0- 8%	8-15%	15-25%	25-40 %	>40 %	
Bekasi Regency	0	0	0	0	0	0
Depok City	0	0	0	0	0	0
Jakarta City	0	0	0	0	0	0
Bekasi City	0	0	0	0	0	0
Bogor Regency	0	11,974.70	36,848.03	21,195.34	15,693.13	85,711.21
Bogor City	87.00	0	0	0	0	87.00
Tangerang Regency	0	0	0	0	0	0
Tangerang City	0	0	0	0	0	0
Tangsel City	0	0	0	0	0	0
Total	87.00	11,974.70	36,848.03	21,195.34	15,693.13	85,798.21

Sources: Calculated Result, Authors, 2016

Table 3 shows that in 2020, predicted use of forest land mostly in Bogor Regency. Nearly 90% of the forest area located in Bogor Regency

3.3. Prediction Agricultural Areas in 2020

Agricultural land is the land use type that is sensitive to be developed into a built-up area. Considering topography, the land area located within the slope of 0-15% is vulnerable for conversion. Based on such assumptions, the prediction area of agricultural land locations spread in any class of slope (Table 4).

Table 4. Predicted size of agricultural areas in 2020 (Ha).

Region	Area based on Slope (Ha)					Total
	0- 8%	8-15%	15-25%	25-40 %	>40 %	
Bekasi Regency	0	152.09	0	0	0	152.09
Depok City	795.30	0	0	0	0	795.30
Jakarta City	0	0	0	0	0	0
Bekasi City	1,008.56	0	0	0	0	1,008.56
Bogor Regency	66,607.43	31,639.47	18,735.38	5,146.20	8,336.41	130,464.89
Bogor City	1,647.22	1,642.58	162.36	0	0	3,452.15
Tangerang Regency	0	136.87	0	0	0	136.87
Tangerang City	617.32	0	0	0	0	617.32
Bekasi Regency	2,963.84	0	0	0	0	2,963.84
Total	73,639.67	33,571.01	18,897.74	5,146.20	8,336.41	139,591.02

Sources: Calculated Result, Authors, 2016

3.4. Prediction Park Area in 2020

Estimation size of park areas in 2020 is 1,178.99 Ha. The locations are spread throughout the region of Jabodetabek and located on the slope of 0-8%.

3.5. Calculation of Carbon Absorbed in 2020

Stratified planting vegetation is one of the methods to improve the quality of green open space. Stratified vegetation is a type of vegetation by planting not only trees and grasses but also shrubs.

3.6. Park Area Capacity in Absorbing CO₂ Gas with Planting Stratified Vegetation

The estimated Park area in 2020 is 1,178.99 Ha (Table 5). The ability of the parks area to absorb CO₂ Gas with stratified planting vegetation, consisting of 50% trees, 30% shrubs, and 20% grasses, is as follows:

Table 5. Park capacity in absorbing CO₂ gas with planting stratified vegetation.

Type of Vegetation	CO ₂ Gas Absorption (ton/ha/year)	Area (Ha)	Total CO ₂ Gas Absorption (ton/ year)
Tree 50%	569.07	589.50	335,463.92
Bush 30%	55.00	353.70	19,453.34
Grass 20%	12.00	235.80	2,829.58
Total		1,178.99	357,746.83

Sources: Calculated Result, Authors, 2016

Table 5 shows that the amount of carbon absorbed in park areas with the stratified planting vegetation method, with 50% trees, 30% shrubs and 20% grass, reaches up to approximately 357,746.83 tons/year. Compared with the ability to absorb CO₂ gas without planting vegetation method, there is an increase in the capability in absorbing CO₂ gas of 25 times.

3.7. Agricultural Area Capacity in Absorbing CO₂ Gas with Planting Stratified Vegetation

The estimation of the amount of agricultural area spread in 2020 reaches up to 139,591.02 Ha. The ability of the agricultural land use to absorb CO₂ Gas with stratified planting vegetation, consists of 20% trees, 30% shrubs and 50% agricultural land is as follows:

Table 6. Agricultural capacity in absorbing CO₂ Gas with planting stratified vegetation.

Type of Vegetation	CO ₂ Gas Absorption (ton/ha/year)	Area (Ha)	Total CO ₂ Gas Absorption (ton/year)
Trees (20%)	539.07	27,918.20	15,049,866.23
Bush (30%)	55.00	41,877.31	2,303,251.83
Grass	12.00	-	-
Agricultural-land (50%)	12.00	69,795.51	837,546.12
Total		139,591.02	18,190,664.18

Sources: Calculated Result, Authors, 2016

Table 6 shows that planting with the stratified vegetation, consists of 20% trees, 30% shrubs, and 50% paddy fields on agricultural land use, the rate of CO₂ gas absorption reaches up to 18,190,664.18 ton/year. Compared with the ability to absorb CO₂ gas without stratified vegetation planting (1,675,092.20 tons/year), there is an increase in ability to absorb CO₂ gas is about 10%.

3.8. Forest Area Capacity in Absorbing CO₂ Gas with Planting Stratified Vegetation

In detail, with consideration to the canopy width and spacing of trees, the maximum total of trees that can be planted on forest land is approximately 90%. By estimating the size of the forest areas in 2020 will reach up to 85,798.21 Ha. With the composition of trees and bushes of 90% to 10%, the ability of the land area to absorb CO₂ as follows (Table 7).

Table 7. Forest capacity in absorbing CO₂ Gas with planting stratified vegetation.

Type of Vegetation	CO ₂ Gas Absorption (ton/ha/year)	Area (Ha)	Total CO ₂ Gas Absorption (ton/ year)
Trees 90%	539.07	77,218.39	41,626,117.50
Bush10%	55.00	8,579.82	471,890.16
Grass	12.00		-
Agricultural land	12.00		
Total		85,798.21	42,098,007.65

Sources: Calculated Result, Authors, 2016

Table 8. Capability to absorb CO₂ between Homogeneous and Stratified Vegetation.

Green Open Space	The Ability to Absorb CO ₂ Gas (Ton/Year)	
	Homogeneous Vegetation	Stratified Vegetation
Parks	14,147.82	357,746.83
Agricultural Land	1,675,092.20	18,190,664.18
Forests	48,825,187.36	42,098,007.65
Total	50,514,427.38	60,646,418.66

Sources: Calculated Result, Authors, 2016

Table 8 shows that with the stratified planting vegetation which consists of 90% trees and 10% shrubs in agricultural land use, the rate of CO₂ gas absorption is 42,098,007.65 ton/year. Compared with the ability to absorb CO₂ gas without stratified planting vegetation (48,825,187.36 tons/year), there is a decrease in ability to absorb CO₂ gas for about 14%. Based on the review above, with the stratified

planting vegetation, the total ability of the mainland to absorb CO₂ gas is 60,646,418.66 tons/year. The amount is increased by approximately 20% compared to the ability of the land to absorb CO₂ gas regions with homogeneous vegetation (Table 8). An increase that happens is not in accordance with the expected increase to comply the commitments the Government of Indonesia in the G-20 meeting in Pittsburgh. However, when the increase is accumulated with the amount of CO₂ gas absorption of CO₂ gas that comes from the yard of the house, green belt, roads railways green open space, etc., the capability of CO₂ absorption.

4. Conclusion

The study results showed that with the stratified planting vegetation method, there is an increase in the rate of CO₂ gas absorption by about 20%. Unfortunately, such improvements are still not enough to meet the commitment of the GoI to increase the absorption of CO₂ gas by 29% in 2030. However, when accumulated with the rate of CO₂ gas absorption that comes from the yard of the house, green belt, roads, and railways green space, and etc., the ability to absorb CO₂ gas is expected to achieve the commitment of the GoI mentioned above. Based on this research, we may conclude that stratified planting vegetation is the most suitable planting method for lands with the height of 0-700 m above sea level.

Acknowledgment

This research was supported by Ministry of Research, Technology and Higher Education of the Republic of Indonesia through the mechanism of research grants namely “Hibah Bersaing”. We gratefully acknowledge the support and generosity of Ministry of Research, Technology and Higher Education of the Republic of Indonesia mentioned above.

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